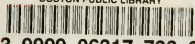


BOSTON PUBLIC LIBRARY



3 9999 06317 733 9

TUFTS UNIVERSITY LIBRARY
DOCUMENT COLLECTION
D-258

**A Study of the
SPOTTED TINAMOUS
and the
PALE SPOTTED TINAMOUS
of Argentina**



SUPERINTENDENT OF DOCUMENTS
DEPOSITORY

MAY 1902

BOSTON PUBLIC LIBRARY
GOVERNMENT DOCUMENTS DEPT

**UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Special Scientific Report--Wildlife No. 120**

UNITED STATES DEPARTMENT OF THE INTERIOR, WALTER J. HICKEL, *SECRETARY*
Leslie L. Glasgow, *Assistant Secretary for*
Fish and Wildlife, Parks, and Marine Resources
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife, John S. Gottschalk, *Director*



As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of this department of natural resources.

The Department works to assure the wisest choice in managing all our resources so that each shall make its full contribution to a better United States now and in the future.

On the cover

Spotted tinamou.

**A Study of the
SPOTTED TINAMOUS
and the
PALE SPOTTED TINAMOUS
of Argentina**

by

GARDINER BUMP and JANET W. BUMP
Division of Wildlife Research
Bureau of Sport Fisheries and Wildlife



Special Scientific Report--Wildlife No. 120

Washington, D. C. • April 1969

THE FOREIGN GAME INVESTIGATION PROGRAM

Year by year the number of individuals seeking relaxation through hunting is increasing. Yet the area available for this sport is slowly decreasing. Likewise, much of the habitat which mothers the game crop impact of clean farming, over-grazing, drainage, power equipment, increased use of insecticides and herbicides, scientific forestry, urbanization, and declining soil fertility.

Faced with this situation, common sense dictates an all-out effort to increase habitat productivity. There are many habitats which have been so thoroughly changed by man that native species can no longer maintain themselves therein in numbers sufficient to provide good hunting. Competing interests and the cost of reversing this trend are such that only a part of these lands can be restored to reasonable productivity in the foreseeable future. There are other coverts which never were fully occupied by native game birds or mammals possessing the characteristics requisite to survival in the face of today's intensive hunting pressure. For these, new, adaptable species possessing a high hunting resistance should be sought, so that such areas might provide greater hunting opportunities. This is the logic behind the foreign game introduction program as developed cooperatively by the U. S. Fish and Wildlife Service, cooperating State Fish and Game Commissions, and the Wildlife Management Institute.

The program is based on requests for assistance from State Fish and Game Commissions following an ecological appraisal of their game deficient habitats. After such information is in hand, biologists are assigned to make a careful study of game species occupying similar habitats and climates in foreign countries. From dozens considered, one or two may be selected on the basis of their characteristics, habits, reproductive capacity, resistance to predation and disease, relation to agriculture, ability to withstand heavy hunting pressure, and the possibility of competition with game species native to the United States. Modest, carefully planned trial introductions of these species, utilizing wild-trapped or farm-raised individuals, carefully quarantined before shipment are then carried out in cooperation with interested State Fish and Game Commissions. Unplanned or "hit and miss" introductions are actively discouraged.

CONTENTS

The foreign game investigation program	ii
Foreword	vii
Abstract	x
Tinamous in general	1
Tinamous of Argentina and Chile	1
The spotted tinamou group, genus <u>Nothura</u>	2
Distribution	2
Taxonomy	2
Introductions	3

	<u>Part One</u>	<u>Part Two</u>	
	<u>Spotted tinamous</u>	<u>Pale spotted tinamous</u>	
		Darwin's	Salvador's
The spotted tinamous, <u>Nothura maculosa</u>	4		
The pale spotted tinamous, <u>Nothura darwini</u>		87	89
Common names	4	90	90
Distribution and abundance	6	90	90
Range in Argentina	6	90	90
Abundance in Argentina	7	92	92
Description	9	93	
Field identification	9	93	
Subspecies	9	94	94
Description of the pampas spotted tinamou (<u>N.m. annectens</u>)	10		
Description of the pale spotted tinamous		94	98
Coloration	10	94	98
Measurements			
Wings	11	95	98
Spotting of the 9th and 10th primaries	11	94	
Pattern of neck and breast feathers	11	94	
Tarsi	11	95	
Toes	12	95	
Size and weight	12	95	98
Development	12	95	98
Weight at hatching	12	95	
Weight by weeks	12	95	
Egg tooth	13	96	
Bursa of Fabricius	13		
Feather development and moult	14	96	
Natal	15		
Juvenal	15		
Adult	16		

	<u>Spotted tinamous</u>	<u>Pale spotted tinamous</u>	
		Darwin's	Salvador's
Color of the eyes	16	96	99
Reproductive organs	18	96	
Sex identification	18	96	
Birds of the year	18		
Adults	19		
Age ratio	20		
Habitat	22	99	99
Habitat by subspecies	22	99	99
Pampas	25	99	
Savannahs		100	100
Western brushlands		101	101
Cover preferences	26	101	105
Use according to cover composition	26	101	105
Effect of weather on cover use	33		
Topography and elevation	33	105	106
Soils	33	106	106
Climate	35	106	106
Throughout the range	35	106	106
Climatic comparisons between Argentina and the United States	38	108	108
Food and water	41	111	111
Summary	41	111	115
Food by seasons	42	112	116
Spring	42		117
Summer	43	112	
Fall	43	113	117
Winter	43	113	117
Economic importance	43		
Protein intake	43		
Other items of interest	44	115	117
Water	44	115	117
General habits and behavior	49	119	119
Movement and mobility	49	119	119
Flight	49	119	119
Wariness	50	119	119
Dusting and bathing	51	120	120
Resting and roosting	51	120	120
Breeding	52	120	120
Period	52	120	121
Breeding age	54	121	
Effect of interzonal hemi- spheric transfer	54		
Behavior during the breeding season	54		

	<u>Spotted tinamous</u>	<u>Pale spotted tinamous</u>	Darwin's Salvador's
Mating behavior	55	121	
Promiscuity and homosexuality	56	121	
Time and frequency of mating	56	122	
Nesting and renesting	56	122	122
Period	57	122	
Location	57	122	
Types of cover preferred	57	123	123
Height and density	59	124	
Edge effect	59	124	
Construction and character of nest	59	124	
Reaction of male to the dis- covery of the nest	60	124	
Abandonment of the nest	60	124	
Renesiting	60	124	124
Eggs and egg laying	61	124	
Size, shape, weight and color	61	124	
Laying habits	61	127	
Egg movement	61	127	
Clutch size	61	127	
Time of laying	61	127	
Interval and duration of laying	62	128	
Fertility	63	128	
Incubation and hatching	63	128	
Brooding and rearing	64	128	
Gregariousness	64	128	
Temperament	65	129	129
Calling	65	129	
Signal	65		
Emotional	66		
Territorial	66		
Periodicity	66		
Time of day	66		
Seasonal variation	67		
Influence of weather	67		
Effect of sex	67		
Audibility	67		
Responsive calling	67		
Interbreeding	67	130	
Predation	68	130	
Summary of reproductive capacity	68	131	131
Diseases and parasites	69	131	131
Diseases	70	131	131
Protozoan	70		
Bacterial or virus	71		

	<u>Spotted</u> <u>tinamous</u>	<u>Pale spotted</u> <u>tinamous</u>	
		Darwin's	Salvador's
Internal parasites	72	131	131
Parasites of the crop . . .	72		
Parasites of the proventri- culus and gizzard	72	132	132
Parasites of the small intestine	72	132	132
Parasites of the liver . .	73	132	132
Parasites of the cecum . .	73	132	132
Parasites of the body cavity	73	133	133
External parasites	74	133	133
Parasites among birds raised in captivity	74	133	
Analysis of competing interest . . .	76	136	136
Relation to agriculture	76	136	136
Usefulness	76	136	136
As a game bird	76	136	136
As a source of income and food	77	136	136
As a fighting bird or a pet	78	136	136
Relation to other game birds . .	78	136	136
Breeding and rearing	79	137	137
Research program	79		
Recommendations	80		
Trapping and marking	86	138	138
Trapping	86		
Marking	87		
References	139	139	139
Appendix	143	143	143

FOREWORD

Under the pressure of modern agricultural practices, grasslands are increasing in area particularly in the southern United States. They are predominant in the Southwest. With more intensive management and use, many of these grasslands are becoming much less attractive to native game birds. In some areas, particularly in the South, there are no native species that find their optimum habitat requirements adequately met where grasslands are well grazed.

In search of foreign game birds particularly adaptable to such habitat types, biologists of the Bureau's Foreign Game Investigation Program spent almost 3 years in a substantial study of tinamous, a group of birds well adapted to the pampas, savannahs, and grassy brushlands of Argentina. This report presents the results in sufficient detail to provide a substantial basis for determining whether or not trial introductions into the United States of one or more of these species, might be justified.

The current report refers mainly to three subspecies of the spotted tinamous of the genus Nothura. These are the pampas spotted tinamou, Nothura maculosa annexans, Darwin's pale spotted tinamou, Nothura darwini darwini, and Salvador's pale spotted tinamou, Nothura darwini salvadorii. Other subspecies are considered mainly in relation to their distribution and habitat.

Excluding taxonomy and distribution, the only fairly detailed report on tinamous in Argentina is the Monografia de las Tinamiformes Argentinas published in 1936 by Dr. Jose Liebermann and long out of print.

Our study was a cooperative undertaking. The authors concentrated mainly on spotted and Darwin's tinamous. Most of the field data on Salvador's tinamous were gathered by our associate Wayne H. Bohl, who also provided many of the illustrations for this subspecies. Janet Bump reviewed the literature, handled the hatching of eggs and the rearing of the chicks, participated in much field work and studied the diseases and parasites of the subspecies under consideration. The identification of parasites, including several as yet undescribed, was made by Drs. Katherine Prestwood and Elon Byrd of the University of Georgia. Miss Florinda E. Ibarra, Chief of the Federal Division of Seed Analysis in Argentina, considerably identified the seeds consumed by spotted tinamous. Insect identifications were completed by Drs. Ricardo N. Orfila, Jose Liebermann, Alejandro A. Ogloblin, and Adolfo Vetrano of Instituto Nacional de Tecnologia Agropecuaria. Dr. G. Covas, Director of I.N.T.A. in the Province of La Pampa was most helpful in identifying foods eaten by Darwin's tinamous as was Dr. Ruiz Leal, University de Cuyo, Mendoza, for seeds consumed by Salvador's tinamous.

Cooperation, without which the Program would have been much the poorer, was extended by many local residents including Mrs. R.S. Blaise,

Mrs. Jacob Rothmeyer, Mr. Peter Miles, Mr. George Belcher, Mr. Richard Graves, Mr. Pedro de Lafuente, and by the operators of the King Ranches in Argentina.

Particular credit is due to Dr. Juan Carlos Godoy, Director of the Office of Hunting and Conservation of the Fauna for the Republic of Argentina, Dr. Claes C. Olrog, Professor of Ornithology, Instituto Miguel Lillo, University of Tucuman, and Roberto Ciaffone, Chief Game Warden, Province of La Pampa, for wholehearted cooperation and encouragement throughout the study period. Had it not been for the unfailing interest and keen eyes of our Argentine assistant, Mr. Maurice Rumboll, many observations in the field might have escaped our notice.

The unfailing support of these and many others made this report possible.

Gardiner Bump

"We saw everywhere great numbers of partridges Nothura major (now N. annectens). These birds do not go in coveys, nor do they conceal themselves like the English kind. It appears a very silly bird. A man on horseback, by riding round and round in a circle, or rather a spire so as to approach closer each time, may knock on the head as many as he pleases. The more common method is to catch them with a running noose, or little lasso, made of the stem of an ostrich's feather, fastened to the end of a long stick. A boy on a quite old horse will frequently thus catch thirty or forty in a day..."

From "The Voyage of the Beagle" by Charles Darwin.

The spotted tinamous are "a very satisfactory game bird that might thrive if introduced into the more temperate portions of the United States."

From "Observations on the Birds of Argentina, Paraguay, Uruguay, and Chile" by Alexander Wetmore.

ABSTRACT

Tinamous are the principal upland game birds of South America. The spotted tinamou group Nothura is the most widely distributed and abundant of the tinamous resident in Argentina. It inhabits short grasslands, often rather intensively grazed and utilized but is not dependent upon adjacent cultivation. Various species appear to be climatically adaptable to the southern and southwestern United States. This study presents in detail the characteristics, habitat and climatic requirements, life history, and propagation of the several species and subspecies of spotted and pale spotted tinamous as a means of evaluating the desirability of and potential for a successful trial introduction into the United States.

TINAMOUS IN GENERAL

Tinamous are nonmigratory Neotropical birds found from southern Mexico to Patagonia. The body is compact; tail very short and often hidden by down-drooping of the upper tail coverts; the bill slender, often elongated and slightly curved downwards, and the wings short and rounded. In some species the hallux or hind toe is elevated or lacking. Tinamous range in size from forms smaller than a bobwhite quail to others somewhat larger than a domestic chicken. Most kinds are relatively inconspicuous with gray, brown or cinnamon plumage accented with soft bars, stripes or spots. The sexes are alike in color and other external characters though often with a small weight differential in favor of the female. Habitats vary from open grasslands through brush to forest where the climate is tropical to lower temperate and precipitation ranges from less than 6 to over 80 inches annually. Swampy areas are not favored.

Much remains to be learned about the physical and behavioral characteristics of tinamous. Though they are the principal upland game birds of Central and South America, they are certainly much more closely related to ratite birds such as the possibly primitive rheas, than to partridges, quail or grouse. In fact, based on their palaeognathous palate, cranial structure, bill covering or rhamphotheca, and other characteristics, many taxonomists believe that both ratites and tinamous are monophyletic in origin (Brock 1963, Parks and Clark 1966). Yet many tinamous fly well, for their breastbone is strongly keeled. Their heart is very small in comparison with body size, and this may account for their rapid but often not long-sustained flight. As with most ratites, the male tinamou makes a simple, well-concealed nest on the ground, and incubates the eggs, often being forcibly encouraged by the more aggressive female. Incubation periods are short varying from 16 to 21 days depending upon the size of the species. The eggs are surprisingly large, often attractively colored wine, brown, green, blue or purple, with a hard, porcelainlike though relatively thin shell. The chicks are precocial with some youngsters taking to wing at about 10 days of age. The brood often scatters shortly thereafter. In Argentina second and even third nests are common.

In the most recent classification of the Tinamidae by Hellmayr and Conover (1942), 9 genera, 43 species, and 105 forms (species and subspecies) were recognized. Subsequently some revision of species and subspecies has been suggested. Further taxonomic study of the entire family is indicated.

TINAMOUS OF ARGENTINA AND CHILE

Considerable attention has been given recently to the tinamous resident in Argentina and Chile. Revisions of the genera Nothura (spotted tinamou) and Eudromia (elegant or crested tinamou) were published by Conover in 1950. Nine years later, Olrog (1959) of

the Instituto Miguel Lillo, Tucuman, Argentina, suggested a revision of the latter genus and recognized a new subspecies of Nothura and of Nothoprocta (brushland tinamous). In his "Lista y Distribucion de las Aves Argentinas" published in 1963, 7 genera, 15 species, and 29 subspecies were recognized. From Chile, 3 genera and 6 species were recorded by Johnson (1965).

This report is concerned with the spotted and pale spotted tinamous of the genus Nothura. Other genera will be covered in subsequent reports. A list of the species and distribution of tinamous in Argentina and Chile is given in the appendix.

THE SPOTTED TINAMOU GROUP, GENUS NOTHURA

Distribution

The spotted tinamous are widely distributed over South America. The genus Nothura to which the spotted tinamous of Argentina belong is generally divided into 4 species and 12 subspecies. Two of the species are found only in Brazil. The white-bellied tinamou, Nothura boraquira, is resident in northeastern Brazil south to Minas Gerais, in eastern Bolivia, and in the drier parts of the Paraguayan Chaco. The lesser tinamou, Nothura minor, occurs in eastern Brazil from Minas Gerais south to Sao Paulo and west to the eastern border of Bolivia (Mato Grosso). Both are inhabitants of the tropical to subtropical zones.

The spotted tinamou, Nothura maculosa, is the most widespread and abundant tinamou in northern, eastern and southeastern Argentina. The pale spotted or Darwin's tinamou, Nothura darwini frequents the drier, colder and more western parts of Argentina as well as Bolivia and Peru, extending to higher elevations than maculosa. Both occupy the lower temperate zone with some incursion into the subtropical. The habitats of both are predominantly grasslands and adjacent cultivation.

A major objective of the investigation of tinamous in Argentina was the location and study of game birds potentially adaptable to grasslands, including grazed pastures, in the United States. Close attention was therefore directed to 7 subspecies of maculosa and 2 of darwini and in particular the more abundant Nothura maculosa annectens and Nothura darwini darwini. Most of the data here presented refers to these, although other subspecies were studied also as opportunity arose.

Taxonomy

Conover (1950) separates the species of the genus Nothura by the following characteristics:

- A. Lesser underwing coverts barred with dusky and inner webs of primaries immaculate.....boraquira

- B. Lesser wing coverts unbarred
 - a. Toes and tarsus relatively short. Middle toe with claw generally under 28 mm.
 - 1. Smaller, wing not over 120 mm. middle toe with claw 21 to 24 mm.....minor
 - 2. Larger, wing over 120; middle toe with claw over 24 but generally not over 28 mm.....darwini
 - b. Toes and tarsus relatively long and stout. Middle toe with claw generally over 28 mm.....maculosa

Conover also suggests a fifth species chacoensis from northern Argentina but Olrog (1963) in a more recent and detailed study considers this as a subspecies of maculosa.

Introductions

No successful introductions of spotted or pale spotted tinamous are recorded. Liebermann (1936) in his "Monografia de las Tinamiformes Argentinas" indicates that several species of tinamous were sent to zoological gardens and private estates in central Europe in the early part of the present century for exhibition and trial propagation. Presumably spotted tinamous were included. Writing in 1936, he reported that these birds reproduced well in captivity and were becoming established in parts of Germany, France, Belgium, Poland, and Holland. As is customary his informants proved overoptimistic for there is no subsequent indication of successful acclimatization.

Few tinamous apparently have been shipped to the United States for trial release. In 1921, following his visit to Argentina, Alexander Wetmore (1926) was impressed with the possibilities of introducing the spotted tinamou to the temperate United States. But the only private attempt of which we are aware was made by Ambassador David Bruce who in 1949-50 collected about 40 spotted tinamous in Argentina for liberation on an island off the coast of Georgia. The results of this trial have not been recorded.

In 1966, at the request of the Florida Game and Fresh Water Fish Commission, pampas spotted tinamous, wild-trapped near Los Conquistadores, Province of Entre Rios, were forwarded for trial liberation. Specific habitat descriptions, including photographs of suitable cover, were provided. Of this group, 95 birds were liberated northeast of Ocala in the Ocala National Forest and others on St. Vincent's Island near Apalachicola in basically woodland habitats. Though the spotted tinamou is predominantly an openland species, a few individuals were still reportedly resident in 1968.

PART I

THE SPOTTED TINAMOUS, *NOTHURA MACULOSA*

The spotted tinamous occupy a larger range and live in a wider variety of habitats than do other tinamous in Argentina. Though preferring grasslands, spotted tinamous have adapted well to the increased cultivation and to the intensive grazing practices which have characterized recent agricultural development in Argentina. Though they are not particularly wild, a high reproductive capacity coupled with their comparatively small size allows them to withstand heavy hunting pressure. This is the more remarkable since they are most abundant in the eastern parts of the country which is also the most densely populated by man. Here, in many areas, they are currently the only dry land game bird to be found. Their survival in large numbers in the face of today's changing conditions is indicative of considerable adaptability.

Common Names

The name tinamou was first applied to this group of birds about 1741 by Barrere who collected them in the Guianas (Liebermann 1936). It arose from the Indian name ynambu with the spelling changed to conform to the French pronunciation. In 1783 Latham adapted the name to English.

Tinamous were among the first birds mentioned by Jesuits and by Spanish and Portuguese conquistadors. They called them perdiz after the red-legged partridges of the Iberian Peninsula.

Since almost all of South America speaks some form of Spanish, Portuguese, or Indian, and tinamous in general are rather inconspicuously colored, less than the usual multiplicity of common names has arisen. Those most frequently encountered for the spotted tinamous include the following:

Spotted tinamou	English
Spotted-necked tinamou	English
Perdrix	French
Perdiz	Spanish, Argentinian
Kleines striesshuhn	German
Ynambu	Indian (Guiana)
Inambu	Indian (southern South America)
Inambui	Indian (Argentina)
Perdiz chica	Argentinian, Paraguayan, Uruguayan
Perdiz chica comun	Argentinian
Perdiz chica de Buenos Aires	Argentinian
Perdiz chica del littoral	Argentinian
Perdiz chica del campo	Argentinian
Perdicita	Argentinian
Cordonis	Brazilian



Figure 1. Provinces of Argentina referred to in the text.

Distribution and Abundance

Range in Argentina

The spotted tinamou is the commonest game bird in Argentina, Uruguay and Paraguay with a practically continuous distribution from north-eastern Chubut to Minas Gerais in central Brazil. Since, to most people, the nine subspecies look alike, a general idea of the region in which each occurs may be of interest. Two are not resident in Argentina. Spix's spotted tinamou, N. m. major, has been identified from the interior of Brazil and the Ceara spotted tinamou, N. m. cearensis, from Lavras (northeast of Sao Paulo, Brazil).

Though none of the range boundaries of the subspecies are clearly defined and though some certainly overlap, Conover (1950) and Olrog (1963) have provided the best descriptions of these for the seven Argentine subspecies. Supplemented by our own collection of skins of N. m. maculosis and N. m. annectens, these are as follows:

<u>Name</u>	<u>Distribution in Argentina</u>
Patagonian spotted tinamou (<u>Nothura m. nigroguttata</u>)	Moist plains of eastern Rio Negro and Chubut west to southeastern Neuquen. Probably limited largely to coastal regions and to interior river valleys.
Neuquen spotted tinamou (<u>Nothura m. submontana</u>)	Known only from northern Neuquen near Chos-Malal but probably more widely distributed.
Pampas spotted tinamou (<u>Nothura m. annectens</u>)	Grasslands of eastern, central, and southern Cordoba, central Santa Fe, southern Corrientes and western Uruguay south to at least 100 km south of Bahia Blanca, west to the eastern border of La Pampa and north to south-western Cordoba and adjacent San Luis. ^(a)

(a) Birds collected north of San Justos (Sante Fe), in the valleys adjacent to the Sierras de la Ventana north of Bahia Blanca, about 100 km south of Bahia Blanca and near Villa Iris (Buenos Aires) were annectens in the judgment of the authors. Collections, often extensive, along the eastern border of La Pampa from Jacinto Arauz to Villa Sauce were darwinii. About 3 miles west of Banderalo at the northeastern corner of La Pampa we collected annectens but 10 miles further west only darwinii. Annectens was also collected from several points in southeastern Cordoba. Two birds shot east of Mercedes in San Luis were probably referable to this subspecies. Some 500 birds trapped north of Los Conquistadores along the border between Entre Rios and Concordia appeared to be mainly annectens but with some tendency to intergrade with maculosa.

Spotted tinamou

(Nothura m. maculosa)

Savannahs, plains, and open palm forests from Misiones south to north-eastern Entre Rios and west to north-eastern Sante Fe. Also southern Brazil, eastern Paraguay, and northern Uruguay.

Swamp spotted tinamou

(Nothura m. paludivaga)

Marshy grasslands and savannahs of eastern Formosa and Chaco westwards an undefined distance. Also in Paraguay from the Rio Paraguay west about 150 kms and up the Rio Pilcomayo for at least 235 kms.

Chaco spotted tinamou

(Nothura m. chacoensis)

Chacoan plains of Formosa. Southern, eastern, and western limits not known. Also the more arid parts of the Paraguayan Chaco from about 150 kms west of the Paraguay River probably west to the Bolivian border.

Gray spotted tinamou

(Nothura m. pallida)

Moist Chacoan grasslands and savannahs from northern and eastern Salta and western Formosa and Chaco southwest through northern and western Santiago del Estero to eastern Catamarca.

The approximate distribution of the spotted tinamous in Argentina is shown in figure 2.

Abundance in Argentina

In grasslands and weedy pastures with sparse to fairly dense vegetation from 4 to 20 inches in height and at times heavily grazed, spotted tinamous may be very abundant. Except near centers of population it was rare indeed that we did not put up at least a bird per 5 acres of suitable cover. Where not heavily hunted the average was much higher.

The density of birds varied but little throughout the year, For example, in eastern Santa Fe in early spring (September), 20 birds were flushed from about 20 acres and the farmer indicated the surrounding countryside to be equally well stocked. In October in southern Corrientes we drove our Jeep over about 150 acres, locating 84 birds. In the same month, when we pulled a rope over 8 acres to flush birds and find nests, 14 individuals were counted. In January, in southern Sante Fe, a rope drawn between 2 horses across 50 acres flushed 58 fast flying birds and 4 young. All the fields thus checked were selected at random. On a managed hunt that covered 267 acres of one ranch in June, 484 birds were flushed, an average of 1.8 per acre.

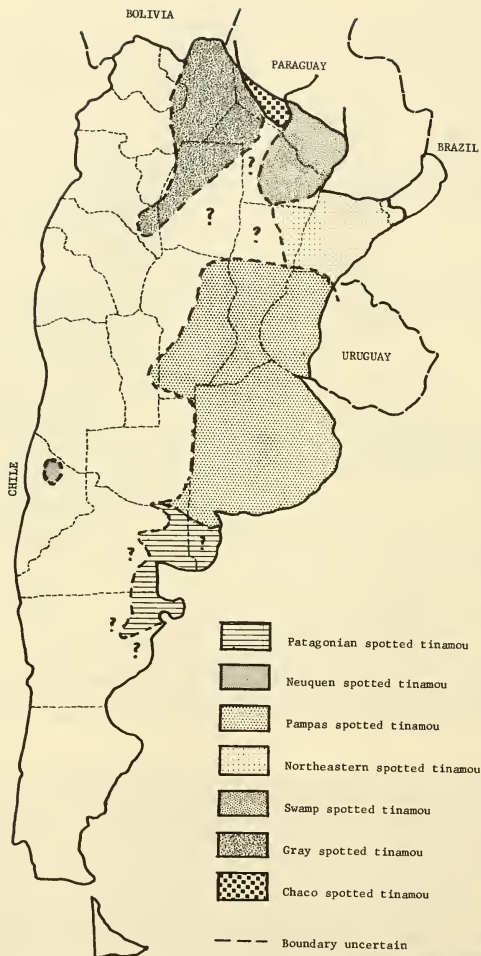


Figure 2. Approximate range of the subspecies of the spotted tinamou, Nothura maculosa, in Argentina.

These were by no means exceptional cases nor was the cover selected as being particularly favorable. Over much of the countryside in the pampas a bird per 2 to 4 acres was normal and a maximum density was about 2 birds per acre. The spotted tinamou is not gregarious, so birds were normally flushed singly or in pairs well scattered throughout the cover.

Description

Field Identification

Spotted tinamous are partridge-shaped birds, somewhat larger than bobwhite quail, that appear to be practically tailless. The general color is ochraceous brown, inconspicuously spotted, barred or streaked with black, brown or gray. When standing or running the head is held high, the neck vertical and outstretched. Flight is swift, low and direct. The birds are often observed crossing roads or feeding unconcernedly in grassy roadsides.

In Argentina the only bird with which the spotted tinamou might be confused is the pale spotted tinamou, Nothura darwini, which in general has less distinct and finer markings on the back and is often slightly smaller.

Subspecies

Recognition of the subspecies of the spotted tinamou is difficult. Differences are not marked. Individual variation in color and feather pattern within a subspecies is considerable. Intergradation between subspecies where their ranges meet or overlap is apparent from our field observations. Skins for study are stored in many museums but are seldom sufficiently numerous or available to permit clear differentiation and to define adequately the limits of the range of any subspecies.

In spite of this obscurity, the differentiation of the species into subspecies, though admittedly imperfect, is of interest not only to the taxonomist and bird lover but also to the sportsman since for no two subspecies is the habitat, including temperature and precipitation, quite the same.

No key to the subspecies has been published. But there are differences which are at least indicative, especially when considered in relation to the particular part of Argentina in which a subspecies occurs. In broad terms the distinctive features ^(a) are as follows:

(a) Adapted from descriptions by Conover, by Olrog and from personal examination of skins.

Rather bright yellow and black above, underparts fairly bright ochraceous buff. Range northern Patagonia along the coast and in the moister valleys.....nigroguttata

Light olive and grayish above, pale buff below. Range northern Neuquen.....submontana

Ochraceous brown above, chest more streaked than spotted, abdomen buff. Inner web of 8th and 9th primaries usually 3/4th to completely spotted. Range the lush grasslands of eastern Argentina.....annectens

Rufescent brown and black above, abdomen buff tending towards reddish brown. Chest rather heavily spotted. Inner web of 8th and 9th primaries 2/3rds to 3/4th spotted. Range northeastern Argentina.....maculosa

Rather grayish black to dull yellow above, more gray than buff or reddish brown below. Chest rather heavily spotted. Inner web of 8th and 9th primaries about 3/4th spotted. Range northern part of the eastern Chaco.....paludivaga

Light ochraceous buff above, almost pure buff below. Chest with less well-defined markings often in the form of narrow shaft streaks. Range northern Formosa.....chaccensis

Grayish buff above, light buff below (more like darwinii), chest pale, lightly streaked. Inner web of 8th and 9th primaries slightly to 1/2 spotted. Range northern portion of the western Chaco.....pallida

Description of the Pampas Spotted Tinamou (N.m. annectens)

Coloration -- The pampas spotted tinamou is the subspecies that received the most attention by Program biologists and was trapped or reared and sent to the United States for trial propagation and introduction. Since it is impractical to describe all of the subspecies in this report this race has been selected. Conover, who first recognized this subspecies, gave the following description:

"Top of head dark brown, each feather tipped with rusty buff and edged with light buff; throat white; sides of head superciliary stripe and neck all around light buff with dark brown shaft streaks to each feather; feathers of mantle, back, scapulars and upper tail coverts dark brown, vermiculated with rufous brown and with broad edges of grayish buff inside of which are longitudinal streaks of white often tinged with dull buff; tail feathers light buff barred with dusky; upper wing coverts barred with dark brown and ochraceous buff; primaries dark brown, the outer web broadly notched with buffy white and the inner web

broadly barred with ochraceous buff; under wing coverts and auxiliaries ochraceous buff, the very outermost coverts spotted with dusky; secondaries broadly barred with dark brown and ochraceous buff; chest dull buff, the feathers with longitudinal streaks and spots of dusky; flanks dull buff, heavily marked with broad bars of dark brown; abdomen, vent and under tail coverts dull ochraceous buff."

Wings -- The wings of tinamous are comparatively short and rounded. Conover gives 141 inches as the average length of wing for annectens. By weighing, sexing and measuring the wings of 18 adults collected on one ranch on June 19, 1965, it was apparent that wing length is related to sex but not to weight. The average wing length for 10 males was 134.4 mm; for 8 females 141.6 mm. Wing lengths of males varied from 130 to 142 mm; for females from 139 to 146 mm. Variation in weight by sex was not correlated to length of wing as indicated in table 1.

Table 1. Weight in relation to sex and average length of wing.

Weight (grams)	<u>Males</u>		<u>Females</u>	
	<u>No. of birds</u>	<u>Average wing length</u>	<u>No. of birds</u>	<u>Average wing length</u>
231-250	2	136 mm	0	--
251-270	3	135	1	145 mm
271-290	4	133	3	142
291-300	1	134	4	141

Spotting of the 9th and 10th primaries -- Some taxonomists have used the extent of spotting on the inner web of the 9th and 10th primaries as an aid in separating pale spotted tinamous (Nothura darwini) from spotted tinamous (Nothura maculosa) as well as subspecies of the latter group. More comparative data are needed to establish the limits of validity of this character. For annectens, with 20 sets of wings examined from birds shot on the ranch mentioned above, the spotting of the 9th primary was 65 to 90 percent complete; for the 10th primary from 0 to 100 percent complete. This spread is confirmed from an examination of 32 skins, collected widely from the range of this subspecies.

Pattern of neck and breast feathers -- The neck and breast color pattern of the pampas spotted tinamou varies from rather dark brown spots to elongated, usually fairly wide streaks. Of 20 birds taken from one area, 13 were more spotted than streaked, 2 were intermediate, and 5 were mainly streaked. Color pattern was not related to sex.

Tarsi -- The tarsi of annectens as with many tinamous are stout but long for the size of the bird. Conover gives 41 mm as the average length.

Toes -- Not only wing length but also length of the middle toe and claw were used by Conover to separate species of spotted tinamous. The average length of the middle toe and claw on 20 birds collected on one ranch was 32.8 mm with a variation of from 31 to 34 mm. The average for 8 males collected from other parts of the range was 30.0 with variations from 27.9 to 31.7 mm. Females averaged 30.7 and ranged from 29.2 to 32.0 mm in length.

Size and Weight

Spotted tinamous are chunky birds though often appearing slimmer when alertly standing or running with neck outstretched and head held high. The pampas spotted (N. m. annectens) is about 1 1/2 times the size of a bobwhite quail, 3/4th the size of a Hungarian partridge or a Spanish red-legged partridge.

The weight of adult birds varied substantially by individuals as well as by sex. The average weight of 55 birds collected from all parts of the range was 251 grams for males, 272 grams for females. The variation in weight of adults all collected on June 19, 1965, (mid-winter) from one ranch near Venado Tuerto is interesting. The average weight of 90 males was 250 grams, of 92 females, 289 grams. Male adults varied from 193 to 297 grams, females from 192 to 361 grams. The weight distribution by sex of these birds is illustrated in figure 3.

Eight adult female spotted tinamous (N. m. maculosa) collected in September and October from southern Corrientes Province averaged 299 grams. The lone male collected weighed 265 grams. The females ranged from 238 to 291 grams.

Weights by month and sex for 58 pampas spotted tinamous are given in table 21 in the appendix.

Development

Developmental studies were limited to the pampas spotted tinamous since the hatching and rearing of a large number of these birds in captivity presented an unusual opportunity for observations.

Weight at Hatching

The average weight of chicks from wild-gathered eggs at hatching was 18.6 grams; the heaviest bird weighed 21.6 grams.

Weight by Weeks

Time did not permit the marking and following of young birds in the wild. Weights by weeks given in table 2 represent wild eggs, hatched artificially and reared at our research station during the

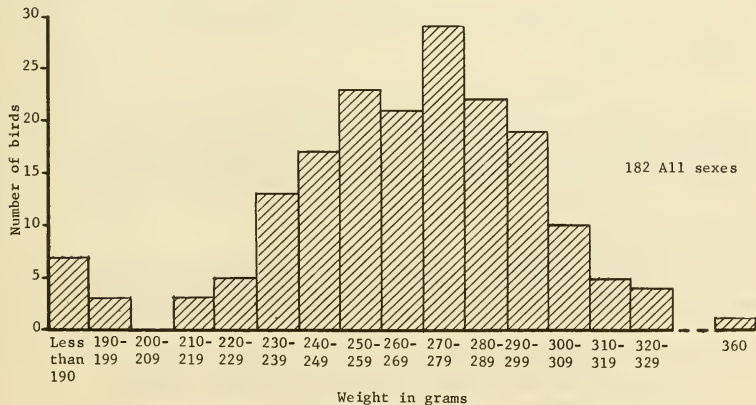
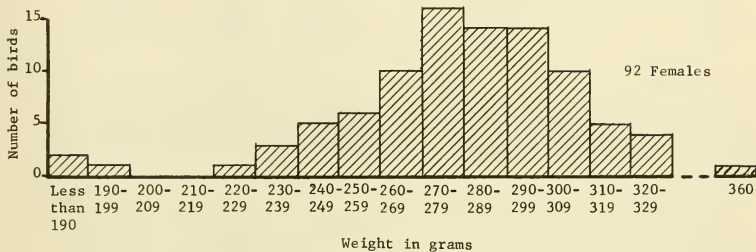
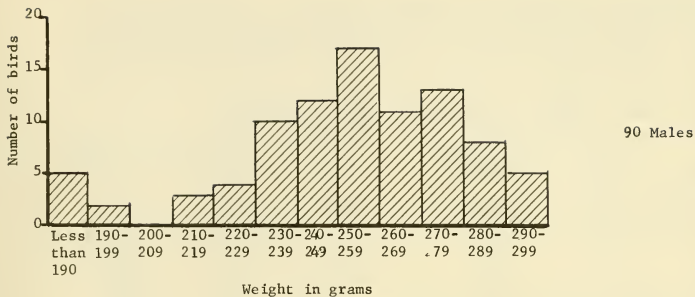


Figure 3. Weight distribution of 182 pampas spotted tinamous by sex.

1964-65 breeding season. Since food requirements were not well defined, these weights may well be lower than for birds reared in the wild.

Table 2. Weights of chicks by weeks.

<u>Week</u>	<u>No. birds</u>	<u>Av. weight (grams)</u>	<u>Week</u>	<u>No. birds</u>	<u>Av. weight (grams)</u>
At hatching	10	18.6	8	4	155.8
1	15	29.8	9	3	178.7
2	15	57.8	10	12	186.0
3	15	85.9	11	7	194.4
4	15	108.1	12	15	195.9
5	11	116.7	20-22	14	217.1
6	11	135.5	37-39	14	221.5
7	8	149.5	68-70	13	223.6

The influence of food on weight in captivity is illustrated by one group of 22 birds that averaged 226 grams at 14 1/2 weeks. The birds were raised on a high protein diet. Another group of 19 birds reared on a low protein diet averaged 231 grams at 35 weeks of age.

Egg Tooth

Many species of game birds at hatching have a small whitish protuberance at the end of the upper mandible called an egg tooth. This was present in almost all of the youngsters examined. Generally it had fallen off by the beginning of the second day after hatching.

Bursa of Fabricius

Young gallinaceous birds have a blind pouch or protuberance extending off the cloaca. Since this is absorbed before the young become adults, it aids in separating birds of the year from adults. Though in young spotted tinamous the surface of the cloaca is often slightly pitted, we were unable to locate a true bursa either by visual examination or by dissection.

Feather Development and Molt (a)

The feather development of tinamous differs from many other families of birds in several respects. For example, the natal down of newly hatched chicks is tipped with hairlike processes that create a

(a) In collaboration with George B. Wint, Superintendent, Oklahoma State Game Farm.

kiwi-like appearance. True down feathers are confined to the feather tracts unlike most species. Tinamous are often allied taxonomically with the ratite birds which lack powder down, yet these feathers reach their extreme development in tinamous (Van Tyne and Burger 1961). An interesting subfeather, called an aftershaft, is characteristic of the major body feathers of many gallinaceous birds. Though tinamous and galliformes are taxonomically far apart, this aftershaft is also present in tinamous. In the spotted tinamous it is plumaceous and one-half to two-thirds as long as its accompanying feather.

Little is known of feather development and the pattern of the moult in spotted tinamous. Time did not permit us to study this in great detail but observations and measurements of a fair number of individuals of known ages were made.

Natal -- At birth the chicks are covered with down tipped with long, paired, hairlike ends. Long rectal bristles are found about the mouth. Mammalian-like "eyelashes" are prominent. The color of the back is dark brown, finely streaked with buff. The crown of the head is dark. Throat and breast are whitish and separated by a wide patch of light buff. No primaries are visible.

Juvenal -- The weekly pattern of feather development varies with individual birds but is sufficiently constant to provide a general indication of age. Feather development is much more rapid than is usually realized. As is normal, only the natal down is present at hatching. By the third day, the first 9 of 10 primary wing feathers^(a) and most of the secondaries are already visible. The 10th does not appear until the chick is about 2 weeks old.

At 1 week the scapulars are developing rapidly; the upper wing coverts are 2 to 4 mm; flank feathers, about 1 mm; and upper back feathers, less than a millimeter in length. While there is considerable variation, the length of each of the first 6 primaries averages 6 to 10 mm with primary number 2 usually the longest.

By the second week primaries 1 to 3 have already attained their full length of 40 to 48 mm and are fully developed. The feathers on the crown, back and breast as well as the wing coverts are well developed. The down with its hairlike tips has disappeared and much of the general color pattern typical of a spotted tinamous is evident.

By the third week the head is well feathered and pin feathers are appearing on the belly.

(a) Counting from the secondaries outwards to the tip of the wing.

At the end of the fourth week adult wing feathers are appearing as primaries 1 and 2; juvenal primaries 4 to 6 are fully developed. The 10th primary does not reach this stage until about the ninth week. By the sixth week the 1st adult primary has stopped growing as evidenced by the absence of blood in the quill. From this time on adult feather replacement proceeds rapidly to about the 21st week when the growth of the 8th adult primary is completed.

The time of moult of immature primaries 9 and 10 is not yet adequately determined. Our records indicate that between the 20th and 22nd week, five individuals had not moulted these feathers and four had adult 9th primaries from one-fifth to four-fifths grown. During the subsequent three weeks the 9th primary on 12 birds measured from one-half to full development. With the 10th primary at 20 to 22 weeks, four were partly developed, five were not yet moulted. Four individuals examined between the 23rd and 25th week all showed developing feathers which we took to be adult. But George Wint in examining birds reared by him, found that primaries 9 and 10 were not shed by the 24th week. Further observations to clarify this point are indicated.

In many gallinaceous birds the juvenal 9th and 10th primaries are sharp pointed and are maintained over winter. Thus this becomes a characteristic by which birds of the year may be separated from adults. In a spotted tinamou these are not distinctly sharp pointed and are of less value in separating birds of the year from adults.

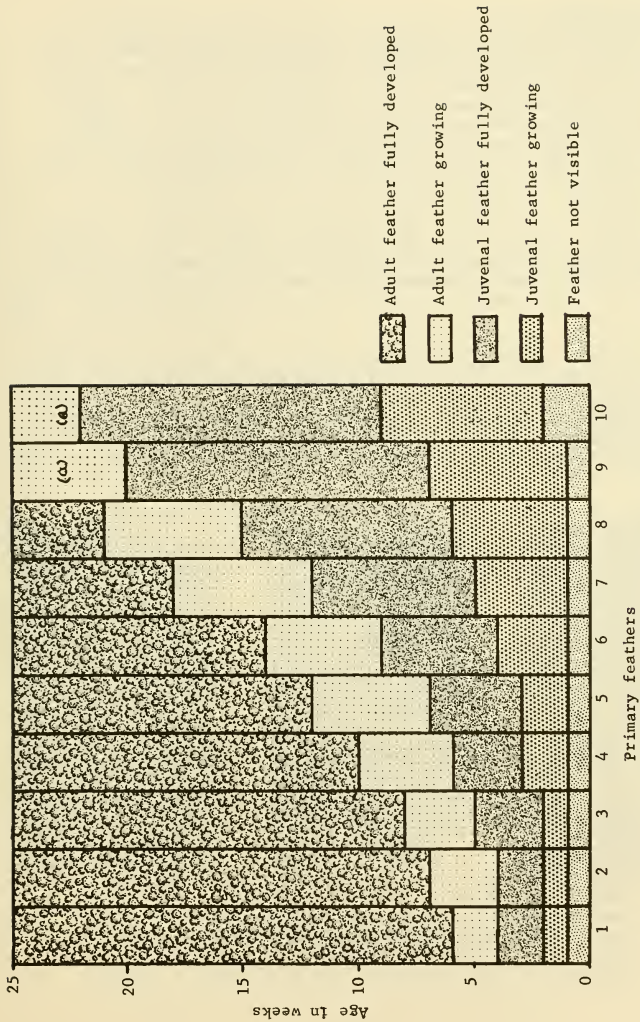
The sequency of moult and feather replacement of the primaries by weeks is presented in figure 4.

Adult -- No study of the time or pattern of moult among adults was made. It may be that spotted tinamous are continuous moulters like ptarmigan.

Color of the Eyes

Until the present investigation discovered that eye color is usually sex linked in the adult spotted tinamou, little attention was directed to this characteristic. With study, interesting differences were noted.

At hatching time the eyes of both sexes are dark brown. In a week's time they are changing to deep blue. This becomes a lighter blue by the end of the third week. At 7 to 8 weeks eye color begins to change to a pale yellow. By 3 months of age the eyes of some males begin to darken, while those of some females become orange-yellow. This differentiation becomes more pronounced with age. It is described in detail in the section on Sex Identification.



(a) George Wint found juvenal primaries numbers 9 and 10 had not been shed by 24th week.

Figure 4. Sequence of moult and primary feather replacement by weeks.

Reproductive Organs

Biologists and aviculturists working with spotted tinamous often need to separate males from females. The only accurate method of determining sex is by an examination of the reproductive organs. After removal of the intestines one can usually find the two oval, whitish or occasionally grayish testes of the male lying on either side of the backbone and close to the forward portion of the kidneys. During the breeding season these organs become greatly enlarged but at other times may be difficult to locate.

In females only the left ovary is normally functional. In it are follicles that contain the ova or female germ cells. These are tightly bunched with an individual measuring less than 1 millimeter in diameter except during the breeding season. While most are quiescent at this period, one to three may be found in various stages of enlargement.

As with the rheas, the penis is spirally twisted and eversible like the fingers of a glove. Van Tyne and Burger (1961) indicate that tinamous possess a small, simple penis. This is also true for most upland game birds (Galliformes). But in 3 of the 5 genera of tinamous studied (Nothura, Rhynchotis and Nothoprocta) this is not the case. In the crested tinamou, Endromia, the penis is short. In this connection it is interesting to note that tinamous of the 3 genera mentioned above are all extremely leisurely breeders, whereas the crested mates very quickly.

The penis of the adult spotted tinamou is often 8 to 12 cms (3 to 5 inches) in length. It is whitish in color, wormlike and inclined to coil when extended in winter but may be much thickened and clublike during the breeding season.

Sex Identification

The determination of sex by plumage differences is difficult with most tinamous. A careful comparison of feathers by sex of both the spotted and the pale spotted revealed no constant differences.

Weight, also, is not a reliable indicator. Females, on the average, are 25 to 30 grams (about an ounce) heavier than males but weights of both sexes vary to a degree that makes this characteristic almost meaningless.

As previously indicated, eye color, varying from light yellow to orange-brown, depends upon age and sex as shown below:

Birds of the year

1. Individuals over 3 months old with pale yellow eyes are almost always males.
2. Those with dusky yellow eyes may be either sex.
3. Those with eyes that borderline between dusky yellow and orange-brown or that are orange-brown are almost always females.

4. With age the color of the iris tends to darken in both sexes. The eyes of most males over 6 months of age are dusky yellow; none are orange-brown. Of the females, 37 percent will be dusky yellow, 62 percent borderline or orange-brown in color.

Adults

1. The tendency towards dusky yellow eyes in the males and orange-brown in females is stronger. Almost every bird with an orange-brown eye is a female.
2. By the time individuals are 2 years old almost all male eyes are dusky yellow, occasionally with a tinge of orange-brown; most female eyes are orange-brown.

In checking eye color one must remember that tints appear to be a little darker under artificial light than they do out of doors. Table 25 in the appendix provides the supporting data for the conclusions presented above.

The final and only certain way to determine the sex, without sacrificing the bird, is by cloacal examination. With a little practice this is not difficult and very seldom causes injury to the bird. Place it on your lap, ventral side up, head pointing towards your knees, and body cupped with your hands. Press slowly outwards and downwards and then slightly inwards on the edges of the cloaca. Repeat this several



Figure 5



Figure 6



Figure 7

Figure 5 Cloaca of female showing phalloid organ.

Figure 6 Penis of male in nonbreeding condition.

Figure 7 Penis of male in breeding condition.

times to relax the muscles. If the bird is a male this should cause the white, often slightly coiled, wormlike to clublike penis to extrude, often for 10 mm or more. Be careful not to confuse it with the arrow-shaped, flesh colored phalloid organ that extends backwards from the surface of the cloaca and will appear first.

Age Ratio

The determination of immature versus adults in the winter population is complicated. Spotted tinamou mature at a very early age. We were unable to find a bursa of fabricius. Weight differences beyond the 12th to 15th week appear not to be a reliable indicator. Gonad and penis development, while more indicative, still show considerable variation by age class. Time did not permit a detailed study of moult but the data available is presented in the section on feather development and moult and in table 4.

On June 19 (early winter) Dr. Milton Weller, Wayne Bohl and the authors sexed 182 birds by gonadal examination. Of these 69 randomly selected were then aged on the basis of the size and stage of development of the penis in males, the increased pigmentation of the cloacal area and the presence or absence of a stretched or enlarged oviduct in the females, and feather development. The results as regards weight by sex and age are presented in table 3.

Upon analyzing this table it would appear that the population contained more adult than immature males and that the reverse was true for females. This may well be the situation for the females but it is doubtful whether the figures accurately represent the ratio of immature to mature males. Most males mature earlier than females and data presented elsewhere indicate that the testes and penis occasionally are well developed as early as the 10th week. It is probable that by early winter sexual development in subadults has progressed to a point where it is no longer a reliable indicator of age.

On the other hand the enlarged oviduct, indicating that the bird has been laying, and the increased pigmentation of the cloaca with age are considered to be reasonably indicative of mature females. Based on these characters, the age ratio in early winter was about 2 to 1 in favor of immature birds. The weight of individuals varies widely with age, but as a group immatures were about 30 grams lighter than adults at this period.

Table 3. Distribution of immature versus mature birds by sex in a population of pampas spotted tinamous in early winter.

Weight by sex and maturity

	(a)		(a)	
	Males	Males	Females	Females
	<u>Immature</u>	<u>Mature</u>	<u>Immature</u>	<u>Mature</u>
	286	281	245	298
	218	296	282	292
	232	281	305	245
	228	272	241	263
	224	280	257	300
	249	265	294	303
	196	277	280	301
	279	256	291	294
	290	266	266	292
	146	257	272	298
	158	269	242	291
	249	270	304	313
		226	267	
		267	258	
		297	286	
		231	230	
		185	251	
		152	282	
		156	284	
		253	297	
			311	
			278	
			279	
			173	
			<u>123</u>	
Number of birds	12	20	25	12
Percent of birds	17.4	29.0	36.2	17.4
Average weight	229.6	256.9	263.9	291.6
Weight range	146 to 290	152 to 297	123 to 311	254 to 313

(a) in grams.

Habitat

In Argentina either 10 or 11 distinct vegetational zones are recognized (Consejo Nacional de Desarrollo 1962). Of these, spotted tinamous are found in five though only in those areas where grass and forbs are common.

About two-thirds of the country is characterized by grasslands that often extend beyond the horizon, or by open savannahs composed principally of grasses intermixed with scattered shrubs and trees. In the more humid eastern and northeastern pampas the grasses were originally tall and luxurious. Trees and shrubs were few, possibly kept out by prairie fires that annually blackened vast areas. Darwin mentions fires set to drive out the Indians. In these grasslands spotted or pale spotted tinamous were abundant (Barlow 1938, Liebermann 1936).

Then came the white man, bringing with him cattle, sheep and goats. His hand was often on the plow. Along with his grain for cultivation, largely corn and wheat, travelled the seeds of many weeds common in Europe or Asia, thus providing a rich, new source of food for birds. Until the ranges were saturated with cattle, tall grasses were still common but in the last few decades many of these have been replaced with short grasses, often heavily grazed and interspersed with cultivation.

Under the new conditions, the red-winged and to a lesser extent, the crested tinamou faltered, but the more adaptable spotted tinamou took the changes in its stride. In fact it may even have found the shorter and less-dense cover to its liking especially in the more fertile and humid pampas.

Spotted tinamou have adapted themselves to a combination of grass and forbs. Yet differences in the types of grasses and forbs, in precipitation, and in temperatures in various regions have prevented their successful establishment in much of Patagonia and in most of the central and western reaches of Argentina. In these regions a closely allied species, the pale spotted tinamou (Nothura darwini) has developed. In what kinds of cover, then, have the various subspecies of the spotted tinamou become established?

Habitat by Subspecies

The Patagonian spotted tinamou finds the somewhat more abundant grass and forb cover and slightly higher temperatures and precipitation along the lowlands of the south Atlantic coast of northeastern Patagonia and the valleys of the Rios Negro and Colorado to its liking in contrast to the more inland, barren and colder upland steppes.

The Neuquen spotted tinamou appears to be a race, perhaps isolated from other spotted tinamou, in a slightly colder and, so far as we now know, drier region with less luxuriant grass. This is more typical of

country preferred by its pale spotted relative. How it got there and what differences in vegetation and climate allow it to survive are questions for which no one now has an answer.

The pampas spotted tinamou thrives under relatively humid, more temperate conditions where grass and forbs are luxuriant even though closely grazed or beaten down by cattle. Much of its range is now under cultivation. Such fields are more commonly used when the crop is young or after it has been harvested, for these birds prefer short, open to fairly dense cover. Cultivation is, however, by no means essential and must be closely associated with grassy edges or fields to attract many birds. Conversely alfalfa is attractive even though freshly cut and from then to maturity.

Much the same habitat, though somewhat warmer and with some trees and shrubs, characterizes the part short grass, part savannahlike habitat of the northeastern spotted tinamou. Grass may be shorter since the soil is less fertile.

Northwest of this species is found the swamp spotted tinamou. Collectors of this species from the Paraguayan Chaco write "The part near the river (Parana) is swampy and covered with a sweet grass..." (Conover 1950). Certainly the flood plain and the low lying land to the west is subject to winter flooding which is reflected in a more varied and luxurious vegetation than is characteristic of the rather dry, slightly higher elevations. We did not observe this subspecies and never encountered a spotted tinamou that lived where the ground was wet to waterlogged throughout the year. The eastern Formosa and Chaco habitat of this subspecies is characterized by some subtropical forest interspersed with palm savannahs and pastures in which grasses and forbs are abundant and varied. At slightly higher elevations and to the west where precipitation in winter is less xerophytic vegetation and less dense grass-and-shrub lands are the rule. Temperatures border on the subtropical.

The limited range of the northern Chaco spotted tinamou in Argentina is dry and subtropical with vegetation resembling that of the western Chaco.

The range occupied by the western Chaco spotted tinamou is xerophytic, subtropical in the north and barely lower temperature to the south. Open deciduous, mostly leguminous scrub, bushy palms or giant cacti constitute the shrubby cover. Extensive areas are sparsely grassed, saline, barren plains or swampy depressions with clumps of saltgrass and often dry part of the year. Olrog (1963) indicates that Salvador's pale spotted tinamou (N. d. salvadori) is also local in the western and southern part of this zone.

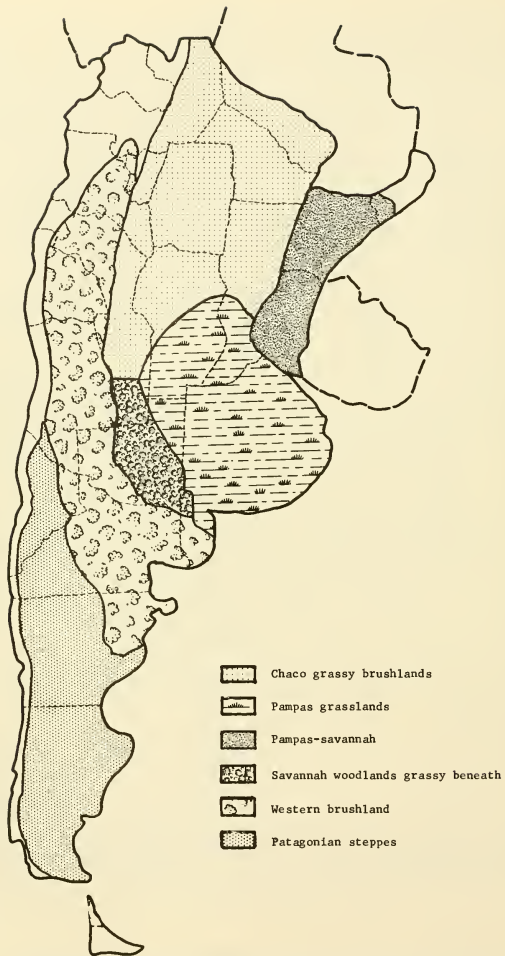


Figure 8. Vegetational zones in Argentina in which spotted or pale spotted tinamou are resident.

It is interesting to note the often close relationship between vegetation indicated in figure 8 and the distribution of the various subspecies both of the spotted and of the pale spotted tinamous as detailed in figures 2 and 28.

The major vegetational and climatic characteristics of the five vegetative zones to which spotted tinamous are adaptable are presented in table 26 in the appendix.

Since it is the pampas spotted tinamou that has been recommended for trial introduction and the pampas, vegetatively, is in general characteristic of most prime spotted tinamou cover, attention was concentrated on it.

Pampas -- Grasses and leguminous plants predominate in the pampas. Characteristic species (Consejo Nacional de Desarrollo 1962) are presented below:

<u>Genera and species</u>	<u>Common names</u>
<u>Grasses</u>	
<u>Bromus brevis</u>	common Indian barley
<u>Bromus uniloides</u>	pampas barley
<u>Poa ligularis</u>	meadowgrass
<u>Poa bonariensis</u>	meadowgrass
<u>Hordeum stebbinsi</u>	foxtail
<u>Hordeum murinum</u>	barleygrass
<u>Hordeum stenostachys</u>	--
<u>Cynodon dactylon</u>	Bermuda grass
<u>Cynodon hirsutus</u>	--
<u>Piptochaetium montevidense</u>	ricegrass
<u>Paspalum dilatatum</u>	honeygrass
<u>Chloris polydactyla</u>	chlorisgrass
<u>Lolium multiflorum</u>	common ryegrass
<u>Sorghum halapense</u>	Johnsongrass
<u>Stipa hialina</u>	feather or bunchgrass
<u>Stipa papposa</u>	feather or bunchgrass
<u>Stipa tenuis</u>	feather or bunchgrass
<u>Legumes</u>	
<u>Trifolium repens</u>	white clover
<u>Medicago polymorpha</u>	--
<u>Medicago lupulina</u>	black medick
<u>Medicago arabica</u>	spotted medick
<u>Medicago minima</u>	--

Species commonly cultivated within the range of the pampas spotted tinamou include wheat, rye, oats, barley, sorghum, corn, flax, sunflower, alfalfa, and several clovers.

Cover Preference of the Pampas Spotted Tinamou

Not much of the habitat of the spotted tinamou, vegetationwise, has remained in its original condition. Goats and sheep in the more arid parts, cattle and cultivation where it is more humid, together with introduced weeds and crops have brought substantial changes. In the pampas, where our study of cover was centered, tall grass, bunchgrass and feathergrass (Stipa) have largely been replaced by short grass often with a generous mixture of forbs, either native or introduced. Among these are the bull thistle (Carduus), white thistle (Silybum), ragweed (Ambrosia), pigweed (Amaranthus), mustard (Brassica), wild carrot (Daucus), tall sweet clover (Melilotus), smartweed, (Polygonum), chickweed (Stellaria), clovers (Medicago), foxtail (Setaria), crabgrass (Digitaria), Bermudagrass (Cynodon), Johnsongrass (Sorghum), and cornflower (Centaurea). Most of these are also common forbs in the United States.

Coverwise, the pampas spotted tinamou is exceptionally adaptable. Wherever there are grass and forbs more than 3 inches high with at least a scattering of higher vegetation this species is at home. Ideal conditions exist where cover is 5 to 15 inches in height and is subject to moderate to fairly heavy grazing. Dense or tall stands of grass and forbs get less use unless opened up here and there by cattle or sufficiently clear beneath to permit the birds to move around readily. Pastures of bunchgrass, even though heavily grazed between the clumps, often attract birds. Forage crops, mainly alfalfa or clover, are heavily used even when freshly cut and from then on to maturity. Grain fields including corn, wheat, rye, barley, or millet are less attractive unless they contain a fair amount of grass and forbs and are adjacent to grassy hedgerows or fields. But the combination of grass, forbs and high stubble or stalks following cutting holds many birds throughout the fall and winter. Only where the ground is completely bare or grass and forbs are grazed mostly by sheep to lawnlike heights are the pampas tinamous excluded.

Use according to cover composition -- Several methods were employed to secure data on cover use by type throughout the year. Excellent information was gathered by pulling a rope either by hand or between two horses over fields of known size during the spring and summer while searching for nests. Fall and winter data on cover use were secured more often by one or more men and a dog working up and back through a field until it was thoroughly covered. Only the birds flushed were counted. Either method proved to be quite indicative of the number of birds in a field at the time of count. Reliability of the rope method was checked on eight occasions by having 5 to 11 men 10 to 20 feet apart follow the rope closely. In addition, four fields were swept with a rope after being thoroughly covered by men and a good dog. In neither case were any birds flushed.

The fields censused were not selected because of known concentration of birds. No hunting was allowed in some, but at least half were



Figure 9. Short grass often provides excellent habitat for spotted tinamous.



Figure 10. Very productive cover for spotted tinamous.



Figure 11. Productive habitat often contains clumps of grass and forbs.



Figure 12. Eleven spotted tinamous were flushed from this pasture in a half hour with the aid of a dog.



Figure 13. Without moderate to fairly heavy grazing, grass and forbs may become so dense as to lower productivity for spotted tinamous.



Figure 14. Tall, dense grass and forbs attract few birds unless sufficiently open beneath to allow the tinamous to move freely about.

open to use by sportsmen. We learned early that fields of grass and forbs more than 6 inches high and fairly heavily grazed were well used as nesting sites. Alfalfa fields also were much utilized. In the process of cutting, many nests were exposed. This facilitated the collection of eggs during spring and summer months. Few fields of standing grain were censused for fear of beating down the ripening stalks.

In all, 62 fields representing 1,758 acres were censused in a total of 84 trips. Most fields were checked only once or twice, but several were censused repeatedly in the same month to check on variations in the number of birds flushed. The work was carried on throughout the year though no one field was checked in all 4 seasons. Thus no attempt is made here to rate cover types according to the degree of attractiveness for pampas tinamous, but some more general observations are indicated.

Table 27 in the appendix presents detailed data on the number of birds flushed in each of 17 types of cover by months and acres censused. These are summarized by seasons and cover categories in table 4 for easier reference. These data, supplemented by a considerable amount of additional field work, provide the basis for the following observations:

1. Pampas spotted tinamou are adaptable to a wide variety of cover containing grass, forbs or forage crops. Of the 17 cover types censused (table 27), the least productive still held 0.3, the most productive, 2.0 birds per acre.

2. Of the various cover types censused, those with grass and moderately grazed forbs, 4 to 24 inches in height, more heavily grazed grass, and forbs with some alfalfa appeared to be attractive to birds at all seasons of the year. Alfalfa was also much used, particularly when 4 to 20 inches high. The differences in use between most of the types was not great and the data are not sufficiently complete to point out preferences in detail.

3. Cover height influences abundance. More birds were flushed from cover that averaged 4 to 12 inches in height than in shorter or taller vegetation (table 4). Fields in which the grain was 10 to 20 inches in height may have attracted more birds than the same fields when the crop was mature. Cut grain fields with 6 to 10 inch stubble in which grass and forbs were growing provided excellent fall and winter cover.

4. Cover density is also important. In general density depends upon the intensity of grazing or the age of a forage crop such as alfalfa. Moderately to fairly heavily grazed pastures held more birds than those lightly grazed or untouched by cattle or sheep. Likewise, alfalfa was often somewhat less attractive as it became taller and denser. Fields covered thickly with tall forbs or grass received little use unless opened up by grazing.

5. Cover use seldom varied much according to the season. Closely grazed fields (2 to 4 inches high) appeared not to attract birds in spring and summer when an abundance of taller vegetation was available. But in late fall and winter, and during a drought when most cover was short and sparse, birds foraged over it, particularly if it supported occasional stems or clumps of forbs or grass. In one such large pasture we saw 5 birds, some as far as 200 feet distant from us, in May while covering 11 acres. Most other types also held birds well throughout the year.

6. The effect of easily recognized edges, providing cover type interspersion, is less well documented with pampas tinamous than with many other species of game birds except in large fields of alfalfa or grain. In fields of grass and forbs, unless intensively grazed, the normal use by cattle provided trails often utilized by tinamou as travel lanes. A scattering of taller, less palatable species and frequent small patches of less heavily utilized vegetation were also present in habitat of pampas tinamous. This interspersion in height and species provided edges on a small but apparently important scale. In alfalfa, birds were flushed from all parts of the field but in one 52-acre plot the center 22 acres contained only 2 birds, the outside 30, 18.

7. The number of birds in a given field varied substantially from day to day. In one 15 acre field of moderately grazed grass and forbs, swept by a rope, 3 birds were flushed; a few days later 21 were seen.

8. Congregations of birds occasionally occurred though the spotted tinamou is not normally gregarious. In one field of grass, forbs including thistles, and about 20 percent alfalfa, 13 birds were flushed from $1\frac{1}{2}$ acres. Occasionally a high density of birds was found well scattered over much larger fields. On the hunt, previously mentioned, 198 tinamous were flushed from a well-grazed 85-acre field. In composition it was 40 percent rye, 40 percent alfalfa, and 20 percent grass and forbs, mostly 4 to 8 inches tall with some higher stems.

9. Nesting cover was enhanced in heavily grazed pastures by an abundance of large thistles. Cattle tended to avoid these, thus providing more protection against trampling for the nest.

10. Alfalfa attracted, but "improved" pastures repelled birds. Many of the best fields censused contained at least a scattering of alfalfa or clover. Conversely so called "improved" pastures, composed almost entirely of grass with few forbs, supported but few birds unless more adequate food producing vegetation was close by.

11. Bunchgrass, when common to abundant, even in heavily grazed pastures, attracted many birds because of the shelter provided.

The types of vegetation particularly preferred for roosting and nesting are discussed in the section on General Habits.

A few observations not falling within the topics discussed above are worth recording. While many birds were not often located in grain fields, including corn, this type was often used as escape cover. For example, of 19 birds flushed from alfalfa on October 30 all flew into an adjoining field of oats 10 to 15 inches high rather than back into the alfalfa or to equally available grassy pastures. Three of six birds put up along the edge of a large field of grass and forbs in January chose shelter in an adjoining field of standing corn.

Birds also were not afraid to forage out from cover into very heavily-grazed pastures where the grass was turflike with little taller vegetation. Spotted tinamous were encountered, not infrequently, 50 to 200 feet out from denser vegetation as well as in alfalfa fields that had been close cut only 1 to 4 days earlier. Occasionally birds even chose to forage on freshly plowed or planted ground.

Effect of weather on cover use -- Weather may also affect cover use. On October 11, following heavy wind and rain only 4 birds were flushed from a usually well occupied field of grass and forbs 4 to 6 inches high with thistles up to 12 inches. At the same time 13 individuals were heard calling from an adjacent field of wheat 9 to 12 inches high.

Few pampas tinamous were observed where the ground was soggy even though the vegetation appeared otherwise to be attractive. Yet, for short periods, birds did not seem to mind flooded fields as is evidenced by an April observation of 3 birds apparently feeding on insects in a field of forbs and grass covered by 2 inches of water. Birds in our pens would without hesitation walk or run through puddles of water that gathered following a rainstorm.

Topography and Elevation

Almost all of Argentina within the range of the spotted tinamou is low, flat to rolling country. In the Sierras de la Ventana in southern Buenos Aires Province we collected these birds at the base of the mountains, but interior upland valleys held only the pale spotted form (N. d. darwini). Though topography of the habitat is probably more important than elevation, no spotted tinamous were collected more than 1,000 feet above sea level. Minor irregularities of the ground such as grassed-over sand dunes, small ravines or deep river banks, though used largely as escape cover, were accepted.

Soils

Four broad soil types are included within the range of the spotted tinamou. The Patagonian spotted is resident on brown soils of the planosol group. These soils are high in nutrients with a conspicuous layer of accumulated lime in the subsoil, but they usually occur in regions so arid as to provide relatively sparse grass.

SOILS

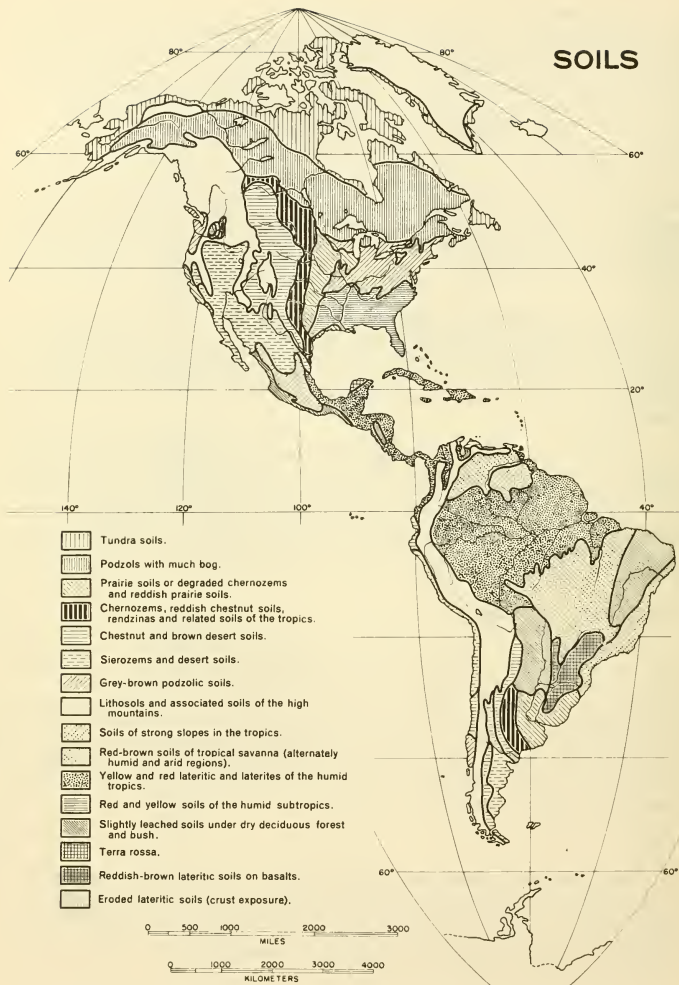


Figure 15. Distribution of major soil types for the Americas.
Map modified from Van Royen (1954)

In contrast the soils of the pampas are chernozems that have developed under luxuriant grass cover in a temperate climate. They are stoneless, blackish, claylike, very fertile, and moderately alkaline. The distribution of the pampas spotted tinamou corresponds rather closely to soils of this type.

The spotted tinamous of northeastern Argentina are confined mainly to the red-yellow podzolic soils common in many subtropical regions. This soil is largely clay and rather low in plant nutrients.

The swamp spotted tinamou in northern Argentina and Paraguay seems to prefer alluvial soils deposited by the Parana River but may extend southwards and westwards to the reddish-chestnut soils. These probably developed when the climate was warm but dry.

The soils of the western Chaco, home of the spotted tinamou by that name, are mainly reddish-brown, with an accumulation of lime in the upper subsoil. Though high in plant nutrients they are so arid and often so salty that only scattered grass, forbs, shrubs, or stunted trees will grow, except where fresh water from the mountains or from periodic flooding is available.

Figure 15 illustrates the general distribution of soil types within the range of spotted tinamou together with the distribution of soil types in North America.

Climate

Throughout the Range

Of the 9 species or subspecies of spotted tinamous, 3 occupy tropical to subtropical climatic zones, 3 subtropical to lower temperate and 3 lower temperate zones. In Argentina about one-fourth of spotted tinamou range lies in the subtropical and three-fourths in the lower temperate zone. Here average maximum temperatures seldom exceed 90 to 95°F in summer; average minimums are normally from 30 to 45°F in winter with occasional short periods of 15 to 20°F in the more southern habitats. Annual precipitation ranges from less than 10 inches for the Patagonian spotted tinamou to 20 to 45 inches for the pampas subspecies and 30 to 60 inches for the northeastern spotted tinamou. Normally the rains come from late spring (November) through early fall (March) often in the form of heavy downpours with little to moderate precipitation in winter (June to August). Snow is uncommon to absent. Relative humidity over most of the range of the spotted tinamou in Argentina is highest in late fall and winter, when precipitation is least, and lowest in summer with the annual average lying between 65 and 75 percent. Dry periods of 2 to 5 months are normal with some subspecies and even in the pampas and the northeastern part of the country where precipitation usually is well scattered throughout the year, droughts are not infrequent. Dew is normally substantial.

Table 5. Average maximum and minimum temperatures and average precipitation by seasons in the range of five subspecies of spotted tinamous.

Temperature and precipitation by seasons(a)	Subspecies of spotted tinamous												
	Patagonian (d)		Pampas		Northeastern		Swamp		Western Chaco				
	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	
Spring (b)													
Avg. maximum	71.2	78.3	62.1	74.1	78.8	68.0	79.9	82.9	77.5	86.2	87.8	83.7	89.1
Avg. minimum	45.9	48.2	44.6	49.6	55.4	44.6	56.7	60.8	52.3	60.7	63.1	57.7	60.2
Avg. monthly precipitation	0.8	1.3	0.3	3.0	4.2	2.1	4.2	6.1	2.9	4.2	5.0	3.3	1.7
Summer													
Avg. maximum	83.1	89.6	72.9	87.0	89.6	82.4	91.0	92.7	88.3	94.5	96.3	93.2	95.0
Avg. minimum	56.8	60.3	54.9	62.4	66.2	55.4	66.2	70.3	63.1	69.0	70.3	67.5	68.0
Avg. monthly precipitation	0.7	1.1	0.4	4.0	4.5	2.0	4.5	5.8	3.8	4.9	5.6	4.5	3.3
Fall													
Avg. maximum	69.3	73.4	64.9	73.2	77.0	68.0	78.8	81.1	75.2	83.6	85.5	81.9	82.6
Avg. minimum	46.6	49.5	42.5	51.1	55.4	46.4	57.9	62.1	53.6	61.4	64.0	59.0	58.3
Avg. monthly precipitation	1.2	1.9	0.6	3.6	5.4	2.4	5.0	6.7	3.7	4.3	5.5	3.6	1.7
Winter													
Avg. maximum	55.9	58.2	53.1	61.2	68.0	55.4	69.1	72.1	64.4	75.0	77.0	72.9	74.8
Avg. minimum	36.0	37.9	32.9	41.3	48.2	35.6	48.7	53.1	44.1	52.3	54.3	47.7	47.3
Avg. monthly precipitation	0.7	1.0	0.4	1.6	2.8	0.8	2.4	4.4	1.1	1.5	2.4	0.8	0.4

(a) In degrees Fahrenheit or in inches for 1941-1960.

(b) Spring, September to November; summer, December to February; fall, March to May; winter, June to August.

(c) Highest seasonal average recorded by one station within range.

(d) Lowest seasonal average recorded by one station within range.



Figure 16. Distribution of major climatic zones for the Americas.
Map modified from Van Royen (1954)

Temperatures and precipitation for each season of the year varies somewhat for each subspecies of spotted tinamou. These are presented in table 5 for five subspecies. For greater clarity temperatures are expressed as average maximums and average minimums by seasons rather than as simple averages or medians.

Climatic comparisons between Argentina and the United States

To provide a quick, visual comparison the broad distribution of climatic regions in North and in South America, according to Van Royen (1954), are presented in figure 16. For clarity however, we prefer to consider the lower half of his zone 7 in Argentina as lower temperate rather than subtropical.

A much more detailed comparison of climate within the range of the pampas spotted tinamou (*N. m. annectens*) with that of the southern United States is desirable. This was the subspecies that was wild-trapped by us and also hand-reared. It was selected because it thrives in a habitat and under climatic conditions closely resembling those in the southern United States. It is also abundant, widespread and available. The types of cover it prefers have already been described but it is less easy to analyze climate accurately. Temperature and precipitation are also paramount in considering trial introductions of a foreign species. But when averaged for comparison between native and proposed ranges they can mislead. We believe that climacurvic graphs (Bump 1951), based on the average maximum and average minimum temperatures in relation to precipitation by months or seasons provide the best means yet developed for comparing these factors in different areas. Once these graphs are made it is easy to plot thereon comparable data for any point in the United States. If the points plotted fall within or close to the lines representing temperature and precipitation the macroclimate is probably suitable.

Climacurves for the 4 seasons are presented in figure 17. These are based on records from 24 stations within the range of the pampas tinamou. On these graphs are also plotted the comparable temperatures and precipitation for 26 areas in the United States.

Upon comparison we find that temperatures in much of the southern United States fall within or close to those of the range of the pampas tinamou. Summer and fall temperatures may be slightly higher and winter slightly lower though still well within the range of tolerance for the species. Annual precipitation is normally somewhat higher in the South than in Argentina. The difference is generally slight except in winter which is relatively dry in Argentina. This is well illustrated on the climacurve for winter, and could be a limiting factor for distribution where much of the winter precipitation comes as snow. Otherwise it would probably be within the tolerance range for this tinamou. Seasonal precipitation may vary widely in Argentina apparently without seriously affecting tinamou numbers except under conditions associated with severe drought extending over several years.

Food and Water

Food preferences of spotted tinamous are about what one would expect of a grassland loving species. Great dependence is placed on forb, grass and leguminous seeds and leaves. Insects are eagerly sought at all seasons of the year. In summer, when most available, the diet may be mainly insects.

A thorough review of "El Hornero," the Argentine Ornithological Journal, and of other references uncovered only one definitive study of spotted tinamou food habits. Earlier Serie (1921), Aravena (1927) and de Costa (1960) had listed some seeds and insects found in crops or stomachs but it remained for Dr. Bonetto and Sres. Pignalberi and Saporito (1961) to make a more thorough study. Their examination of 500 crops collected over a two year period revealed 23 genera of plants and numerous insects, particularly grasshoppers, ants and beetles, to be commonly taken. Genera and species were indicated but were not listed by frequency by seasons or by volume consumed. Nevertheless, the study does provide an excellent general indication of foods taken by the pampas spotted tinamou. Much credit is due these investigators for this pioneer work.

Our studies, less comprehensive and more detailed than Dr. Bonetto's, confirmed many of his observations though differing in important details. In all, 87 crops collected from pampas spotted tinamous and representative of the various seasons were examined. Items were recorded by frequency of occurrence and by a visual estimate of volume. Time permitted only general observations on food preferences in relation to availability.

Summary

Based on the crops examined, a wide variety of vegetable and animal material was eaten. Identified were 19 families, 39 genera and 41 species of plants and 6 orders and 28 genera of insects. The food for the year was 65.8 percent plant and 34.2 animal by volume.

Half of the genera of plants providing food belonged to 3 families. Eleven were grasses, 5 composites and 5 legumes. Three-quarters of the plants identified were exotics, mostly forbs. Almost all of these are also found in the United States.

Seeds or leaves of cultivated plants, wheat, oats, rye, corn, sorghum, flax, and alfalfa, were found in 29 percent of the crops that were not empty but represented only a small part of the total volume of material consumed. They were taken largely in fall and winter.

Plants most frequently eaten included clover (Medicago), ragweed (Ambrosia), seeds of thistles (Carduus, Centaurea), crabgrass (Digitaria), foxtail (Setaria), fumatory (Fumaria), mallow (Sida), chickweed (Stellaria), and honeygrass (Paspalum). In the study by Dr. Bonetto

barnyard grass (Echinochloa), brome grass (Bromus), goosegrass (Eleusine), sensitive joint vetch (Aeschynomene) and sorrel (Rumex) seeds were also commonly reported.

Considering the volume as well as the number of seeds eaten, lady's thistle (Silybum), vetch (Vicia), wild sorghum (Sorghum), and wheat, rye and oats might be added to the list mentioned above.

Beetles (Coleoptera), followed by grasshoppers and crickets (Orthoptera), and moths and butterflies (Lepidoptera) provided the main insect food.

Food by Seasons

The number of crops examined by seasons are admittedly insufficient to provide a full picture of seasonal consumption, but they may be adequate to chart significant trends. The distribution and comparison of plant and animal components is given in table 6. From this and an analysis of table 7, the major characteristics and items of seasonal food consumption may be determined.

Table 6. Distribution of vegetable and animal foods by season in spotted tinamou crops.

Season	No. of crops		Veg. and animal	Crops by contents		% volume	
	<u>Examined</u>	<u>Empty</u>		<u>Veg. only</u>	<u>Animal only</u>	<u>Veg.</u>	<u>Animal</u>
Spring	35	10	16	8	1	59	41
Summer	6	0	5	1	0	11	89
Fall	32	6	15	11	0	56	44
Winter	<u>14</u>	<u>0</u>	<u>9</u>	<u>4</u>	<u>1</u>	76	24
	87	16	45	24	2		

Spring -- Spring foods were 59 percent plants and 41 percent insects by volume. Seeds commonly eaten included mallow, fumitory, sedge, chickweed, foxtail, wild sorghum, crabgrass, and wild pansy. Though this is the season for planting cultivated grains few were taken. This is not unexpected since spotted tinamous seldom scratch or dig. Grass blades and leaflets of clover provided most of the green food.

Beetles comprised a majority of the insects taken, with the alfalfa-leaf beetle most commonly identified. Leafhoppers were also favored. Spring and summer are the seasons in which great quantities of the alfalfa butterfly (Colias) larvae and pupae are consumed. More ants were found in spring crops than in those representing all the rest of the year combined, but they proved to be less important both in numbers and volume than has been generally thought.

Summer -- With only six crops examined, our data on this season is inconclusive. However with 89 percent of crop contents by volume composed of insects, the emphasis on animal food is clear. Alfalfa butterfly larvae and pupae, owl moths, snout beetles, grasshoppers, crickets, cutworms, and ants were eaten. The emphasis on insects is a clear indication of summer food preference since the habitat also provided an abundance of plant seeds which were available and consumed at other seasons of the year. Plant food consisted predominantly of thistle seeds with one crop also containing fumitory. Grain was available but untouched.

Fall -- Almost half, or 44 percent, of the fall food by volume was also insects. Grasshoppers were taken as frequently as all other insects combined and provided the bulk of the animal food consumed. Beetles, ants and cutworms were also favored.

Four species of thistles, of which the star (Centaurea) was most important, along with foxtail, crabgrass, honeygrass, mallow, fumitory, ryegrass, bindweed, and vetch were commonly consumed in fall. Waste grain, mainly wheat and oats, were not passed by. Grass blades and clover were taken less frequently than in spring.

Winter -- As expected, seeds and leaves provided the bulk of food at this season. When available waste grain, wheat, rye, corn, and oats were commonly taken. Seeds of flax were also eaten. But ragweed was found in as many crops as were all of the cultivated grains combined. Also common were feathergrass, pigweed and leaves of clover.

Insects provided a surprising 24 percent of winter foods by volume consumed. Beetles led the list with grasshoppers a close second. As in spring considerable attention was paid to the alfalfa-leaf beetle. Only one crop contained ants.

Economic Importance

It has long been recognized that most noxious insects in nature are controlled much more by their food supply and by diseases and parasites than by birds. Yet the number of alfalfa butterfly larvae and pupae, alfalfa-leaf beetles, grasshoppers, cutworms, and corn root borers eaten by spotted tinamous represents an additional natural control not to be overlooked. One bird, collected in summer, had eaten 15 alfalfa butterfly pupae; a winter crop contained 43 alfalfa-leaf beetles.

Protein Intake

The contents of six representative crops collected in late fall were submitted to the Cargill Poultry Nutrition Laboratory in Buenos Aires for protein analysis. The average of these was 19.18 percent.

Other Items of Interest

Foodwise, spotted tinamous are least active in mid-morning. Full crops were the rule in late afternoon. Of 87 crops collected, 16 were empty. All of these were collected between 9:00 a.m. and mid-day.

Though these birds consume a large amount of insects they are still largely omnivorous. Of 71 crops with food, 45 contained both plant and animal material; 24, plants only; and 2, only insects.

While 41 plants and 35 insects were identified, availability still seemed to play a substantial part in foods chosen. For example, four birds were shot in a field composed of 30 percent rye, 40 percent alfalfa and 30 percent forbs and grass. Their crops contained 97 percent rye, by volume. In general, where cultivated grains were left following the harvest, substantial amounts were eaten. Yet birds were equally abundant on large ranches where no cultivated grains were grown.

While ants are less sought after than many other insects, they are by no means shunned. One bird, shot in fall, had eaten 480 small thief ants which were 83 percent by volume of the crop contents.

Animal food other than insects was rarely taken. One bird collected in early winter had eaten a $1\frac{1}{2}$ inch segment of an angleworm. Another collected in spring held 2 slugs. Liebermann (1936) reported birds feeding on rats (presumably dead) and hamburger made of ground beef was eagerly accepted by captive spotted tinamou. Also eaten, according to Bonetto (1961), are millepedes (Diplopoda), spiders (Aracnida), and snails (Gastropoda).

Grit was seldom taken, probably because pampas soils contain almost no stones. Glass, tile and brick were each found once in separate birds. Grit, fed to captive tinamous was freely utilized.

Water

Open water for drinking appears not to be a necessary part of spotted tinamou habitat in Argentina. These birds seldom range far afield and are still abundant in areas far removed from streams, pools or puddles. Dew is normally substantial and was frequently utilized by our birds in captivity even though waterers were always available. Leaves and grass blades were present in many crops examined as were soft-bodied insects.

Table 7. Foods eaten by the pampas spotted tinamou by number and percentage of occurrences for each season of the year.

Foods	Parts eaten	Season							
		Spring		Summer		Fall		Winter	
		No.	% (b)	No.	%	No.	%	No.	%
<u>Plant</u>									
<u>Ambrosia tenuifolia</u> - Ragweed	seeds	1	4.0					10	71.4
	flower heads								
<u>Ammi majus</u> - Bishop's weed	seeds	1	4.0						
<u>Asclepias</u> sp. - milkweed	seeds					1	3.8		
<u>Avena sativa</u> - oats	seeds	1	4.0			3	11.5	1	7.1
<u>Carduus acanthoides</u> - thistle	seeds	2	8.0	5	83.3	1	3.8		
<u>Carex</u> sp. - sedge	corm	4	16.0			1	3.8		
<u>Cassia</u> sp. - senna	seeds					1	3.8		
<u>Centaurea calcitrapa</u> - star thistle	seeds					7	26.9		
<u>Chenopodium</u> sp. - pigweed	seeds	2	8.0					2	14.3
<u>Cirsium vulgare</u> - bull thistle	seeds					2	7.7		
<u>Convolvulus arvensis</u> - field bindweed	seeds	1	4.0						
<u>Cucurbita andreana</u> - melon	seeds	1	4.0						
<u>Cynara cardunculus</u> - Spanish thistle	seeds					4	15.4		
<u>Digitaria sanguinalis</u> - crabgrass	seeds	3	12.0			5	19.2		
<u>Fumaria</u> sp. - fumitory	seeds	6	24.0	1	16.7	2	7.7	1	7.1
<u>Geranium dissectum</u> - crane's bill	seeds	1	4.0						
<u>Helianthus annuus</u> - sunflower	seeds					1	3.8		
<u>Linum usitatissimum</u> - flax	seeds							2	14.3
<u>Lolium multiflorum</u> - ryegrass	seeds					2	7.7		
<u>Medicago arabica</u> - spotted clover	seeds	4	16.0			2	7.7		
	leaves								
<u>Medicago sativa</u> - alfalfa	seeds	1	4.0			1	3.8	6	42.9
	leaves								
<u>Melilotus indicus</u> - sweet clover	seeds					1	3.8		
<u>Paspalum dilatatum</u> - honeygrass	seeds					5	19.2		
<u>Piptochaetium</u> sp. - ricegrass	seeds					1	3.8		
<u>Polygonum convolvulus</u> - black bindweed	seeds					2	7.7		
<u>Raphanus sativus</u> - radish	seeds					1	3.8		
<u>Secale cereale</u> - rye	seeds							4	28.6
<u>Setaria</u> sp. - foxtail	seeds	3	12.0			5	19.2		
<u>Sida</u> sp. - mallow	fruit								
	seeds	6	24.0			3	11.5		

Table 7, cont'd

Foods	Parts eaten	Season							
		Spring		Summer		Fall		Winter	
		No. (a)	% (b)	No.	%	No.	%	No.	%
<u>Silybum marianum</u> - lady's thistle	seeds			1	16.7	1	3.8		
<u>Solanum sisymbriifolium</u> - Jerusalem cherry	fruits seeds	1	4.0			1	3.8		
<u>Sorghum saccharatum</u> - sweet sorghum	seeds	3	12.0						
<u>Sorghum technicum</u> - guineagrass	seeds					2	7.7		
<u>Stellaria media</u> - chickweed	Pods seeds	4	16.0			1	3.8		
<u>Stipa brachychaeta</u> - feather grass	seeds							2	14.3
<u>Trifolium</u> sp. trefoil	leaves seeds	1	4.0			2	7.7		
<u>Triticum aestivum</u> - wheat	seeds	1	4.0			8	30.8	3	21.4
<u>Urtica urens</u> - nettle	seeds	1	4.0						
<u>Vicia</u> sp. - vetch	seeds					2	7.7		
<u>Viola arvensis</u> - wild pansy	Pods seeds	3	12.0						
<u>Zea mays</u> - corn	seeds					1	3.8	2	14.3
unidentified material	grass blades leaves								
				throughout the seasons					
<u>Animals</u>									
Coleoptera - beetles									
<u>Anisodactylus cupripennis</u>	adult	1	4.0						
<u>Astylus quadrilineatus</u>	adult	2	8.0						
<u>Bradycassis drewseni</u> (c) tortoise beetle	adult								
<u>Chrysodina</u> sp. - alfalfa leaf beetle	adult	5	20.0					2	14.3
<u>Coccinella ancoralis</u> - ladybug	adult	1	4.0						
<u>Cyphus inhalatus</u> - snout beetle	adult	1	4.0						
<u>Disbrotica speciosa</u> - corn root borer						1	3.8	1	7.1
<u>Elateridae</u> - click beetles	larvae	2	8.0						
<u>Eriopus connexa</u> - ladybug	adult	2	8.0			1	3.8		
<u>Eurymetropus fallax</u> (c) beetle	snout adult								

Table 7. cont'd.

Foods	Parts eaten	Season							
		Spring		Summer		Fall		Winter	
		No.	%	No.	%	No.	%	No.	%
<u>Gratiana lutescens</u>		1	4.0						
<u>Heilipus scabripennis</u> (c) - snout beetle	adult								
<u>Listroderes aequiroca</u> (c) - snout beetle	adult								
<u>Mitragenus dejeani</u> (c) - darkling beetle									
<u>Mitragenus coarcticollis</u> (c) - darkling beetle									
<u>Naupactus leucoloma</u> - snout beetle	adult	1	4.0					1	7.1
<u>Naupactus ovalipennis</u> - snout beetle	adult			3	50.0	3	11.5		
Scarabacidae - scarab beetle	larvae adult	5	20.0						
Diptera - flies									
<u>Allograptia exotica</u> - fly	adult	1	4.0						
Homoptera - leafhoppers									
<u>Ceresa</u> sp. - treehopper	adult	4	16.0						
Hymenoptera - bees, wasps, ants									
<u>Acromyrmex balzani</u> - ant	adult	1	4.0					1	7.1
<u>Acromyrmex lundii</u> - ant	adult	1	4.0						
<u>Acromyrmex</u> sp. - ant	adult	4	16.0	1	16.7	1	3.8		
<u>Solenopsis</u> sp. - thief ant	adult					2	7.7		
Lepidoptera - moths and butterflies									
<u>Agrotis</u> sp. - cutworm	pupae					2	7.7		
<u>Colias lesbia</u> - alfalfa butterfly	pupae larvae	2	8.0	3	50.0				
	adult								
Noctuidae - owlet moths	adult	3	12.0					1	7.1
<u>Peridroma magaritosa</u> - cutworm				1	16.7				
<u>Pseudaletia adultera</u>	larvae					1	3.8		
Orthoptera - grasshoppers, crickets									
<u>Anurogryllus muticus</u>	adult			1	16.7				
<u>Dichroplus elongatus</u> - grasshopper	adult			1	16.7	2	7.7		

Table 7. cont'd.

<u>Foods</u>	<u>Parts eaten</u>	<u>Spring</u>		<u>Season</u>		<u>Fall</u>		<u>Winter</u>	
		<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
<u>Dichroplus pratensis</u> - grasshopper	adult					1	3.8		
<u>Dichroplus</u> sp. - grasshopper	adult					3	11.5	2	14.3
<u>Gryllus</u> sp. - cricket	adult	1	4.0			1	3.8	1	7.1
<u>Scyllinops bruneri</u> - grasshopper	adult					2	7.7		
Lumbrycidae - earthworm	segment							1	7.1
Limacidae - slugs	adult	1	4.0						
Miscellaneous									
Grit	tile	1	4.0						
	brick	1	4.0						
	glass	1	4.0						
egg shells (of spotted tinamou)									
	pieces	1	4.0						

-
- (a) Number of crops containing food in which the item was found.
 (b) Percent of crops containing food in which the item was found.
 (c) Seasonal distribution unavailable.

General Habits and Behavior

Movement and Mobility

Spotted tinamous are nonmigratory and appear to be quite sedentary. They prefer to walk or run, although they fly readily when pressed. In fairly open to dense coverts their progress was alert but unhurried with many pauses. Where the cover is sparse they move more rapidly with a constant eye out for danger though still appearing to be thoroughly at home. They are very clever at sneaking away when danger threatens. One individual landing after flight was reflushed 20 seconds later some 25 feet away and at right angles to the line of flight. Its movement between the two points was unobserved even though cover was fairly short. In fact, it was usually impossible to follow an individual bird for more than 10 to 20 feet unless the field was closely grazed or, as occasionally happened, they chose to run along cattle paths.

Birds moved about readily but did not seem to be easily driven out of favorable cover or home area. In looking for nests we pulled a rope over 31 acres of a pasture composed largely of clump grass and weeds, flushing 28 birds. In covering a quarter of the same field several days later, seven birds were flushed. While individuals were seldom encountered in the same location day after day, it was normal to find them in about the same numbers in various parts of a field. Other fields, repulled, confirmed this conclusion. Yet for short periods most may abandon a favored covert. Following a rainstorm in October only four birds were flushed from a field of thistles, grass and forbs which usually contained about five times that number. Yet an unusually large number of individuals were calling from an adjacent field of wheat 9 to 12 inches high.

Birds flushed from a covert are in no hurry to return. Six birds were flushed from a field of alfalfa and weeds in mid-morning by dragging a rope. The same field checked again in midafternoon yielded no tinamous. Three days later, five birds were put up.

Individuals may occupy the same cover for a considerable period. While making repeated call counts in a field, one bird with an atypical tone to its trill call was noted. On three other occasions, the last one 3 weeks later, the same unusual call was heard from locations not far apart in the same field. Plastic identification tags were attached to three wild-trapped birds but these were seldom recontacted; the few that were seen were close to the point of original capture. Time limitations prohibited a really intensive search for the marked birds.

Flight

Some taxonomists consider tinamous to be a fairly primitive order of birds with many characteristics resembling the ratites or flightless birds. This may explain the origin of the idea that tinamous fly

poorly. Unlike ratites, tinamou possess a fairly well-developed keel on the sternum to which strong flight muscles are attached. Certainly all of the species observed in Argentina fly well.

Our second day in the field dispelled the legend that the spotted tinamou is poorly airborne. One individual, flushed 3 times in quick succession at distances of 10 to 70 feet, flew 250, 400 and then over 900 feet before alighting. On another occasion a bird flew over 1000 feet before being lost from sight. Normal flight distances are 75 to 200 feet when not frightened and from 300 to 600 feet when shot at.

Spotted tinamous launch into the air with a jump rather than a run and with a low whirl of wings. Wing beats are rapid at first until the bird gains altitude and momentum. This is followed by gliding interspersed by rapid wing beats with a longer terminal period of gliding and a slight curve upwards just before alighting.

Flight is direct, possibly slightly slower than that of a bobwhite quail, and seldom more than 10 to 20 feet above the ground. Tinamou tail feathers are at best extremely short and weak, preventing the bird from changing direction rapidly in flight. In fact, Liebermann (1936) reported that many spotted tinamous were killed by contact with barbed wire when the Argentine pampas was first fenced.

Country folk reported that rain-drenched spotted tinamous were often incapable of flight. We found only that they were more reluctant to fly immediately after heavy rains.

When two birds, usually a pair, are travelling together one bird will usually flush a few seconds earlier than the other. Often they do not fly in the same direction.

Wariness

Spotted tinamous are nervous but not particularly wary unless heavily hunted. Usually, when disturbed, they attempt to walk away from danger or to sit tight unless closely approached. Once they move it is difficult to keep track of them without a good dog. They seem to drift away from you and to lie somewhere else than in the spot where last seen. Surprised by a car or a person on foot, they often appear unconcerned while utilizing patches of cover or irregularities of the ground for concealment and escape but some individuals would forsake adequate cover by walking into cut alfalfa or short grass for 50 to 100 feet then appearing to eat nervously. Pursued, they soon took to flight.

During the hunting season we were never able to decide whether the majority of spotted flew or froze when closely approached. It was not unusual to have birds fly 30 to 75 feet in front of us or our pointer. Others had to be kicked out of a clump of grass and forbs practically at our feet. In our search for nests, birds would usually

fly when 5 to 10 feet ahead of the rope used to flush them. But on two occasions, Janet Bump who often followed the rope to pinpoint flush locations, put up birds that had merely squatted and let the rope pass overhead. This was unusual, but we have also seen birds so unconcerned as to be up-ended by the rope jerking over a patch of short grass and forbs.

Where hunting is heavy, these birds soon learn to associate man with danger and often flush wild.

For some reason many birds are attracted to roadsides where they move about with apparent unconcern for passing cars. But let one stop, the birds freeze and then sneak away, though they seldom go far. A favorite trick of hunters is to shoot them on the ground from a slow moving car or to try to find them as they move away. Once lost sight of, few sneaking birds are flushed without a dog.

In captivity the spotted tinamous were the most nervous of all those studied. Their movements were quick and incisive and even pen-raised birds seldom became tame enough to take food from the hand.

Dusting and bathing

Dusting birds were frequently observed in our pens. This practice is instinctive for spotted tinamous only a few days old would attempt to dust on the clean, white paper toweling that covered the bottom of the brooders. This proving unsatisfactory they would forsake it for the mash in the open dish of feed. Adults often scooped out holes several inches deep while dusting where the soil was friable.

Although bathing was triggered by the advent of rain the desire to bathe was even stronger than to dust among our penned birds. Particularly with the advent of warm weather the pens would frequently be sprayed with water. In almost every case, with the first drops, the birds would squat, turn on one side and lift one wing over the back exposing the flank much as do some pigeons and doves. After a few moments most would arise, shake themselves and bathe again. In fact so strong was the urge that, when one pen was sprinkled, most birds in adjacent pens would go through all the motions of bathing in evident anticipation.

Resting and roosting

No preference for any particular type of cover for resting was noted.

Roosting sites, always on the ground, were observed in all types of habitat except uncut grainfields. Fairly open cover, often moderately to heavily grazed pastures, usually contained many roosting locations. Each was marked by a slight hollow, usually snuggled into



Figure 18. Bathing in the rain.

the ground cover under overhanging clumps of grass or among the forbs. The accumulation of droppings was often so substantial at a site as to indicate continued use for more than one night.

In sandy soil a definite night hollow, up to 2 inches deep, may be scratched out, the bird half squatting and turning in one or more full circles in the process.

These birds never covey at roosting sites though in one instance two were found only 3 feet apart under forbs 6 inches high in a pasture where the grass averaged but 4 inches. The pair-bond is not especially strong but in our pens some pairs would roost side by side during the breeding season.

Breeding

Period -- An examination of testes, egg sacs, and ova of 69 pampas tinamous collected throughout the year indicates that, while breeding may begin in late winter (August) and continue into fall (April), the usual period is mid-September to early March. The onset of breeding varies greatly among individuals. The situation throughout the year may be summarized as follows:

Winter. Through June and July the testes are minimal in size. The average for 15 shot birds was 5.1 by 2.8 mm for the left and 5.6 by 2.6 mm for the right testis. Of two birds collected in August one had slightly enlarged testes while the right testis of the other was 11.5 by 6.0 mm in size and the left was missing. Testes normally begin to enlarge at this time.

In the females both ovary and ova were dormant in June and July. The ovary in 8 birds averaged 14.7 by 6.5; the largest ovum 1.2 mm.

The ovary of one bird measured in August was 17.1 by 8.0; the largest ovum 2.0 mm.

Spring. Predictably the testes averaged much larger from September through November in nine birds examined but showed wide variations. Three collected in September were enlarged by only a quarter; one enlarged by three-quarters, measured 13.0 by 8.5 mm (left) and 15.5 by 8.4 mm (right). The testes of one bird collected in October were only enlarged one-eighth, another by three-quarters. Two males shot in November were in full breeding condition, the left testis averaging 16.6 by 13.6 and the right 17.8 by 13.7 mm.

A greater variation in the size of female than of male gonads was apparent in spring. Of four females taken in September and October, three showed no development. Another, shot in September, was laying judging from the enlarged oviduct and an ovum almost ready for passage.

Summer. No wild males were examined between December and February. Two females collected in January had been laying.

Fall. Ten males were examined from March through May. One bird measured in March and two of four in April still had testes partly enlarged. The largest pair of testes measured 9.0 mm long (left) and 9.7 mm (right). Regression to winter size was evident in two other March birds. All five birds measured in May had very small testes averaging 4.7 by 1.3 mm (left) and 4.6 by 2.3 mm (right).

Two females taken in April and three of four in May had small gonads, the ovary averaging 17.0 by 5.0 mm, the largest ovum 1.1 mm. Regression in one May bird was still incomplete, the ovary being 16.0 by 10.0 mm with the largest ovum 4 mm.

Table 21 in the appendix provides the supporting data for the above summary.

Age may affect the period at which breeding begins. Before sexual maturity and during the quiescent winter months the penis is wormlike. Beginning in late July or early August it may begin to thicken, swell and become clublike with a knob at the tip as the season progresses. Between August 11 and 24, pampas spotted tinamous, some wild-trapped near Los Conquistadores in northern Entre Rios, some pen-reared, were aged by size, weight and feathering or time of hatching. Penis development was then determined in the males by extrusion through pressure on the sides of the cloaca. The results, presented below, indicate that about twice as many adults as birds of the year were already entering the breeding season by mid-August.

Table 8. Age as related to the development of the penis in male pampas spotted tinamous at the beginning of the breeding season.

<u>Shape of penis</u>	<u>Adults</u>		<u>Young</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Wormlike	11	30	51	65
Partly swollen	2	5	2	3
Clublike	24	65	25	32
	37	100	78	100

Age in relation to the onset of the breeding season among females is much more difficult to determine. Pen losses were minimal and no external way of determining ovary or ovum size was available. Furthermore, from the females examined ovum size appeared to be an unreliable indicator of breeding condition since the development of ova is very rapid just preceding laying and they may remain almost pinhead in size between clutches.

Breeding age -- Spotted tinamous mature very rapidly in behavior and morphologically. Males and females, hatched in January, were observed to mate in September. The postmortem of one male 10 weeks of age revealed a penis in breeding condition. Joseph Hardy, biologist at the Tennessee State Game Farm, reports that females, hatched in April, began laying eggs 57 days later. Among game birds known to us only the coturnix quail normally matures in a shorter period of time.

Effect of interzonal hemispheric transfer -- The effect on breeding of transferring tinamous from the southern to the northern hemisphere was an important consideration to those State biologists who are attempting to propagate these birds for trial liberation. Over a 2-year period, 237 pampas spotted tinamous, pen-raised in Argentina, were sent to six States cooperating in this experiment. Shipments, by necessity, continued from the middle to the end of the breeding season in Argentina. These birds were then penned in mid to late winter at State propagation units.

Interruption of the breeding cycle was surprisingly small. Many adults again entered the breeding cycle after a rest of only 3 or 4 months. Some young of the year also started to breed at an earlier age than was normal in our pens in Argentina.

Birds held in quarantine near New York, following winter shipments, were kept warm under infrared lamps. As expected this stimulated a breeding response. In at least three cases egg production was resumed in quarantine or during shipment to recipient States. Those eggs that were set did not develop.

Behavior during the breeding season -- Only two instances of behavior associated with the breeding season were observed in the wild. On October 13 we saw one bird chasing another across a field, obviously

interested in mating. The bird ahead ran, flew a short distance, ran flew again, than continued running. In between there were several pauses during which the pursuer attempted to mount the pursued.

The second observation on the same day probably involved both breeding and defense of territory. A single bird walked in a wide circle, calling frequently. Soon it was joined by a second. The probable pair continued on together for some distance before encountering a third bird. One of the pair then slowly circled the intruder weaving back and forth and making threatening passes with its beak. Apparently discouraged after more sparring, the intruder slowly retired. Shortly thereafter the pair separated. One joined up with and subsequently chased another bird until out of sight. The other member of the pair returned to a spot about 10 feet from a nest containing four eggs and was lost from sight.

Breeders in captivity, penned 1 male to 1 female, 1:2, 1:4 or 2:2, were not particularly pugnacious during the breeding season. Chasing was minimal and the relation between the sexes was generally undisturbed until the female, by squatting, indicated a desire to mate.

Mating behavior -- Of the seven species of tinamous studied in captivity at the Buenos Aires Station five might be characterized as leisurely breeders. With the crested tinamou (Eudromia) chasing was determined and quick, and short contact the rule.

In captivity coitus was usually triggered by the sudden squatting of the female spotted tinamou. Occasionally the male picked gently at or slowly attempted to mount a walking female in an obvious effort to force her to squat. Such behavior often continued for several minutes usually ending in the hen squatting of her own volition. Unsuccessful pursuit was repeated frequently throughout the day.

Mounting was leisurely and usually completed without use of neck or back feathers of the female for support. Treading was deliberate with the feet alternately stroking the back in slow movements for five to ten seconds interrupted by a period of complete quiet of about the same duration. This routine was occasionally interrupted by the male picking lightly at the bill of the motionless female. On several occasions males were observed to pause, straighten up, call and then continue treading. Not infrequently males slipped and fell off the hens. The females then often shifted their position, while still squatting, or raised up and walked away with the males in slow pursuit.

Curiously enough it appears to be the male who requires this extended period of excitement. Not uncommonly the female raised her rump feathers and dilated the cloaca several times as the male attempted unsuccessfully to make contact. The actual period of coupling occupied but a few seconds. Then the hen raised up and walked away. At the instant of completion the male frequently seized the female by the feathers of the upper back, slipped off the female and was dragged along for several feet. The female then shook her feathers

and unconcernedly resumed her normal activities. The male appeared exhausted for about 30 seconds.

Promiscuity and homosexuality -- The frequency of these traits in the wild is unknown. Both were observed among penned spotted tinamous. When two males and females were penned together both males might attempt simultaneous mountings. The unsuccessful one might mill vigorously around the breeding pair but was never seen to dislodge the mating male. On October 9 a male was observed treading a female. He slipped off and his place was immediately taken by another male without objection from the female. This mating was successful.

We were surprised also to observe homosexual breeding activity among females on several occasions. On November 2 in a pen containing several birds of each sex, normal breeding was in progress. After about 3 minutes the female shifted her position causing the male to lose his balance. Immediately another female mounted the squatting hen. The subsequent actions of both females conformed precisely to those of the normal mating ritual except in the final stages. Later, in confirmation of sex, both birds were caught and again sexed by cloacal examination. Both were unquestionably females. The same practice was also observed on an earlier occasion among penned pale spotted tinamou females (Nothura darwini).

Time and frequency of mating -- During the height of the breeding season spotted tinamou in captivity were likely to mate at any hour of the day. At the beginning and towards the end of the season, mornings until 9:00 a.m. and afternoons from 4:00 p.m. until dusk represented favored periods for breeding.

It was not unusual to observe the same pair of birds attempting to mate, often apparently successfully, two or even three times in the same day.

Nesting and Renesting

The male spotted tinamou builds a shallow nest lined casually with grass, forbs and usually a few feathers. It is normally located on the ground and is well concealed by vegetation.

During 2 years of field work, the nests of 37 pampas spotted and four of northeastern spotted tinamou were located. Of these, 16 were found by pulling a rope over some 1200 acres of fields and pastures, 16 by local residents, six while cutting alfalfa or hay, 1 from horseback and two with the aid of a dog. Many additional nests were uncovered by men mowing alfalfa who collected any unbroken eggs for us but kept no records. School children, asked to help, came up with seven of these nests and were rewarded by a brief talk on game birds and conservation. The data for each nest were entered separately on the form illustrated in figure 41.

Period -- Nesting reportedly begins in early September and lasts until March. We located no nests before October 10 probably because little intensive searching was carried out except in October and November. The latest nest was discovered on April 6, contained six eggs, and had recently been abandoned. Pereyra (1928) discovered a nest that contained three eggs near Zelaya, Buenos Aires, on June 3 and reported finding nests from August to April.

Location -- All but one of the nests for which data are available was placed on the ground. The exception was a single nest about 6 inches off the ground in the center of a clump of bunchgrass.

In cover of uneven height, nests are usually located in or at the edge of clumps which varied in heights from 6 to 30 inches and averaged 13. Since most pastures were moderately to heavily grazed, the clumps were normally small, spreading from 8 to 48 inches in diameter and averaging 19 inches. The lower wide spreading leaves of tall, robust thistles provide favored concealment and some measure of protection from cattle in heavily grazed pastures. Eight nests were located here, six in grass clumps, three in grass and forbs, two in clumps of grass and alfalfa, two in bunchgrass, and one under the tangled, broken down stems left after wheat was cut.

In fields of alfalfa and in ungrazed pastures the vegetation is generally rather uniform in height. If not too dense such cover is also commonly utilized for nesting as evidenced by 19 nests located therein.

There appears to be a preference as to side of a clump on which most nests are placed. A choice is evident, for 13 nests were on the warm north side and three each to the east and west. No nests faced south.

Occasionally nests were placed close to each other. An enclosure, approximately 50 feet square, containing a tank for water storage surrounded on three sides by almost bare ground and on the fourth by a field of wheat 12 inches tall, had grown up to forbs and grass. Two nests, both with eggs, were located about 40 feet apart within the enclosure.

More than one nest was often found in the same field. In one pasture composed of 80 percent grass, 15 percent forbs, both about 10 inches in height, and 5 percent taller thistles, 18 birds were flushed including eight from nests by sweeping the area with a rope. Included in this pasture of about 75 acres were 60 head of cattle and six horses.

Types of cover preferred -- Spotted tinamous utilize a great variety of cover for nesting. Our data cannot be used to determine preference since equal amounts of all types of cover were not censused and records indicative of the total acreage of each type checked are incomplete. But the data are indicative of use.

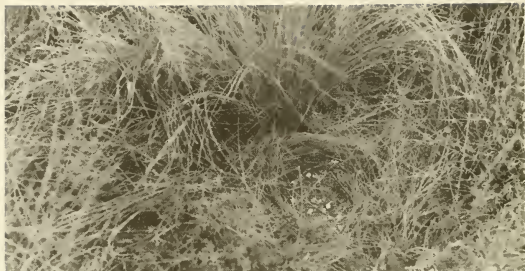


Figure 19. Night roosting spots are identified by droppings.



Figure 20. Nests are well hidden even in short grass.



Figure 21. Thistles provide favored sites for nesting.

Fields of alfalfa, where available, were commonly chosen for nesting as evidenced by 15 nests found therein. Fields, predominantly grassy or of grass and forbs, accounted for eight nests each. Seven were located in pastures in which grass and alfalfa were the predominant cover. Bunchgrass, a favorite nesting cover, accounted for two nests and wheat stubble, with much adventitious forbs and grass, for one.

Height and density -- The average height of the vegetation in a field seldom seems to affect its choice as a nesting site. True, no nests were found when the average height was less than 3 inches and only one where it was 30 inches, but nests were placed in cover of all heights between these extremes.

The substantial use of heavily grazed pastures for nesting was surprising. Eleven nests or 27 percent were located in fields where the general height of the vegetation was only 4 to 6 inches. In such comparatively open situations a clump of grass and forbs, a thistle or even a slightly higher patch of vegetation provided cover sufficient for nesting.

The height of the vegetation in fields, of course, varied by type and intensity of use. Seven nests were located in fields of grass and alfalfa in which cover height was from 5 to 24 inches with a median of 6 inches. Eight nests were uncovered in grassy fields. Cover height here ranged from 4 to 30 inches with a median of only $7\frac{1}{2}$ inches. Grass and forbs, often less intensively grazed, held eight nests in vegetation ranging from 6 to 30 inches with a median of 15 inches. Fifteen nests were discovered in alfalfa from 12 to 28 inches tall with a median height of 16 inches. Bunchgrass 15 to 30 inches in height, with the intervening grass often grazed down to 2 inches, contained 2 nests. One nest was found in wheat stubble 6 inches high mixed with adventitious grass and forbs.

Dense vegetation and tall forbs are usually avoided unless they are open beneath and interspersed with well-grazed patches.

Edge effect -- Many game birds prefer to locate their nests close to a road, trail or the edge of a field. No such tendency is noted with the spotted tinamou. Nests were found from 1 to 900 feet from a change in cover type. The average distance was 156 feet.

Construction and character of the nest -- Male birds are supposed to construct the nest. This always proved to be the case among our captive tinamous. The male selected the site, then scratched or snuggled out a depression 1 to 2 inches deep in the vegetation, seldom removing much if any dirt. This depression was then loosely lined with grass to which a few feathers were usually added. Of 32 nests, for which we recorded the lining, six used only grass and 26 grass plus feathers. Five to 10 were the usual number although 34 feathers were counted in one nest.

Reaction of male to the discovery of the nest -- Most males sit tight on the nest to avoid discovery. Birds normally did not flush until they were closely approached on foot or almost touched by the census rope. In fact one bird sat so tight that it was stepped on, injuring the bird and rupturing 2 eggs. The maximum distance at which birds were flushed from the nest was 6 feet. In cutting alfalfa on one of the King ranches in Argentina, birds were killed frequently by the cutter bar. Many of those found on or alongside a nest were sexed. All were males.

In captivity our birds, when disturbed, would slowly move off the nest. In the field wild individuals when flushed from the nest flew strongly from 60 to over 600 feet. The average flight for 14 males was 270 feet.

Abandonment of the nest -- Of the nests located and subsequently rechecked only one was abandoned. Another nest with six eggs had apparently not been sat on for some time before it was located by us. Birds flushed from nests usually returned to them within $1\frac{1}{2}$ to 4 hours.

Renesting -- This term may be inappropriate when applied to the spotted tinamou and, we suspect, to other tinamous as well. Normally with game birds it refers to the tendency for a species to lay and incubate a second clutch of eggs when the first has been destroyed. With spotted tinamous the situation might be more aptly described as almost continuous reproduction throughout the breeding season. Various authors have hinted that this may be true. Liebermann (1936), Godoy (1963) and Buchanan (personal communication) all indicate that 3 to 4 broods a year are normal.

From field observations it would appear that nesting is the rule from early spring well into early fall. Alfalfa cutters reported about as many nests mowed over in January as in October. We observed young birds with about the same frequency from mid-spring to early fall. True, the latter could have represented late nesting birds but from our observations of captive breeders this would appear unlikely.

Throughout the 1965 and 1966 breeding seasons, intensive propagation experiments were conducted with 25 to 40 hand-reared breeding spotted tinamous. All were marked for easy identification. Mating was observed and in a number of instances the same females laid eggs at frequent intervals from early October well into January. Some males constructed rough nests in which eggs were laid but proved to be too nervous to incubate until liberated in a large enclosure containing adequate natural cover. Here one male hatched three successive broods in quick succession. The first brood was lost in very heavy rain at 7 days of age. Within 2 days thereafter the male was singing and within 10 days was again firmly setting on eggs, though in another nest. Shortly after hatching, the second brood was removed. Within 11 days the same male was again incubating. Captivity often engenders abnormal reactions but here, at

least, is an indication that many males make new nests and incubate new clutches of eggs in quick succession.

Eggs and Egg Laying

Size, shape, weight and color -- The eggs of all tinamous observed are large for the size of the bird. In fact, though spotted tinamous are only about one-third the size of a bantam chicken, the eggs are almost as large. Sixty eggs, collected from wild nests over two seasons, averaged 43.6 by 31.3 mm, and varied from 47.9 to 39.0 by 36.1 to 29.0 mm. The average weight of 17 unincubated wild eggs was 22.8 grams.

The eggs are unspotted and of a rich chocolate brown to deep wine color. The shape is broadly oval but slightly pointed at one end. Slight variations in size, color and shape often allowed us to identify the eggs laid by different females. The shell is weak but of a lustrous, porcelainlike texture, quite unlike those of most game birds.

Laying habits -- In captivity two or more females often lay in the same nest. In fact, three eggs were added to one nest in the large enclosure in one day. This suggests that, in the wild, two or more females may contribute to the clutch which is thus completed in a few days.

One or more females may continue egg deposition in the same nest during incubation. Of two eggs collected from a nest partially destroyed by mowing, one hatched 2 days later, the other after 7 days.

Egg movement -- An unusual habit in captivity is for tinamous to bill the eggs out of the nest for a distance of several feet. This habit was observed not only with the spotted but also with the small brushland tinamou (Nothoprocta pentlandii) in captivity, and particularly with the red-winged tinamou (Rhynchotis rufescens). With the last named species this was observed both in captivity and in the wild.

The following notes are descriptive of this habit among our penned birds: October 9 - two eggs of the pampas tinamou found, one 12 inches out of the nest, one in. Marked both eggs and returned to nest. October 10 - both eggs again marked removed from the nest and again returned. October 11 - one egg out, one in nest. With each of the above named species the eggs were returned to the nest by the birds before incubation commenced.

Clutch size -- The number of eggs in a clutch has been recorded as from 5 to 8 (de Costa 1960), to 9 to 12 (Buchanan, personal communication). In checking 37 nests, we found clutch sizes to vary from 3 to 9 with a median of 5.

Time of laying -- In our pens, eggs were usually deposited in the morning, often before 9 o'clock. Out of 53 eggs in which the time of laying was recorded, 43 were deposited during the morning and 10, in the afternoon.

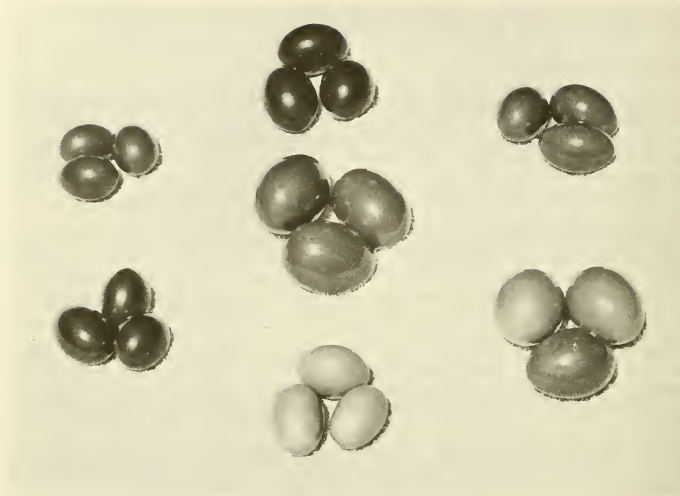


Figure 22. Tinamou eggs by species.

	Large brushland	
Pale spotted		Canyon
	Red-winged	
Spotted		Crested
	Blue	

Interval and duration of laying -- The same female may continue egg laying at intervals throughout the breeding season. In captivity a female often laid from 5 to 10 eggs at intervals of 1 to 2 days per egg then paused for a week or so before recommencing laying. We are not sure as to the total number of eggs laid in a season by one bird since most of our pens held more than one female. It is probable that our most productive bird laid over 30 eggs. Subsequent generations in

Pale spotted tinamou	<u>Nothura d. darwinii</u>
Spotted tinamou	<u>Nothura m. annectens</u>
Large brushland tinamou	<u>Nothoprocta cinerascens</u>
Red-winged tinamou	<u>Rynchotus r. pallescens</u>
Blue tinamou	<u>Crypturellus t. tataupa</u>
Canyon tinamou	<u>Nothoprocta pentlandii</u>
Crested tinamou	<u>Eudromia elegans</u>

captivity should increase this figure. One red-winged tinamou (Rhynchotis rufescens) is reported to have laid over 80 eggs in the London Zoo in one season (Liebermann 1936). One of our redwings, penned singly, laid its 40th egg on the day it was shipped to the United States.

Fertility -- As with most game birds, egg fertility is high. Of 114 eggs collected from wild nests only 6, or 5.3 percent, were infertile.

Incubation and Hatching

The male incubated the eggs without assistance from the female. To us it was amazing to note how perfectly he has adopted the habits and practices characteristic of incubating females in most species of game birds.

The period of incubation is surprisingly short. It extended from 16 to 18 days based on our incubator records, on eggs set under bantam hens and on four nests hatched by male birds in our large enclosure.

The male is steady and reliable in incubation. In our pens, and probably in the wild, the male would be on and off the eggs intermittently for a day or two before settling down to serious setting. Thereafter he was no more easily distracted nor disturbed than would be the female of most game bird species under similar circumstances.

Upon leaving the nest, he often covered the eggs with bits of leaves and grass as do many other species of game birds. Enlarged or clocker droppings, characteristic of many incubating birds, were found from 20 to 60 feet from the nest on several occasions.

As expected, he is an extremely firm setter during the period of hatching. We often lifted the male in our enclosure enough to check the progress of the chicks when hatching only to have him settle back immediately once our hand was removed. Nor does he appear anxious to leave any unhatched eggs in the nest. One of our incubating male birds remained on a nest of three chicks and two unhatched eggs for 1½ days after the first chick emerged. During this time the chicks made a considerable number of short exploratory sallies. He finally left the nest early in the morning. That afternoon we checked the remaining eggs, heard peeping from one and placed it in our incubator. That night it too hatched. The following morning the chick was returned to the father who immediately accepted it.

Very few eggs failed to hatch. Of 108 fertile eggs, collected from wild nests, 95 or 88 percent hatched even though transported long distances over rough roads before being placed in our incubators. Left undisturbed in the nest, the proportion hatched would have been considerably higher judging from the almost complete absence of fertile eggs found in nests that had hatched in the field even late in the summer.

The male and his brood leave the nest together, usually shortly after the last chick is dry, and do not return.

The average weight of 32 chicks, hatched in our incubator from eggs already partly incubated in wild nests, was 18.6 grams.

Brooding and Rearing

The chicks are brooded and reared by the male apparently with little or no help from the female judging from observations in our large enclosure. The actions of the male toward the young and vice versa during brooding and rearing appeared to be normal in every respect. He appeared deeply concerned, attentive, aggressive and helpful with the newly-hatched chicks as occasion demanded. He encouraged the chicks in the selection of food items, calling their attention, in a low tone, to a desirable item and often encouraging them to eat by picking up food and dropping it. During the first few days he moved only short distances, stopping to brood the chicks at frequent intervals.

Our observation of one brood continued for 7 days being interrupted by a torrential rainstorm that flooded the enclosure and forced us to take the chicks indoors to be dried out. When returned to the enclosure on the following morning the male refused to accept the brood, leaving them to scatter aimlessly through the vegetation. Shortly thereafter all died.

In the wild the male normally must keep the brood well-hidden in fairly thick vegetation for we did not see a family together during our entire time in the field. Godoy (1963) reports that, unlike other tinamous, the parent of the spotted cares for the young until the next breeding season. But on three occasions while searching for nests we flushed single young, barely able to fly 15 to 25 feet, with no evidence of an adult in the immediate vicinity. Furthermore it was not unusual to flush chicks, 4 to 6 weeks of age, alone and unaccompanied. These observations point to an unusually early breakup of the brood which would facilitate the rearing of several broods in a season by the same male. The question is by no means settled, however, for a man cutting alfalfa reported mowing over a brood of 9 half grown spotted tinamous, 3 of which were killed by the cutting bar.

Gregariousness

Spotted tinamous are not sociable, never travelling in flocks but may congregate in particularly favorable cover for short periods. During the fall and winter we normally encountered single birds, well scattered throughout a field. With the approach of the breeding season pairs were common, reaching 70 percent of the birds observed during the height of the season.

Concentration of birds, while not common, did occur. Our field assistant, Maurice Rumboll, flushed 32 adults in 21 acres and 8 birds

in an area 45 feet square. We counted 13 birds in a field of $1\frac{1}{2}$ acres in late April. But in most cases where four or more birds were observed in close proximity they were pairs travelling together on courses which happened to cross.

Temperament

Both in the wild and in captivity spotted tinamous are nervous though not particularly active birds. Except where heavily hunted they could often be approached to within 25 feet. Then they would walk or run, either down a path or into sheltering cover a few feet away, holding their heads high and uttering a high-pitched note. None of our hand-raised birds became unusually tame though several that could be handled without difficulty were reared by other people. Wild birds, when penned, became as tame as hand-raised individuals in 4 to 8 months and laid readily in captivity.

Psychologically, spotted tinamous are quite adaptable, not particularly complex and fairly predictable as regards reactions. For example, a bird when caught might struggle violently for a few seconds then relax completely to the point of appearing about to expire only to burst violently from the hand, if not firmly restrained. Hudson (1920) also noted this tendency to feign death. De Costa (1960) reported them to be "timid and shy," but we found them alert and apparently not unduly concerned even when facing imminent danger. At such times they would often "sit tight" or, on occasion, face up to it by raising their feathers and extending their wings outwards and downwards thus assuming a pugnacious attitude. Liebermann (1936) quotes Pozzi as observing a bird that, when cornered by a dog, "raised its feathers, thus increasing its size, thrust back its head, shook its wings and struck the ground with its feet, thus changing it into a strange and diabolical being that was completely boss of the situation."

In captivity these birds moved about constantly with short pauses for resting, preening or dusting, though few of these activities were long continued. In general, the female appeared to be somewhat less nervous and easier to handle than the male.

Calling

Signal -- Van Tyne and Burger (1961) recognize three types of primary song: signal, emotional and territorial. One of these, the signal call, is well developed by spotted tinamous. One bird or a pair, when disturbed, often ran ahead of the intruder or into sheltering vegetation uttering fairly sharp, high pitched "quit, quit, quit" notes repeated at intervals of $\frac{1}{2}$ to 1 second for 10 to 30 seconds or until the intruder ceased pursuit. This often permitted us to follow individuals for 10 to 50 feet even through fairly dense cover until they hid or flew. This alarm call was given by both sexes.

Sclater and Hudson (1889) records another call consisting of "20 to 30 short, impressive whistling (to us peeping) notes of great compass, followed by a half dozen rapidly uttered notes beginning loud and sinking lower until they disappear." More a call than a song, this we heard not infrequently from a field in which most birds were "trilling." Often it appeared to us as though the call was more commonly given when the birds were slightly disturbed and that its function in part might be to alert other birds to possible danger. Among penned birds, males were more likely to give this call than females.

Emotional -- Spotted tinamous are habitual emotional songsters throughout the year. The most frequent call is a fairly high pitched, continuous trill usually monotonic, lasting for 4 to 6 seconds. To us it somewhat resembled a much abbreviated spring song of the American toad though lower in tone. This song may end with three to five much lower, distinct notes, usually on a descending scale. The trill, deceptively soft at first, seems to come mysteriously from nowhere, swell in volume then die away in the distance as though the caller was running out of air and energy.

This trill call may be a compulsive response. Three times we observed males, while treading females, stop, straighten up, raise the head high, utter the trill call, then continue mating. On another occasion we watched a bird raise its wings slightly, squat and defecate in the middle of a call without interruption. Preening birds will suddenly stand straight up, call, then go on preening. A male pursuing a female, stopped to call then continued the chase.

Territorial calling -- One would assume that the trill call at times is used to delimit territorial boundaries. This was suggested but not definitely confirmed by field observations.

Periodicity -- The trill call may be repeated at intervals of 20 to 120 seconds. The usual time between calls varied between 40 and 65 seconds in spring and summer. Captive birds often called for several hours, rested for a variable period then commenced again.

Time of day -- Birds may be heard calling at any time of day though most frequently from 4 to 8 a.m. and again from 4 p.m. until almost sunset. In captivity, in spring, some birds called at night usually towards dawn. Both these and wild birds frequently ceased calling for a short period between 6 and 8 a.m. In late winter we noted "all species in our pens started calling at about 4 a.m. and continued at frequent intervals until about 6 a.m., stopping just at dawn and before small birds started singing." On a field trip in mid-fall (April) we wrote "out at 6:45 a.m. Sun just up. Spotted calling everywhere, at least as commonly as in spring. By 8 a.m. calling had almost ceased but picked up again between 9 and 10 in the morning."

Seasonal variation -- Birds called throughout the year though normally more frequently and over a larger part of the day in spring and early summer. In October (spring) Maurice Rumboll, our assistant, making call counts of 2 minutes duration every 15 minutes recorded 194 trilling songs between 4:30 and 6:15 p.m. On an early April morning 78 calls were noted in an hour using the same technique. This was perhaps unusual for we also have a note indicating "heard only a few birds calling in fields in mid-June and on July 17 (the Austral winter)."

Penned birds increased their frequency of calling in late winter when the average daily temperature reached 45° to 50°F.

Influence of weather -- Weather influenced but did not entirely stop calling. On foggy mornings calling was less and usually started later. Many birds were heard calling in the heat of the midday sun or during a gentle rain. Rumboll recorded the 194 calls while a storm was brewing. Calling ceased when it commenced to hail. Strong winds, particularly if cold, resulted in noticeably fewer calls.

Effect of sex -- Among our penned birds, females called more frequently than males particularly in late winter and early spring.

Incubating males on leaving the nest not infrequently called as did those with broods. Calling increased markedly in frequency within 2 days after the chicks were taken away from the male.

Audibility -- To sharp ears the trill call can be recognized from well over a quarter of a mile away on still days.

Responsive calling -- In both field and pens we often observed almost immediate response of one bird to the calling of another. Very occasionally the response to the trill call given by a female in one pen would be a half dozen sharp, well spaced notes from a female in another pen.

Interbreeding

Subspecies of spotted tinamous may cross where ranges overlap. Inspection of many birds, trapped in northern Entre Rios where both N.m. annectens and N.m. maculosa can be found, indicated clearly that crossing of the two subspecies has occurred.

No interbreeding between different species of tinamous was observed. The range of the pampas spotted tinamou closely parallels that of the pale spotted or Darwin's tinamou in many places. Many individuals collected from one or the other side of the boundary, some as close as 4 miles apart, showed no evidence of interbreeding.

In confinement, many species interbreed more commonly than in the wild. We penned spotted and Darwin's tinamou together, observed mating

and secured a few eggs, none of which were fertile. This rather surprised us since these species are difficult to tell apart except by close examination.

Predation

Throughout their range in Argentina, spotted tinamous are exposed to predators in variety and numbers at least comparable to those present in the United States. Hawks and owls are very common as are foxes, skunks, opossums, and armadillos. Raccoons and crows are absent; large snakes are only occasionally encountered.

No evidence that predation seriously reduces the number of birds was observed. During field work less than a dozen kills were noted. Of these four were avian and one was mammalian in origin. Six entrance mounds of the slow-flying burrowing owl (Speotylo c. cunecularia) were checked. On one only were feathers and the eaten wing of spotted tinamou in evidence. On all were many remains of insects, mostly beetles, and mice. It is doubtful that these birds catch many tinamous other than the sick and the maimed.

Broken up nests were occasionally encountered. Of six for which the agent responsible could be determined, three were the work of foxes, one of opossum or skunk and two of cattle trampling.

In clover or alfalfa fields the mower may be a lethal predator. Unlike the red-winged tinamou that usually runs at the approach of the mower, the spotted often sits tight on the eggs until flushed by the cutting bar. Operators estimated that at least 40 spotted tinamous were killed, 25 nests uncovered, and many eggs broken in making three to four cuttings of alfalfa in one series of fields some 200 acres in extent. The loss of birds almost ceased with the attachment of a flushing bar to the tractor.

With reproductive capacity apparently very high and overall losses from disease and hunting low, it is possible that predation plays an important part in keeping spotted tinamou populations within the carrying capacity of the coverts in which they live.

Summary of Reproductive Capacity

A distinct increase in breeding potential seems to have resulted from the polyandrous habit of the female and the acceptance of incubation and brooding by the male. The latter practice allows the female adequate time to recuperate between periods of egg laying without the substantial drain on physical resources associated with nesting and care of the chicks. The male apparently recovers so quickly from the stress of incubation and brooding as to be interested in nesting again

in from 10 to 15 days. Furthermore the brood probably disperses at a younger age than is characteristic of most game birds. The result is a high breeding potential and reproductive capacity. This minimizes the effects of losses and encourages large population increases following periods of unfavorable weather or other limiting conditions.

Breeding age -- Spotted tinamous certainly breed the first year following hatching. Some early hatched males appear to be sexually mature before the close of the breeding season in which they are hatched. As previously mentioned female spotted tinamous, penned at the Tennessee State Game Farm, commenced laying 57 days after they were hatched.

Breeding season -- Early spring through late fall.

Number of eggs -- Normally 4 to 6 with up to 10 reported in a clutch.

Period of incubation -- Short, usually 16 to 18 days.

Fertility -- Usually above 95 percent.

Hatchability -- Excellent. Probably above 90 percent.

Brood survival -- No definite information but probably low.

Life span -- Unknown in the wild; at least 4 years in captivity.

Sex ratio -- About evenly balanced. Of 182 birds shot on one hunt and sexed by gonadal examination, 90 were males, 92 females.

Ratio of adults to immature birds in winter -- Little data are available. From the early winter (June 19, 1965) hunt referred to above, 69 birds were aged by exterior and internal characters. Of these 37 were judged to be immature and 32 mature birds. Of the males examined 12 were immature and 20 mature; of the females 25 were young and 12 were adults.

Renesting -- Common and long-continued.

Diseases and Parasites

Spotted tinamous in Argentina may be less subject to disease but probably are host to parasites in number and diversity comparable to other game birds with which we have worked. Considering the importance of insects in the diet of these birds, this is not surprising.

Little was known about diseases and parasites of tinamous previous to the present study. Realizing that many parasites discovered would be new to us and some, new to science, the cooperation of parasitologists

specializing in avian parasites was solicited. Parasites with which we were not familiar were sent to Dr. Katherine Prestwood of the Southeastern Cooperative Wildlife Disease Study, School of Veterinary Medicine at the University of Georgia for identification. Some of these parasites subsequently were referred to Mrs. Maybelle Chitwood of the Beltsville Parasitological Laboratory. Dr. Elon Byrd of the Zoology Department, University of Georgia, considerably identified the liver flukes. An atypical case of blackhead was confirmed by Dr. Louis Locke at the Bureau's Disease Research Laboratory, Patuxent. Personnel under the direction of Dr. Karl M. Johnson at the Middle America Research Unit, National Institute of Health in Panama, tested spotted tinamous for susceptibility to the virus of Argentine hemorrhagic fever. As occasion required, birds were submitted to Argentine pathologists and poultry specialists for examination. We were particularly fortunate to have Drs. Byrd and Prestwood with us for 3 weeks of intensive study of tinamou parasites in Argentina.

Postmortems of dead birds were conducted by Janet Bump. Feces from captive tinamous were routinely examined for parasite eggs. When discovered and identified, appropriate elimination measures were taken.

During the investigation several hundred wild spotted tinamous were collected, and about 500 individuals were wild-trapped and quarantined for at least 2 months prior to shipment. From 25 to 50 breeders were maintained and 258 young birds were reared in our pens over a period of $2\frac{1}{2}$ years. Thus a representative sample of spotted tinamous for examination was assured.

In table 9 is presented a list of parasites found during the autopsy of 104 wild pampas spotted tinamous together with their location in the body and the incidence of infection.

Diseases

Surprisingly little evidence of disease was found among either wild or penned spotted tinamous. Losses ascribable to diseases were almost nonexistent.

Protozoan -- Coccidiosis. Birds were consistently examined for coccidian oocysts. Few were found in wild birds. Coccidiosis was not a problem among penned birds since it proved to be easily controlled by sulfamethazine or Ampersol.

-- Histomoniasis. One minor outbreak of atypical blackhead among penned spotted tinamous was confirmed by Dr. Louis Locke from material sent to the Bureau's Disease Research Laboratory at Patuxent. The presence of Histomonas sp. was also confirmed.

In the postmortem of several birds which died from blackhead, the liver and occasionally the spleen were studded with pinhead sized areas

of cream-colored focal necrosis. Few areas were raised above the surrounding tissues. No evidence of cecal involvement was present except for occasional blood in cecal contents.

-- Trichomoniasis. Trichomonas sp. was found in the ceca of two wild birds. It was not the species (T. gallinae) causing trichomoniasis of doves and did not appear to be particularly pathogenic to its host.

Bacterial or virus -- A bacterial or virus infection of the feet and leg joints was observed occasionally in several young, penned birds. This normally started with an injured toe, which, without prompt attention, resulted in badly swollen joints. The infection was sometimes controlled by the frequent application of tincture of iodine to the affected parts.

-- Non-specific enteritis of the intestine was noted in only a few young birds.

Several other diseases, common to domestic poultry in Argentina, were not recorded in spotted tinamous. Fowl pox, present on one occasion among penned large brushland tinamous did not spread to spotted tinamous. No birds were infected with fowl cholera or with Hexamitiasis, a coryza-like infection. Repeated tests for Newcastle disease, conducted by a local private laboratory employing American trained pathologists, were negative.

Shortly after our entry into that country, the hunting season on spotted tinamous was closed because of an epidemic of Argentine hemorrhagic fever in man. This serious and often fatal virus disease was presumed to be carried to man by lice and red mites on rodents and possibly on tinamous as well. Program biologists were alert to the possibility of introducing new diseases or parasites into the United States with birds provided for trial introduction. All birds were quarantined before shipment and again upon arrival but an interesting new possibility arose in Argentina. Consultations with pathologists at the World Health Organization's Zoonosis Center at Azul and the National Institute of Microbiology in Buenos Aires left doubts that tinamous were infectable or involved in transmission. Upon inquiry it was learned from Dr. Karl M. Johnson, Director, Middle America Research Unit, National Institute of Health in Panama, that the virus was transmitted, not by lice or mites but through the excreta of infected rodents. A subsequent test of five birds, provided by the Program, conducted by Dr. Webb of Middle Atlantic Research Unit, indicated no evidence of virus multiplication in tinamous. There was no danger of introducing this disease to the United States through birds shipped by the Program.

Internal Parasites

The number of species and the number of individuals of parasites per bird, were less than expected considering that spotted tinamous are avid eaters of insects. Eighty-one pampas spotted tinamous, collected from many parts of the range were examined in detail by Janet Bump over a period of $2\frac{1}{2}$ years. In addition, Drs. Byrd and Prestwood examined 23 of these birds while in Argentina under the auspices of the South-eastern Cooperative Wildlife Disease Study.

Most of the parasites identified belonged to genera with representatives in North America. In many instances, new species were encountered. Trichomonads, coccidia, tapeworms, roundworms, thorny-headed worms, and flukes were present. Of the 104 birds examined 83 percent were infected with one or more parasites; 17 percent were free of parasites. By far the most common parasites were gizzard worms (Habronema sp.) cecal worms (Heterakis sp. and Subulura sp.), and a filaroid nematode (Tetracheilonema quadrilabiatum) found in the body cavity.

Parasites of the crop -- No Capillaria or other parasites were found upon close inspection of the lining of the crop.

Parasites of the proventriculus and gizzard -- A nematode (Habronema sp.), was encountered in this area of the digestive tract. It occurred in 53 percent of the spotted tinamous examined. Dr. Prestwood suspects that two species may be represented. This appears to be one of the few parasites potentially dangerous to spotted tinamous when infection is heavy or in young birds. One pair of worms was found in a chick about 5 weeks of age and weighing 123 grams. This is about 20 grams less than normal.

Generally only a few nematodes per bird were encountered. In such cases, little effect was visible among adults. Where 10 or more nematodes occur in the proventriculus, the walls are often thickened and the organ filled with blood-streaked mucus. Mature females commonly bury their heads in the wall of the proventriculus; males more often occur in the area adjoining the gizzard, more or less hidden in the lining or free in the mucus. Both sexes are found under the lining of the gizzard. In severe infections the gizzard lining becomes badly macerated and inflamed.

Habronema were found in five genera and seven species of tinamous examined from eight Provinces of Argentina from Entre Rios to Mendoza. Cram found Habronema pileata in the glandular stomach of a quail in southern Georgia (Stoddard, 1931).

Parasites of the small intestine -- Although several types of parasites were found in the small intestine, only 11 percent of the birds examined were infested. Those encountered included coccidia, tapeworms, ascarids, and thorny-headed worms.

Coccidia, probably Eimeria sp., were recognized in the intestine of only one wild bird though commonly present among captive tinamous.

Tapeworms (Raillietina sp.) were found in seven of the wild birds examined. A young bird 5 weeks of age, harbored a mature tapeworm already 6 inches in length. Infection was usually light and appeared unimportant except in one case where about 40 Raillietina provided an apparently effective intestinal block.

Ascarids (Ascaridia sp.) were surprisingly absent from all but one wild bird in which five were present.

Thorny-headed worms were identified in two spotted tinamous with but 1 worm in each.

Parasites of the liver -- Dr. Elon Byrd found liver flukes in four of 23 spotted tinamous examined. These were identified as Athesmia heterolecithodes from one tinamou and Zonorchis sp. from three others. Athesmia heterolecithodes were also encountered in pale spotted tinamous in the Province of La Pampa.

Parasites of the cecum -- Cecal worms were rather commonly encountered in spotted tinamous being present in 53 percent of the birds examined. No damage from these was evident even when many were present. There were normally less than 10 per bird but one harbored about 60 individuals.

Two genera of nematodes were identified from the cecum. While both are classified by Cram (1927) in the family Heterakidae, one is in the sub-family Heterakinae, the other in Subulurinae. An interesting geographical distribution of these was evident.

Heterakis sp. was more common and identified from 37 percent of the birds. It was predominant among birds from Entre Rios and eastern and central Buenos Aires Provinces.

Subulura sp. was identified from 16 percent of the birds collected mostly from western Buenos Aires, Sante Fe or southern Cordoba Provinces. From there west to Mendoza Subulura apparently replaces Heterakis completely in every genera of tinamous that was examined.

Parasites of the body cavity -- Tetracheilonema quadrilabiatum, a filaroid worm, was recovered from 26 percent of the spotted tinamous. Usually from 2 to 10 worms were encountered but a single bird harbored 41 specimens. Two of these helminths were found in a bird of about 8 weeks of age.

This apparently innocuous parasite is widely distributed in Argentina. We identified them in tinamous from Entre Rios to Mendoza. This parasite was described by Mazza and Fiore (1931) from a spotted tinamou

(Nothura, sp.) collected in Jujuy Province in extreme northwestern Argentina, and later Stekhoven (1952) found T. quadrilabiatum in a spotted tinamou and a woodpecker collected in Misiones in the north-eastern part of Argentina. The parasite was located in the kidneys and under the skin of the neck as well as in the body cavity. We, occasionally, recovered Tetracheilonema from under the skin of the lower part of the neck in spotted tinamous collected in the Province of Buenos Aires. In some freshly killed birds the worms could be seen moving from the body cavity towards the neck.

External Parasites

External parasites were much less common among wild tinamous than is generally supposed. Though some birds were examined for lice, they were detected on only four birds as follows:

Menocanthus sp. from two birds

Heptosogaster sp. from three birds

Heptosogaster minor from one bird.

Surprisingly enough neither mites nor ticks were detected on any of the birds examined. While studying hemorrhagic fever, pathologists of the National Institute of Microbiology in Buenos Aires examined 45 wild spotted tinamous for mites without success.

Parasites Among Birds Raised in Captivity

Few of the parasites mentioned above were found in spotted tinamous raised for shipment as breeders to the United States. This is to be expected since this flock was established from eggs collected in the wild. In addition, birds were kept almost entirely on sand which was frequently changed and the pens disinfected.

Losses among these birds were minimal and usually from accidents, such as flying into the wire of the pen or from feather picking. This provided very few birds from our pens for examination. From microscopical examination of many wild birds, Mrs. Bump identified eggs of most of the helminth parasites. Thus by frequent and continuous examination of droppings from captive birds, the presence or absence of most parasites was determined.

Coccidia were often present and easily controlled. Cecal worms (Heterakis and Subulura) were occasionally encountered during the third year of propagation. It was necessary to dust penned birds for lice fairly frequently.

Two genera of parasites, common to domestic poultry and some species of wild birds, were identified from other species of tinamous that were being reared in close proximity to the spotted tinamou.

Table 9. Parasites found during autopsy of 104 wild pampas spotted tinamous (a)

<u>Parasites</u>	<u>Location in body</u>	<u>Incidence of infection</u>	
		<u>Number</u>	<u>Percent</u>
Protozoa			
<u>Trichomonas</u> sp.	Cecum	2	2
<u>Eimeria</u> sp.	Small intestine	1	1
<u>Eimeria</u> sp.	Cecum	4	4
Trematoda (flukes)			
<u>Athesmia heterolecithodes</u>	Liver	1	4 ^(b)
<u>Zonorchis</u> sp.	Liver	3	13 ^(b)
Cestoda (tapeworms)			
<u>Raillietina</u> sp.	Small intestine	2	2
Unidentified	Small intestine	5	5
Nematoda (roundworms)			
<u>Ascaridia</u> sp.	Small intestine	1	1
<u>Heterakis</u> sp.	Cecum	38	37
<u>Subulura</u> sp.	Cecum	17	16
<u>Habronema</u> sp.	Proventriculus, gizzard	55	53
<u>Tetracheilonema quadrilabiatum</u>	Body cavity	27	26
Acanthocephala (thorny-headed worms)			
Unidentified	Small intestine	2	2
Mallophaga (biting lice)			
<u>Heptasogaster minor</u>	Among feathers	1	4 ^(b)
<u>Heptasogaster</u> sp.	Among feathers	3	13 ^(b)
<u>Menacanthus</u> sp.	Among feathers	2	9 ^(b)
No parasites found		18	17

-
- (a) Drs. Katherine Prestwood and Elon Byrd necropsied 23 of these birds while in Argentina.
- (b) Only the 23 birds on which a postmortem examination was made by Drs. Prestwood and Byrd were examined in detail for lice and flukes. The percentage is adjusted accordingly.

Gapeworms (Syngamus sp.) were identified from large brushland tinamous (Nothoprocta cinerascens) and Dispharynx sp., from crested tinamou (Eudromia elegans). Neither of these parasites was detected either among our propagated spotted tinamous or among their brethren in the wild.

Analysis of Competing Interests

Relation to Agriculture

In Argentina the large rhea may attract more attention, but no other bird enters as completely into the lives of farm folk, ranchers and farmers alike, as does the spotted tinamou. It is generally abundant and unafraid. Its habit of preferring grazed pastures and roadsides and of running with loud peeps ahead of a man afoot or on horseback makes it easy to see. Its usually erect carriage, its graceful movements, its distinct though not showy color patterns, engender interest and satisfaction. Its call, almost flutelike in quality, is one of the pleasantest songs on the pampas. It provides excellent shooting and few country hosts, during the hunting season, will let a guest escape from their table without having enjoyed "pickled partridge" or "perdiz escabeche" as it is called.

On the purely economic side many a landowner refuses to harvest his tinamou because of the large number of insects and forb seeds that they consume. Grasshoppers and beetles are preferred foods. Where alfalfa is common they feed extensively on the larvae and nymphs of the extremely destructive "esoca" or alfalfa butterfly. The grain consumed is entirely waste for they neither scratch for the freshly planted seeds nor pull them up as they sprout.

In short they are like the Argentine countryman, friendly, independent, resourceful and productive when around, and honored in their absence when they have left the "camps."

Usefulness

As a game bird -- The spotted tinamou is the most abundant and widely distributed game bird in Argentina. It is also the most heavily hunted. Godoy (1963) estimated that in 1961, 95 percent of 650,000 sportsmen in Argentina were small game hunters. For these, the main attraction is tinamous which, as Godoy aptly phrased it, "are persecuted with passion by a legion of hunters." His estimate of tinamous shot in an average year is 5 million. Of this number at least three-quarters are spotted and pale spotted tinamous.

Why the popularity? Availability and abundance are part of the story for some 40 percent of the hunters live in the Province of Buenos Aires or in the Federal Capital from which little game except spotted tinamous, waterfowl and European hares are accessible to hunters. Then

too, these birds, while not large, provide enough excellent meat to justify the price of a shell, particularly if the bird can be shot along the road or on the ground. Thus there is little excuse for trapping them except for sale which is now illegal.

There are also many experienced hunters to which the bird on the wing or with evasive tactics offers a challenge within their ability to meet. It may hide and must be found. It may run and be forced to fly. It may provide a nice, straight away shot. Some sit well to a dog, others sneak away only to fly suddenly from an unexpected spot. Finally, almost anywhere in grasslands, one can flush at least 5 to 10 birds in an hour. Only those deeply in love with a special species, such as waterfowl, can ask for better recreation.

Most spotted tinamous are hunted by two to four sportsmen walking in a line through the fields. For special occasions there are well organized hunts in which the birds are flushed by a rope or cable, often 150 to 250 feet in length, pulled over the vegetation by two horses. The men follow the rope closely with boys by their sides to pick up shot birds and run down those wounded, often with the aid of a man or two on horseback. On one such hunt, we flushed 484 spotted tinamous from 264 acres of pasture in about $4\frac{1}{2}$ hours using a cable 275 feet in length. A strip about 250 feet in width was thus covered, allowing for the sag of the cable. On this hunt 9 to 11 shooters collected 256 birds. This represented 53 percent of the birds flushed. This shoot, the only hunting permitted, is an annual affair and has now been conducted over a period of about five years with consistently large numbers of birds being flushed each year.

Certainly the most enjoyable way to hunt these tinamous is with a well-trained bird dog. When not consistently hunted the spotted tinamous are apt either to freeze or to walk slowly away from an intruder. Frightened, they either run rapidly for short distances or take to wing. We used a pointer and our associate, Wayne Bohl, used a laborador retriever with equal success in locating birds. With the pointer the bird normally laid well and flushed at from 6 to 10 feet from the dog. Where repeatedly disturbed the flushing distance was often 50 to 75 feet from the hunter.

As a source of income and food -- Spotted tinamous are whitemeated, tender and neither particularly dry nor gamy in flavor. Their generally high standing as a table delicacy is well attested. Liebermann (1936) reported them in high favor among the chefs in "railroad kitchens." Though the sale of all tinamous is now prohibited, it was once common to see 30 to 50 plucked and cleaned birds hanging from a stick and offered for sale by men and boys along the roadways. In fact the commercial exploitation of tinamous, mainly spotted, crested and red-winged, once was of enormous proportions. Lahille (1921) reported that 9,013,256 birds were exported from Argentina to Europe and North America between 1890 and 1899, of which 1,717,113 were sent out in 1895 alone. On October 10, 1921, 6,240 red-winged, 8,234 crested and 40,188 spotted

tinamous were received in New York from one Argentine packing plant alone. Frank M. Chapman was shocked to find that some 180,000 pairs of spotted tinamous were received at the port of New York during a short interval in 1923. DeCosta confirmed that in 1924 two packing houses sent 62,641 birds to Europe and the States. As the larger red-winged tinamous declined under such intense commercialization the proportion of spotted tinamous increased materially.

The story of the campaign spearheaded by Frank Chapman and the National Audubon Society, which led to the prohibition of tinamou shipments into the State of New York in 1924 and later extended to all the United States, is a heartening example of what one man and an organization, both dedicated to preserving wildlife at home and abroad, could accomplish even 45 years ago.

As a fighting bird or a pet -- None of the tinamous of Argentina are particularly pugnacious. None are kept as fighting birds. Several species are occasionally encountered as pets in the country but the generally nervous disposition of the spotted tinamous in captivity does not encourage this practice.

Relation to Other Game Birds

Competition between different species for living space, territory, food, and nesting sites is always a possibility wherever the habitats of two species more or less overlap. Competition may be severe in one case and almost nonexistent in another.

Biologists of the Foreign Game Investigation Program are alert to the problems of adjustment between foreign game species recommended for trial in the United States and native game birds. To date little competition between introduced and native game birds has been documented in this country. But, to be sure, one must successfully establish a new species in a fresh environment and then analyze the results. Until then the only other source of reference is the study of the species in its native habitat and in captivity.

Spotted tinamous appear to be less aggressive and quarrelsome than are many of our native game birds. Except in defense of nest or young, aggressive behavior towards other birds was not observed either in the wild or in captivity in Argentina. In the field they co-exist in apparent harmony with red-winged and with crested tinamous. In captivity they cause no problems when penned together with other tinamous. They are independent and mind their own business.

They have much in common with pheasants and quail as regards foods eaten. But the short grasslands and often heavily grazed pastures, which are normal habitats to spotted tinamous, seldom support many of the gallinaceous game birds. Nor could there be any serious competition for nesting sites.

Breeding and Rearing

Spotted tinamous, while not particularly difficult to propagate in captivity, will pose problems until a strain adaptable to artificial propagation is developed. Starting with eggs gathered from wild nests and including those laid by our hand-reared breeders, 312 birds were hatched and 258 raised in three breeding seasons at our research station near Buenos Aires. The system employed was an adaptation of one commonly used in propagating grouse or quail.

Research Program

The following were the main objectives for this part of our research program:

1. To provide relatively tame birds for further study of such features as behavior.
2. To develop methods and techniques of propagation by which large numbers of individuals suitable for trial liberation can be produced.
3. To provide States cooperating with the Program with hand-raised breeders for further study and propagation.

Little was known about breeding, incubation, brooding, rearing, and overwintering of spotted tinamous in captivity. Thus each of these had to be considered in some detail. The first year eggs were gathered from wild nests to establish the initial stock of breeders. In the second year about two-thirds of the eggs required came from wild nests, the remainder from our hand-raised breeders. All eggs for the third year's studies were produced at the station.

To determine suitable breeding ratios and conditions, males and females were placed 1:1, 1:2, 2:2, or 3:5 in pens on the ground. Pen sizes from 4 by 8 by 6 feet to 20 by 40 by 6 feet were tested; cover was varied from bare sand, with 10 to 25 percent grass clumps for nesting and escape, to complete coverage with grass, garden plants and alfalfa.

Eggs were gathered daily though some were left in the pens for 5 to 10 days to determine under what condition incubation by the male would occur.

Three methods of incubation were tested. Some eggs were set under Japanese silky bantams. Many of these were broken and in one instance chicks were killed by the hen as they hatched. Male spotted tinamous incubated eggs on four occasions. Most of the eggs collected were set in flat-top, still-air incubators in which temperature and/or humidity was varied to determine optimum conditions.

In the absence of more sophisticated brooding equipment, chicks were started indoors in groups of 4 to 10 in our shipping boxes which were 20 by 24 by 8 inches. At 6 to 10 days many chicks were shifted to larger boxes in groups up to 15.

At 3 to 4 weeks the youngsters were moved outside into pens $4\frac{1}{2}$ by 8 by 6 feet to 9 by 12 by 6 feet in groups of 10 to 20 individuals. Heat was provided for the first several weeks by infrared lamps.

Birds were overwintered in 9 by 12 by 6 feet pens in groups of 5 to 15 without difficulty.

Foods formulated for game birds were unavailable in Argentina so it was necessary to use commercial poultry rations, usually in granulated form. The level of protein in these was below that normally recommended for game birds. To correct this deficiency protein concentrates, methionine, white fish meal, cooked ground liver, or alfalfa leaf meal were added. Hamburger in an amount that would be immediately consumed was often fed once a day.

Losses were few and due mainly to accidents or feather picking. Broken necks were occasional from flying into the wire after being scared by predators or strangers. Four, week-old chicks were lost in a torrential downpour. Several youngsters, when moved from brooders to the ground, died from eating twigs up to 3 inches long, bits of copper wire or hard grass roots. One filled its gizzard with sand, another with feathers. An adult ate a paper clip.

Recommendations

It was obviously impossible to develop an entirely satisfactory system for propagating spotted tinamous in the time and with the equipment available. Breeding, egg production, brooding, rearing, and overwintering posed no unusual problems. Additional experiments to determine the most productive temperature and humidity for artificial incubation are required.

The following recommendations are based on our experience to date:

Wintering breeders -- Pens. Small pens may be used to hold a few birds. In those 9 by 12 by 6 feet, from 10 to 15 individuals winter well. Brush or grass cover is desirable but not required, though some protection from wind is necessary.

Feed. Use a good game bird maintenance feed, preferably granulated. The protein level should be at least 19 percent, the fiber content high. Desirable supplements include wheat, barley, sorghum, millet, cracked corn, and green food such as alfalfa, lettuce or chard. Provide grit.

Feeders. Poultry trough type, set on wire screen to facilitate cleaning, work well.

Waterers. Not much water is required. Quart size dispensers are recommended.

Disease control. Providing pens are set on fresh ground before birds are added, there should be little trouble with disease. Use standard techniques for the control of coccidiosis. Dust frequently if lice are present. If birds are lost from causes other than accident, consult a poultry specialist.

Breeding season -- Transfer period. Transfer birds to breeding pens in late winter.

Pens. Movable pens, 9 by 12 by 6 feet, either divided into two smaller sections or entire, work well. More eggs usually result if the back half of the pen can be placed over alfalfa or tall grass and forbs with the front half open. Nest boxes are not used.

Birds per pen. Establish a ratio 1 male to 1 or 2 females for small pens; 1:2 or 3 or 2:4 for larger pens is satisfactory. Flock mating in larger pens is possible but nests and eggs are often difficult to locate.

Feed. Use a game bird breeding feed, granulated, preferably with 26 percent protein or higher. If green food is not readily available provide alfalfa, lettuce or chard. Provide some grit.

Water. Change water daily. Keep waterers clean.

Eggs. Eggs are subject to sunscald. Collect once a day or oftener if exposed. Mark date laid and pen number on egg with white or yellow India ink.

If birds are not laying move them to a different situation, preferably with more cover.

Store eggs at from 40 to 60°F, air pocket end up and turn twice a day. It is often necessary to candle the eggs to determine this end. Set the eggs within 7 days of the time of collection.

Incubation -- Period. 16 to 18 days required.

Incubator. May be incubated in a forced draft machine but still air (flattop) preferred for hatching. Broody bantams unsatisfactory for incubation.

Temperature, humidity and weight loss. The two breeding seasons available to us in Argentine were insufficient to determine these factors in detail. Definite recommendations must await more work

by game breeders. Currently an incubation temperature of 99¹/₂° in a forced draft or 101¹/₂°F in a still air incubator is suggested with hatching temperatures 1 degree higher. Temperatures should be so regulated that the eggs hatch in 17 to 18 days. Our data on relative humidity were confusing; 70 to 72 percent wet bulb appears to be satisfactory in a flattop incubator. Weight losses data were also inconclusive. Some eggs with from 9 to 14 percent weight loss during incubation hatched but best results were in the 12 to 13 percent range. With one clutch, incubated by the male, four of five eggs hatched with a weight loss of 15 percent.

Males usually take 1 to 2 days to become firm set. During this period the eggs are often left unattended for 2 to 5 hours. This suggests that hatching might benefit from cooling the eggs several times during the first 2 days following setting.

Candling eggs. Dark shell color makes candling difficult; but may be attempted between the 5 and 7th day to identify pens from which infertile eggs are being received. If many eggs from a pen are infertile, switch males.

Brooding -- Brooders. During the experimental period it is wise to use small brooders open enough above so that the birds can be seen at all times but partly covered to conserve heat. Brood each species separately. We found our shipping boxes 20 by 24 by 8 inches fly screened above and heated by a 60-watt, screened light bulb to be very satisfactory. From 6 to 8 chicks were brooded per box for as long as three weeks.

Hover. Use a small electric hover or infrared bulb. Starting temperature should be 95° F and be lowered 5° a week.

Floor covering or litter. Start birds on white paper toweling or muslin for first 4 days, changed as required. Change gradually to a litter that cannot readily be eaten. Check dead chicks to determine if the gizzard is full of litter.

Confining chicks. Confine chicks to the vicinity of the heating unit for the first 4 days using the same method as for pheasants or quail.

Feed. Use a good game bird starting mash or small granules. Add hard boiled egg, finely chopped alfalfa, clover or lettuce several times a day for the first week or longer. Chick grains may be offered beginning at the 7th to 10th day. Small millet seeds are well accepted.

Getting chicks to eat. Shortly after the chicks are removed from the incubator, moisten some mash until it is crumbly but not sticky, add finely chopped lettuce and scatter sparingly on white paper towels or muslin over the bottom of the brooder. Clean and repeat at least four times daily for the first several days, tapping the food with the

finger each time to encourage eating. Then shift to chick feeders or dishes with low sides. For reluctant feeders it may be helpful to add to the brooder a few chicks that are eating readily.

Water. A shallow dish, with stones to prevent the chicks from becoming water soaked, is recommended for the first 4 days.

Time in brooder. Tinamou chicks may be combined into larger groups when well started. If the weather is warm and dry they may be moved to outdoor pens at 3 to 4 weeks of age. Here some source of heat and protection against cold and wet weather is desirable.

Picking. Nose, eye and toe picking may be encountered with young birds. Blind birds may result. Picking the pinfeathers on the wing is also common. Separating the picking birds and beak clipping may help as will the use of red lights and a partial darkening of the brooder.

Picking of back and tail feathers also posed a problem among several groups of older birds. This was often due to overcrowding. Once started it proved difficult to control except by segregating the pickers and, most effectively, by the use of canvas back patches. These, made of stiff duck, were shaped so as to fit closely over the back and tail. They are firmly held in place by two tapes that run under the wings and cross over the upper breast. These require time to make but can be used over and over again.

Number of birds per brooder. The fewer the number of young placed in a brooder the better the results will be in health and growth. A few birds are easier to start than many. Do not start more than 2 to 3 chicks per square foot of floor space.

Rearing -- Pens. Pens 9 by 12 by 6 feet or larger make excellent rearing pens when placed on clean, grassy or weedy ground where the cover is open and not over 6 to 8 inches in height. In a pen of this size from 15 to 20 spotted tinamou may be raised up to 12 weeks of age.

Feed. Game bird growing mash, preferably granulated may be fed after the 4th week, supplemented by grain. Green food is desirable. Feed on wire frames. If the feed does not contain a coccidiostat, one must be offered periodically as with pheasants or quail. The occasional, but not continuous, use of antibiotics may prove advantageous.

Water. Quart to gallon waterers set on wire frames are recommended.

Picking. The only serious problem was feather picking. This was reduced considerably the last year by adding 1 percent methionine to the feed. Shifting pens from one site to another, dividing picking birds into smaller groups sometimes helped. Effective control was obtained by the use of the canvas back covers, described above. Quail



Figure 23. Most chicks were started in cardboard boxes with a light bulb for heat.



Figure 24. Only those who live close to the soil know how to trap spotted tinamous.



Figure 25. Spotted tinamous are trapped by driving them into horsehair snares set in cattle paths.



Figure 26. Once snared they soon cease to struggle so are seldom injured.

type "bits" made of fairly thin wire, attached to the nasal opening and extending in a loop between upper and lower mandibles in such a manner that they cannot quite meet also worked well providing they were not left in place over 2 weeks at a time. Picking may not be as common in grassy pens.

Other problems. Remove sticks, wire, glass, or the like on ground. These are eaten avidly.

Trapping and Marking

Trapping

Trapping tinamous has been illegal in Argentina for some time and trapping techniques, once commonly employed by country folk, have fallen into general disuse.

As usual, a number of methods are described in the literature. Daguerra (1923) writes that trappers catch spotted tinamous with a butterfly type net, some 30 inches across, attached to a handle 10 to 15 feet in length. Mounted on a horse they approach the bird in narrowing circles until close enough to drop the net. A noose at the end of a pole is sometimes substituted for the net. Both methods, were demonstrated to us. Few birds were caught. Our attempt to catch incubating males with a net were likewise not very productive. Where the cover is short and roosting sites are known some birds can be netted at night by immobilizing them with the beam from a strong flashlight. The legend persists that if flushed they will often fly down the beam to the trapper. This we never saw. Liebermann (1936) reports that, after two to three flights exhausted birds were caught by dogs especially trained for the purpose. We chased many a bird with a good dog only to have it fly again and again.

Yet there is one method by which spotted tinamous may easily be caught in large numbers. Using it, a group of country boys provided us with over 500 individuals in about 6 weeks. It is based on the propensity of the bird to walk in a direction away from the intruder and to follow cattle trails or other small paths through the vegetation. The equipment is simple since only a couple of baffles, forbs, brush, or low boards, 3 to 4 feet long, some twine and a horsehair snare are required. Two boys walk slowly through the cover until a bird is sighted. One watches the bird the other circles about until a slight path, furrow or other walk lane is located. On either side and at right angles to this the baffles are placed and connected by stout string from which the horsehair noose is suspended in an opening about 6 to 10 inches across. The two boys then position themselves on the far side of the bird from the snare. By moving a few slow steps at a time towards it they encourage the bird to walk in the desired direction. Any movement of the bird to right or left is followed by a slightly longer movement

of the drivers in the same direction. So sensitive is the bird to this that even a short shift in course will often bring the bird back into line. The path, once located, is usually followed to the snare.

More skill than meets the eye is required. If the bird is driven too slowly, it squats then flies when closely approached. If the movement of the drivers is too fast the bird soon takes to wing. At all costs the birds must not be alarmed by too eager pursuit. The distance between driver and driven varies with the type of cover but is normally between 30 and 60 feet unless the bird becomes particularly nervous. When birds are accustomed to the presence of people and are not heavily hunted they can even be driven across open fields where the cover is only 3 to 5 inches in height and the drivers are in full view at all times.

Almost no birds were injured by being caught by the neck with horsehair snares. Once the bird stops struggling, usually after 5 to 10 seconds, the noose loosens sufficiently to permit uninhibited breathing.

Marking

Spotted tinamous are easily marked for field identification by attaching a colored plastic streamer 2 to 3 inches long with a three-quarter inch safety pin to the loose skin where neck and back join. Penned birds, thus marked maintained this identification for 3 to 11 months. Birds marked in the field by this method were not always easily identified because the streamer tended to move to one side, often becoming stable on the flank.

All birds used in propagation experiments were marked with number 3A or 4 bands. These were seldom lost.



Figure 27. Pale spotted tinamou

PART II

THE PALE SPOTTED TINAMOU, NOTHURA DARWINII

In 1833, Charles Darwin, while on his voyage with The Beagle, made an overland trip through Indian country from Bahia Blanca to Buenos Aires. Enroute he collected a spotted tinamou that differed slightly from those he had observed further north. This Gould named Nothura minor because it appeared to be smaller than the more northern Nothura major (now maculosa). Later Gray, discovering that the name minor had previously been applied to a spotted tinamou from Brazil, named it Nothura darwinii after its now famous collector. Of it Darwin wrote "I have obtained an example of this species in (near) Bahia Blanca, northern Patagonia, where it is common in the dunes and the surrounding country which is always dry. Its color is similar to Nothura major but it is smaller and its spots are somewhat different." Thus was a new species named.

Through the years several taxonomists have considered the pale spotted tinamou to be a race of the spotted. As late as 1942 Hellmayr and Conover called the pale spotted Nothura maculosa darwinii. It was not until 1950 that Conover, after examining many skins, decided that it was worthy of species status.

Meanwhile explorers travelling westward encountered other tinamous of the Nothura group. One from Salta was named Nothura salvadorii after a British ornithologist. Later a similar specimen from Mendoza was called Nothura darwinii mendozensis (Chubb 1917, Wetmore 1926) and Nothura maculosa salvadorii by Hellmayr and Conover (1942). Conover subsequently decided that the Salta and Mendoza birds were definitely darwinii and belonged to the same race. He named them Nothura darwinii salvadorii. Thus the pale spotted tinamous are currently divided into two subspecies.

Spotted and pale spotted tinamous are presented in the same report. Both belong to the genus Nothura. Both are grassland inhabitants. In general characteristics, habits, and behavior there is a close resemblance. In appearance they are so nearly alike as to confuse all sportsmen and many ornithologists as to their separate identity.

Why then recognize them as separate species? Valid reasons appear upon close study. There are minor structural variations in the length of tarsi, toes, and wings, and in weight. The color pattern of the feathers is somewhat different; the call or song not quite the same. The habitat occupied by the pale spotted tinamou, while still predominantly grasslands, is usually less lush, more savannahlike and brushy. While some lowlands are not shunned, the range of the pale spotted also extends into more arid, slightly colder, less fertile upland steppes, hilly terrain and mountain valleys, occasionally to treeline.

In overall distribution, the pale spotted tinamous are less widespread and are represented by fewer subspecies than are the spotted tinamous.

Both species are equally adaptable to captivity and may be propagated successfully using the same methods and techniques.

Common Names

In Argentina both spotted and pale spotted tinamous are commonly called perdiz chica or the small partridge. Names most frequently encountered for the species and subspecies of pale spotted tinamous include:

Nothura darwinii

Pale spotted tinamou	English
Spotted tinamou	English
Spotted Nothura	English
Kleines striesshuhn	German
Inambu	Indian (So. S. Am.)
Inambui	Indian (Argentina)
Perdiz chica palide	Argentinian
Perdiz chica	Argentinian
Perdiz chica comun	Argentinian
Perdiz chico	Argentinian

Nothura d. darwinii

Darwin's tinamou	English
Darwin's Nothura	English
Perdiz chica palida	Argentinian
Perdiz de Patagonia	Argentinian
Perdiz pampeana	Argentinian
Pequena perdiz de Darwin	Argentinian

Nothura d. salvadorii

Salvador's tinamou	English
Perdiz chica del oeste	Argentinian
Perdiz chica de Mendoza (also San Luis, San Juan, Salta)	Argentinian
Yute	Mendoza, Argentina
Picua	San Luis, Argentina

Distribution and Abundance

Range

Pale spotted tinamous are widely distributed mainly in the uplands of western South America from southern Peru to Chubut in southern



Figure 28. Approximate range of the subspecies of the pale spotted tinamou, N. d. darwini and N. d. salvadorii, in Argentina.

Argentina. They are represented by a single species Nothura darwini. Conover (1950) recognizes four or possibly five subspecies. Only two of these occur in Argentina but an examination of skins collected by Wayne Bohl and by the authors and reexamined by Richard Banks strongly suggests that additional subspecies may be represented. Pending clarification of this point the distribution of the subspecies according to Conover (1950) and more sharply defined for the two Argentine subspecies by Olrog (1963) and by our own observations appears to be as follows:

<u>Name</u>	<u>Distribution</u>
Darwin's (pale spotted) tinamou (<u>Nothura d. darwini</u>)	Dry, often high, country possibly from the eastern sierras of Cordoba south through eastern La Pampa to the Sierra de la Ventana in south-western Buenos Aires and the dry, upland steppes of Rio Negro and northern Chubut and westwards towards the Andes for a distance as yet unrecorded. ^(a)
Salvador's tinamou (<u>Nothura d. salvadorii</u>)	Dry steppes and uplands of western Argentina from Jujuy and Salta south to Mendoza and east to western Santiago del Estero, western Cordoba and La Pampa.
Bolivian tinamou (<u>Nothura d. boliviana</u>)	The highlands of extreme south-western Bolivia at elevations from 6,000 to 11,500 feet.
Agassiz's tinamou (<u>Nothura d. agassizii</u>)	The highlands of extreme south-eastern Peru, south through western Bolivia.
Peruvian tinamou (<u>Nothura d. peruviana</u>)	Southeastern Peru in the Department of Cuzco. Very similar to or possibly identical with <u>N. d. agassizii</u> .

The distribution of the subspecies resident in Argentina is represented in very general terms in figure 28.

Abundance in Argentina

Pale spotted tinamou have successfully colonized the less hospitable parts of the range of Nothura. Thus it is not surprising that they

^(a) See figure 1 for location of the Provinces here mentioned.

are widely scattered over the countryside. Yet in northern and eastern La Pampa and in parts of Mendoza Province, where the ground is well covered with grass and forbs and some grain is grown, there are many coverts that hold a bird per 1 to 2 acres. Even as far south as north-eastern Chubut, Banderas reported that 185 crested tinamou and 43 Darwin's tinamou were shot in one day's hunt in cover of scrub and grass.

As might be expected in arid habitats, the abundance of pale spotted tinamous seems to be influenced by the amount and distribution of precipitation over a period of several years. Though this species is accustomed to periods of almost no rain extending over 3 to 6 months, long continued droughts are said to be associated with severe declines in numbers. As conditions improve recovery is rapid.

Description

Field Identification

Pale spotted tinamous can be confused only with spotted tinamous in Argentina. These species are so nearly alike in appearance and actions that positive field identification is difficult. For those casually interested, it is sufficient to say that birds seen in the lowlands west of the eastern border of La Pampa, on the ascending steppes of Patagonia, the grassy, bush country of western Argentina or the hills and mountains of Cordoba or of southern Buenos Aires or from there west to the Andes, are probably pale spotted tinamous.

Yet on close examination some differences are evident. Comparing pale spotted tinamous from La Pampa (N. d. darwinii) with the pampas spotted tinamous (N. m. annectens) the following differences are evident on close examination:

	<u>Darwin's pale spotted tinamou</u>	<u>Pampas spotted tinamou</u>
Back	More dun colored with finer vermiculations, less bold markings that emphasize narrow, lengthwise white stripes.	Stripes, bars, and spots much bolder. Fewer vermiculations.
Lower neck and breast	Feathers with rufous bars edged with narrow dark brown bands on a base of pale ochraceous buff. Longitudinal stripes whitish.	Bold stripes or spots dark brown on a vinaceous to cream buff base. No or few white markings.
Primaries	Inner webs of the outermost primaries immaculate or often indistinctly barred for not over half of their length.	Inner webs of the outermost primaries usually barred from one-half to four-fifths of their length.

Wing Coverts	With many arrowhead-shaped whitish markings.	Few whitish markings.
Flank feathers	More hairlike and longer.	Less hairlike and shorter.
Tarsi and toes	Tarsus shorter and thinner; middle toe with claw varying from 25 to 29 mm in length.	Tarsus longer and thicker; middle toe with claw varying from 28 to 32.0 mm in length.
Size	Slightly smaller, averaging about 225 grams.	Somewhat larger, averaging about 270 grams.

In propagating both species we observed that the newly hatched chick of annectens has a light chestnut ring of feathers around the nape and sides of the neck. In darwinii it is grayer.

Subspecies

Of the subspecies of pale spotted tinamou only Darwin's tinamou (N. d. darwinii) and Salvador's tinamou (N. d. salvadorii) are resident in Argentina. The differences between these are apparent upon examination. Salvadorii is more ferruginous above and with markings much bolder, more prominent and with much less distinct, fine vermiculations. The upper neck and breast is longitudinally streaked without distinct transverse bars. The breast appears more prominently streaked with white. The outer primaries may be immaculate or spotted for up to four-fifths of their length. The middle toe with claw is slightly longer. In general color pattern these birds often resemble the pampas spotted more closely than they do Darwin's pale spotted tinamou.

Description of Darwin's pale spotted tinamou

Coloration -- Top of head rusty brown transversely barred with brownish black. Some longitudinal whitish stripes usually present. Throat white sometimes dark spotted. Sides of head and superciliary stripe buff with darker markings. Nape dark buff. Back, rump, upper scapulars and upper tail coverts very dark brown with transverse narrow bands of light brown and rufous, providing an effect of fine vermiculations, and with narrow longitudinal whitish streaks. Tail feathers short, weak, light buff and covered by upper tail coverts. Secondary wing coverts ochraceous buff with arrow shaped markings of dark brown edged by white. Primaries dark brown with narrow outer web broadly barred with light buff almost to the tip; wide inner web of inner primaries broadly barred with ochraceous buff. Inner web of outermost primaries immaculate or indistinctly barred up to four-fifths of their length. Secondaries broadly and distinctly barred with ochraceous buff. Lower neck and breast ochraceous buff with rufous bars edged with

narrow dark brown bands and with longitudinal whitish stripes. Abdomen and flanks light buff, with a suggestion of pink, narrowly barred with dark brown the latter with somewhat hairlike feathers.

Measurements (a)-- Wings are short, rounded and from 130 to 138 mm in length. Tarsi stubby, 31 to 33 mm; middle toe with claw 25 to 29 mm. The overall length is 22 to 25 cm.

Size and Weight

Darwin's pale spotted tinamous are the smallest of the spotted tinamous (Nothura) in Argentina. Though they average about 20 percent less in weight than the pampas spotted tinamous, the difference is not so apparent in the field as to make weight a good diagnostic characteristic.

As with the pampas spotted tinamous, the weight of adult birds varies substantially among individuals and between sexes. The average weight of 29 birds collected in eastern La Pampa was 214 grams for males, 237 grams for females. Males varied from 200 to 245 grams; females from 209 to 285 grams in weight. Details are presented in table 23 in the appendix.

Development

The pattern of development of the Darwin's pale spotted tinamou coincides closely with that already described for the pampas spotted tinamou.

Weight at Hatching

Since no Darwin's tinamous were resident within 400 miles of our research station near Buenos Aires, eggs from wild nests were gathered and hatched locally for us through the kindness of Mrs. R. L. Blaisse of Estancia Las Vertientes in La Pampa. Thus our records of weights and development were secured from eggs laid by our brood stock of captive birds at the station. These eggs were usually slightly smaller than were those collected in the wild. Chicks, hatched therefrom, also weighed slightly less.

The average weight of 20 chicks at hatching was 13.9 grams. The heaviest youngster weighed 16.7 grams.

Weight by Weeks

With many groups of birds of different species and ages being reared simultaneously, time did not permit us to follow weight gain and feather

(a) Conover (1950) supplemented by examination of 22 of our birds. See table 23.

development of individual birds to maturity. In the absence of more exact data it still appeared desirable to present in table 10 the weight by weeks of those hand-reared birds for which data are available.

Table 10. Weight of Darwin's tinamous by weeks.

<u>Week</u>	<u>No. birds</u>	<u>Av. weight (grams)</u>
At hatching	20	13.9
1	12	20.6
2	15	36.3
3	18	53.6
4	12	66.1
5	9	83.6
6	4	101.5
7	9	102.1
8	6	128.9
9	2	159.5
17	3	216.0
22	3	239.0

Egg Tooth

Many species of game birds at hatching have a small whitish protuberance on top and at the end of the upper mandible. The egg tooth was present in almost all of the youngsters examined; it usually disappeared shortly after hatching. Of two Darwin's tinamous examined one had lost its egg tooth within 24 hours of hatching, the other within 60 hours.

Feather Development and Moult

The feather development and moult of Darwin's spotted tinamous closely parallel that of the spotted tinamou previously described. Chicks of N. d. darwinii often differ slightly from N. m. annectens for several weeks following hatching in that neck down is more grayish and not rufous in color and, from a front view, the head appears to be somewhat broader and rounder.

Neither in the young nor in adults could we find any clearly identifiable differences in feather patterns or colors between males and females.

Color of the Eyes

A striking characteristic of both spotted and pale spotted tinamous is the change in the color of the eyes between hatching and adulthood. The following taken directly from our notes tells the story:

At hatching -- eyes medium to dark brown.

1 week -- No change with most birds though the eyes of one bird appeared grayer.

1½ weeks -- Eyes becoming lighter and grayer.

2 weeks -- With most chicks the eyes have now changed to dusky to deep blue.

3 weeks -- All eyes deep blue.

5 weeks -- Eye color changing from blue to blue green. Some are becoming dusky yellow.

6 weeks -- Most birds now have dusky yellow eyes though often with a greenish cast.

8 weeks -- The more sexually mature males as checked by cloacal examination have dusky lemon yellow eyes. Many females now have medium dark yellow eyes sometimes with a suggestion of rufous.

10 to 12 weeks -- Most males now have the dusky lemon yellow eyes characteristic of the adults though still not quite as dark as they will be at age 1 to 2 years.

Female eyes definitely are changing to a much darker yellow bordering on rufous. With age the yellow is completely lost and the eyes become a rich deep orange-brown in color.

Eye color is indicative of sex in some individuals as early as the 8th week. By the 12th week from 60 to 75 percent of the males and 70 percent of the females can be accurately identified by this method. Among adults over a year old, if the eyes are orange-brown the bird is definitely a female, if dusky but rather light lemon yellow it is a male. If the eye is dark lemon yellow often with a touch of rufous the bird might be either male or female. Usually about 25 percent of the birds of the year examined fall in this class.

Reproductive Organs and Sex Identification

The only sure way of determining sex is by internal examination of the reproductive organs as previously described for spotted tinamous.

Both spotted and pale spotted tinamous mature rapidly. The penis of one darwini examined at 12 weeks of age was already as swollen as in the breeding season. A pale spotted tinamou, reared by George Wint, Superintendent of the State Game Farm in Oklahoma, began laying 47 days after it was hatched.

Description of Salvador's Pale Spotted Tinamou

Coloration and feather pattern -- Conover notes "that salvadorii is very close to the typical race (N. d. darwini) in color though the general tone of the dorsal surface is darker, more ferruginous and less grayish." Specimens gathered by Wayne Bohl from San Luis and Mendoza appeared quite distinct from darwini and in several respects closer to spotted tinamous.

Salvadorii differs from darwini in the following respects:

Back -- In general more ferruginous with much bolder markings similar to those found on annectens. Vermiculations much broader and more widely spaced. Longitudinal whitish feather stripes much broader and often blended with buff.

Lower neck and breast -- General color light buff tinged with pink as in darwini, but transverse bars largely giving way to brownish longitudinal stripes similar to the still darker stripes or spotting of the spotted tinamou.

Abdomen -- A little darker buff and without the suggestion of pink typical of darwini or the light reddish-brown of annectens.

Lower tail coverts -- Less hairlike than darwini, more so than annectens.

Measurements -- Wing short, rounded and from 130 to 152 mm.^(a)
Tarsi less stubby than that of darwini; middle toe with claw 24.9 to 30.7 mm long, averaging 28.3 mm.^(b)

Size and Weight

Salvador's pale spotted tinamous are slightly larger than Darwin's tinamous though the difference is not easily recognized in the field. As is usual for all Nothura, weight varies by sex as well as with the individual birds within each sex. The average weight of 54 birds collected by Wayne Bohl from San Luis and Mendoza was 250 grams for males and 274 grams for females. Males varied from 192 to 307 grams; females, from 197 to 330 grams in weight.^(b)

Development

No particular study of development was made since this subspecies was not propagated by us although some were reared by Bohl at his station near Mendoza. In general, development follows that described for the spotted and Darwin's tinamous.

(a) From Conover (1950)
(b) See table 24 for details

Color of the Eyes

Changes in eye color follow those described for the Darwin's tinamou. Thirteen birds, all at least 8 months of age, were checked by Wayne Bohl. Of these, the eyes of four males were light yellow and of three were dusky yellow in color. Of six females examined the eyes of one was on the borderline between yellow and orange and of five were orange-brown in color.

Habitat

The pale spotted tinamou prefers the semi-arid grasslands, savannahs and open brushy country of central and western Argentina. Throughout its habitat, grazing is less intensive than in spotted tinamou habitat with sheep often replacing cattle. Cultivated fields are not common except along the eastern edge of its range or where water from the Andes permits irrigation. Temperatures are somewhat lower, annual precipitation less though with the same general seasonal distribution, topography often rougher, and soils more sandy and generally less fertile in pale spotted than in spotted tinamou habitat types.

Habitat by Subspecies

As with spotted tinamou, a predominant characteristic of pale spotted tinamou habitat is grass and forbs. But the grasslands may be so invaded with brush and trees as to justify their division into three main phyto-graphic types: pampas, savannahs and grassy brushlands. Darwin's tinamou mainly inhabit the first two types, but they also occupy brushlands of the third type in the eastern sierras of Cordoba and in northern Patagonia. Salvador's tinamou prefer brushlands, the more open and grass covered the better, as well as an occasional cultivated field, grassy and weedy pasture, orchard, or vineyard.

Pampas -- This type is typically the home of the pampas spotted tinamou. But along its western and southern reaches, where sandier soil, lower precipitation and more frequent droughts combine to produce less luxurious vegetation, the spotted is replaced by Darwin's tinamou. In the latter, the country is open, interspersed with scattered, savannah-type open, woodlands. Grasslands are less intensively grazed, with bunchgrass (Stipa spp.) becoming increasingly common. Other grasses include bromegrass (Bromus spp.), redgrass (Sorghastrum sp.), meadowgrass (Poa spp.), honeygrass (Paspalum sp.), barleygrass (Hordeum sp.), ryegrass (Lolium sp.), bristly foxtail (Setaria sp.), panicgrass (Panicum sp.), bittergrass (Elionurus spp.), crabgrass (Digitaria sp.), rushgrass (Sporobolus sp.), goosegrass (Eleusine sp.), and three-awnedgrass (Aristida sp.).

Many of the forbs abundant in the pampas are also present. The Spanish thistle (Cynara sp.) that provides favored nest sites for spotted

tinamous is much less common, being replaced by the Russian thistle or tumbleweed (Salsola kali), Lady's thistle (Silybum sp.) and pigweeds (Chenopodium spp.). Many of these plants, naturalized from the Old World, are found also in the United States.

Cultivation is at the mercy of seasonal precipitation. When adequate, fair to good crops of cereals, alfalfa and clover are produced.

Savannahs -- Through central Argentina, west of the pampas, there is a long, fairly narrow zone of dry grasslands spotted with scattered to rather dense xerophytic trees (largely of the genus Prosopis) and shrubs. This is a savannah-like type except where the grasses have been largely eliminated by overgrazing, permitting brush and trees to become dominant. In the past the basic grassy character had been maintained by frequent range fires.

These savannahs represent a transition type from the moister, treeless pampas to the xerophytic brushlands further west. Bunchgrass (Stipa spp.) predominates, though in favorable locations, most of the grasses listed above are found. Between the rather open clumps there is a scattering of forbs and various grasses. In places common Indian barley (Bromus brevis), bittergrass (Elyonurus sp.), three-awnedgrass (Aristida sp.), rushgrass (Sporobolus sp.), Bermudagrass (Cynodon sp.), and Piptochaetium sp. are not infrequent.

Forbs, characteristic of sandy, dry soils are common. Russian thistle, pigweeds, clovers and other legumes, margaritas, mallows, verbanes, nicotianas, and mustards were noted.

The shrubs, mostly spiny, are largely an extension in range of those characteristic of the brushlands to the west. Three species of creosote-bush including Larrea divaricata are common. Saltbushes (Atriplex spp.) are occasional as is tamarix (Tamarix sp.). A buckthorn, (Condalia sp.), and another common bush called "molle" (Schinus fasciculatus), provide fruits often eaten by tinamous. A wolfberry (Lycium sp.) and four species of cactus including prickly pear (Opuntia sp.), also are present.

The trees, some large, are mostly acacias belonging to the genus Prosopis. Three are abundant. The "calden" (P. caldenia) is typical of the savannahs. Two species of "algarrobos" (P. alba and P. nigra) are also common and become dominant towards the westward edge as well as in the eastern sierras of Cordoba. Both the hard fruits and the leaves of these provide some food for tinamous. Two smaller trees, one a "chanar," (Geoffroea decorticans), the other picturesquely called the bullshade tree (Iodina rhombifolia), are often encountered together with a hackberry (Celtis spinosa).

The transition from open pampas to scattered trees, to savannahs, and to woodlands, with an understory of brush and much less grass except in the openings is accompanied by a decrease in the abundance of Darwin's tinamou from pampas to woodlands.

Western brushlands -- In northern Patagonia west to the Andes and from central Argentina, west of the savannah type, stretches a vast, semi-arid, brushy steppe. Over much of it creosotebush (Larrea), buckthorn (Condalia), saltbush (Atriplex), broom (Bulnesia), and Plectrocarpa are dominant species.

Botanically this type has many affinities with the lower temperate and upper Sonoran zones of our Southwest and northern Mexico, particularly as regards summer annuals and shrubs. There is also much similarity in physical characteristics and in climate which is lower temperate. Precipitation seldom exceeds 8 to 10 inches annually and occurs often as torrential downpours, mainly in summer, except in Patagonia.

The native vegetation is predominately xerophytic. The grasses are mainly annuals too insufficient in density or unreliable in occurrence to provide much sustenance for cattle. Where shrubs are not dominant, bunchgrass (Stipa spp.), Indian barley (Bromus brevis), bristly foxtail (Setaria spp.), lovegrass (Eragrostis sp.), ryegrass (Hordeum sp.), fingergrass (Digitaria californicus), gramagrass (Bouteloua spp.), three-awnedgrass (Aristida spp.), and medick (Medicago spp), may occur. Xerophytic forbs are also widely distributed.

One familiar with the vast creosotebush scrub desert of the United States will feel quite at home in the brushlands of western Argentina. The shrubs are mostly spiny evergreen and scattered to fairly dense in distribution with areas of bare soil or stones often but thinly covered with forbs and grass. At least four species of Larrea occur. One, Larrea divaricata, is a common species in our Southwest. Other shrubs include mesquite, (Prosopis); Guaican (Plectrocarpa), mimosa (Mimosa), bougainvillea (Bougainvillea); Ceridium, Tricomaria, Zuccagnia, and Monttea. Broom (Bulnesia) and Prosopis occasionally become small trees along watercourses or where precipitation is considerable. Cactus including prickly pear (Opuntia) and giant (Trichocereus) are common to the north. Three species of saltbush (Atriplex) are encountered.

Pasturage by stock is light over most of the brushlands except in the moister locations. Dry farming is much at the mercy of the weather. Fruit, grapes, alfalfa, rye, oats, and barley are the main cultivated crops particularly on the highly productive irrigated lands just east of the Andes.

Cover Preferences

Both subspecies of the pale spotted tinamou prefer areas rich in grass and forbs. Cultivation, if adjacent, also attracts many birds. Brushlands with very little grass attract few birds.

Darwin's tinamous are primarily birds of the drier parts of the pampas and of the savannahs. Where trees and brush dominate, these



Figure 29. Darwin's pale spotted tinamou habitat is dryer but otherwise sometimes resembles that occupied by spotted tinamous.



Figure 30. Bunchgrass habitats often attract many birds.



Figure 31. Birds may be common, though often scattered, in savannah like grasslands.



Figure 32. Where precipitation is scanty, depressions supporting tall grasses often attract birds.



Figure 33. Birds are common in fallow fields with scattered grasses and forbs.



Figure 34. Upland grassy fields often attract many Salvador's tinamous.

Photographs by Wayne H. Bohl

birds were usually restricted to the occasional grassy openings. They were not common in the western brushlands except for the moister, more grassy extensions into southern La Pampa and northeastern Patagonia.

Productivity of birds in the more favorable parts of the dry pampas and savannahs was high. In one 18-acre grazed pasture, largely grown to bunch and other grasses, weeds and some alfalfa, we found 12 birds. In a savannah with grass from 12 to 18 inches high 9 birds were flushed from 4 acres. Cultivated or old fields, bordered by woods often attract many birds. From an old 18-acre rye field four men and a dog flushed 14 Darwin's, 11 large brushland and 3 crested tinamous in mid-winter in northern La Pampa. There were also many days in which we would cover 25 to 50 acres of apparently attractive cover yet find but 2 or 3 birds.

Conversely Salvador's tinamous were associated largely with the patches of more abundant grass and forbs in the western brushland type of cover. These birds were seldom common and often were absent from predominantly shrubby areas where there was only scattered vegetation at ground level. But where moisture, soil or elevation favored grass rather than shrubs, as well as in cultivated or old fields, the birds were likely to be found in considerable numbers. Two men with a dog put up 12 birds and located about 30 night roosting sites in a once cultivated, but now abandoned, field grown to grass and forbs 18 to 30 inches high and fairly open. Bohl reported that a party of four hunters flushed about 30 birds in 3 hours from old potato fields and grasslands in July in the Province of Mendoza.

In pasturelands of native grasses where cattle are extensively grazed Salvador's tinamous were commonly found where bunchgrass (Stipa), fescuegrass (Festuca), melicgrass (Melica), three-awnedgrass (Aristida) and, in sandy, broken country, bluestemgrass (Andropogon), are common. Fallow fields, invaded by forbs and grasses, provided preferred feeding and roosting sites. Alfalfa was similarly attractive. Fields of corn, peas and tomatoes were frequented if bordered by grasslands. Orchards and plantations of trees were commonly used for feeding, roosting and nesting where grass and forbs were abundant as a ground cover.

Topography and Elevation

Olrog (1963) indicates that Darwin's tinamous prefer upland steppe-like country. This may be true in Patagonia. In southern Buenos Aires the species is limited to the upland valleys and moderate slopes of the sierras. Birds that we collected from the flat land at the foot of the sierras were invariably pampas spotted tinamous. Further north in the eastern part of the sierras of Cordoba we found pale spotted tinamous fairly common in grassy fields above treeline and on the less steep slopes and valleys downwards into rolling fields.

In contrast to this, much of the best range in eastern La Pampa and southwestern Cordoba is low and flat to rolling with sandy, hilly country to the west.

So long as the slope is not steep, topography seems not to exert a strong influence on Salvador's tinamous. Though their range in general is more elevated, they occur in brushlands under 1,000 feet in elevation in central La Pampa, and from there to the higher sierras of central and western Cordoba and the upland valleys and slopes of the eastern Andes. In fact Bohl collected several salvadorii in May (at the beginning of winter) at 6,000 to 6,700 feet elevation in an Andean valley where cattle were being pastured and where ice had formed in the creek and snow had fallen along the slopes.

Soils

Three broad types of soils occur most commonly within the range of pale spotted tinamous. Darwin's tinamous are resident on brown soils of the planosol group. In La Pampa these are mainly sand mixed with fine clay and have a conspicuous layer of accumulated, caliche or hardened lime in the subsoil. Where much soil is exposed some blowouts or drifting may occur. Parts of this region were once covered by barren sand dunes, but most of these are now stabilized. These soils are high in nutrients and have a fairly high pH but are limited in productivity by generally arid conditions.

Salvador's tinamous range largely over sierozem and desert soils. Mainly sandy, these are high in plant nutrients and in lime but low in organic matter, phosphorus and nitrogen. Low lying areas are not infrequently occupied by alkali beds or salt pans.

With elevation, particularly in the sierras of Cordoba and along some eastern slopes of the Andes, brown mountain soils of the lithosol group are found within the range of Salvador's tinamous. These younger soils, often shallow and rather stony and occasionally enriched by volcanic ash, are productive where not arid.

Figure 15 illustrates the general distribution of soil types within the range of Darwin's and Salvador's tinamous together with the distribution of soil types in North America.

Climate

Throughout the Range

Of the five subspecies of pale spotted tinamous only Darwin's and Salvador's occupy ranges in which the climate is somewhat comparable to that of our southwestern United States. The Bolivian and the Peruvian subspecies, occur in the temperate highlands of the Andes, where average seasonal temperatures fall between 50 and 65°F and vary only 5 to 10°F throughout the year.

Table 11. Average maximum and minimum temperatures and average precipitation by seasons within the range of two subspecies of pale spotted tinamous.

Seasons	<u>Temperature and precipitation</u> ^(a)					
	<u>Habitat of Darwinii</u>			<u>Habitat of Salvadorii</u>		
	<u>Avg.</u>	<u>High</u> (c)	<u>Low</u> (d)	<u>Avg.</u>	<u>High</u>	<u>Low</u>
Spring ^(b)						
Avg. maximum	73.9	81	64	80.2	86	72
Avg. minimum	46.4	52	36	50.5	57	37
Avg. monthly precipitation	1.8	3.0	0.4	1.2	2.7	0.4
Summer						
Avg. maximum	86.7	91	75	89.8	95	84
Avg. minimum	56.8	61	46	61.3	70	46
Avg. monthly precipitation	2.2	4.1	0.4	2.3	6.7	0.5
Fall						
Avg. maximum	71.6	77	63	76.3	81	70
Avg. minimum	46.6	52	36	49.8	57	37
Avg. monthly precipitation	1.9	2.7	0.7	1.2	3.4	0.2
Winter						
Avg. maximum	58.0	66	46	65.1	73	55
Avg. minimum	35.8	41	25	36.7	43	27
Avg. monthly precipitation	0.7	1.1	0.4	0.4	1.1	0.1

Records are for 18 stations for darwinii and 21 for salvadorii. Most of the source records cover:

- (a) The period is from 1941-60. Temperatures are in degrees F, precipitation in inches.
- (b) Spring- September to November; Summer- December to February; Fall- March to May; Winter- June to August.
- (c) Highest seasonal average recorded by one station within range.
- (d) Lowest seasonal average recorded by one station within range.

The range of the Argentine subspecies lies largely in the lower temperate zone. Average maximum temperatures in the summer seldom exceed 90 to 95°F, average minimums in winter vary from 30 to 40°F with occasional short periods of 10 to 20°F at the higher elevations.

Annual precipitation averages from 10 to 25 inches for the range of Darwin's tinamous and from 5 to 20 inches for that of Salvador's. In the extreme northern, nearly subtropical part of the range annual precipitation may average 35 inches. Except in Patagonia the pattern of rainfall is similar to that of much of our Southwest. Summer is the period of greatest precipitation. Least rain falls in winter. Droughts of from 3 to 6 months duration or longer are not uncommon. Snow is rare except at the higher elevations. Relative humidity is highest in fall and winter. The annual average is close to 60 percent. Dew is often heavy.

Temperatures and precipitation by seasons, for the range of Argentine pale spotted tinamous are presented in table 11. To provide more meaningful comparisons, temperatures are expressed in average maximums and minimums rather than in simple averages or medians.

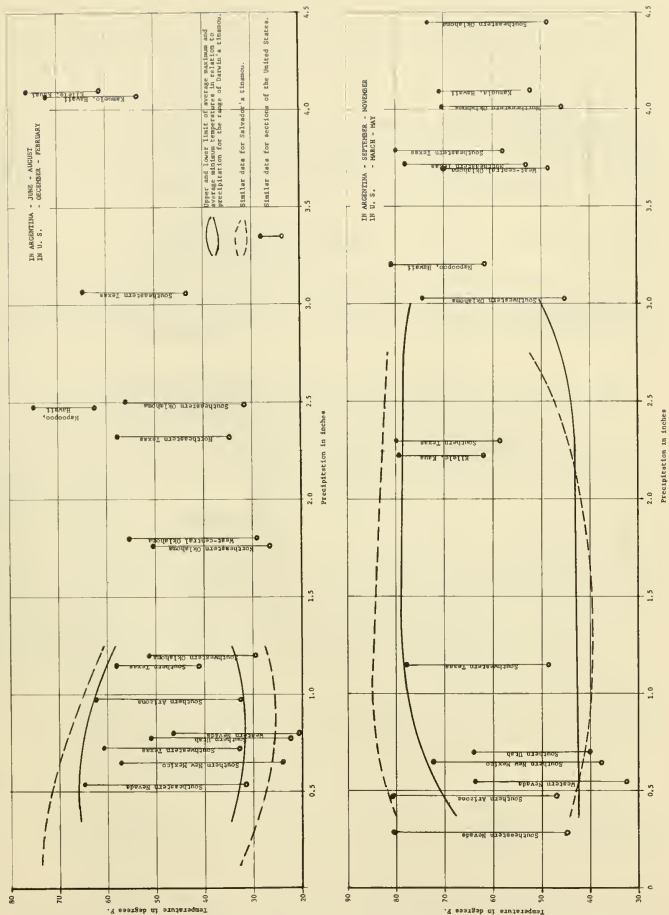
Examining this table we find that the two subspecies accommodate themselves to much the same seasonal temperatures and precipitation. The range of darwini may average a little colder than that of salvadorii but the latter also finds conditions to its liking in upland Andean valleys far from any station where weather records are kept. Darwini also receives a little more rain throughout three of the four seasons. This could be a distinguishing difference between the two ranges, for the result is more grass and forbs, more trees, a wider variety of shrubs, and a more luxurious and varied vegetative complex in general.

Climatic Comparisons Between Argentina and the United States

Words and figures cannot clearly picture the major similarities and differences in climate between Argentina and parts of the United States. Figure 16 presents the picture in general. A quicker more visual method of comparison is provided by the climacurves presented in figure 35. The upper lines represent average maximum temperatures in relation to precipitation by seasons within the known range of darwini and salvadorii. The lower lines refer to average minimums. Records of extremes, while possibly valid have been largely disregarded in plotting these curves.

To provide ready comparison, similar records from areas in the United States with generally corresponding climate are plotted on the graph. Here average maximum temperatures are shown by dark circles and average minimum by light ones. The two circles are then connected by a black line for easy identification. Thus one can see at a glance to what degree temperatures and precipitation in various areas in the United States correspond with those in the range of two subspecies of pale spotted tinamous.

Figure 35. Average maximum and average minimum temperatures according to precipitation by seasons for parts of the United States compared with similar data from the range of two subspecies of the pale spotted tinamou.



In analysing these climacurves, it is apparent that precipitation in winter and spring in Argentina falls well within that characteristic of the southwestern United States from central Texas and western Oklahoma westwards. Summer and fall precipitation from eastern Oklahoma and Texas westwards is well within that under which pale spotted tinamous thrive in Argentina.

Some average maximum and average minimum seasonal temperatures in the southwestern United States are a little above or below those to be found in the range of pale spotted tinamous in Argentina but the differences in most cases are probably too slight to be significant.

Food and Water

Both subspecies of pale spotted tinamous are omnivorous feeders. A wide variety of grass and forb seeds, waste grain, greens and many insects constitute a normal diet. Roughage, mainly sticks, stems, and husks are commonly consumed.

The literature contains no specific references to the food habits of pale spotted tinamous. It is generally assumed in Argentina that their diet closely parallels that of the pampas spotted tinamous. Our studies do not bear this out for half of the seeds found in the crops of Darwin's tinamous and over two-thirds of those identified from Salvador's tinamous were not recorded from the crops of spotted tinamous.

Summary - Darwin's Tinamous

Our study of food habits of Darwin's tinamous was based on an examination of 28 crops, representing three seasons of the year and analyzed both by number of occurrences and by a visual estimate of volume consumed. The identification of the plants and animals consumed were considerately made by botanists and entomologists associated with the Federal Agricultural Research Stations near Santa Rosa, La Pampa, and Buenos Aires. The results, in summary are as follows;

1. A considerable variety of vegetable and animal material was consumed. Identified were 23 genera and 19 species of plants, and 5 orders and 8 families of insects.
2. Of the material examined 73 percent was plant and 27 percent animal by volume consumed.
3. Exotic species of plants represented almost half of the plants identified. Most of these are also found in the United States.
4. Of the vegetable material eaten 79 percent is represented by 4 genera. Grasses constituted 42 percent; composites, 17 percent; legumes, 12½ percent; and the goosefoot family, 8 percent of the genera identified.

5. Wheat, barley, corn, and alfalfa were eaten but many birds were found far removed from any cultivation.
6. Plants most frequently eaten include Russian thistle (Salsola), storkbill (Erodium), burning bush (Kochia), vetch (Vicia), grasses and wheat.
7. Volume-wise, grasshoppers, and seeds of thistles, storkbill and burning bush were most important.

Food by Seasons

Our study does not present a well rounded picture of seasonal consumption since spring is not represented. Other studies and the 400 miles that separated our station from the nearest darwini range were contributing factors. The distribution and comparison of plants and animal foods by the other seasons is presented in table 12. From this, and an analysis of table 13, the major characteristics of seasonal food consumption may be determined.

Table 12. Distribution of plant and animal foods by seasons, type and volume consumed by Darwin's tinamous

<u>Season</u>	<u>No. of crops</u>		<u>Veg. and animal</u>	<u>Crop contents</u>		<u>% volume</u>	
	<u>Examined</u>	<u>Empty</u>		<u>Veg. only</u>	<u>Animal only</u>	<u>Veg.</u>	<u>Animal</u>
Spring	0	-	-	-	-	-	-
Summer	5	0	3	1	1	44	56
Fall	10	1	5	4	0	74	26
Winter	<u>13</u>	<u>2</u>	<u>6</u>	<u>5</u>	<u>0</u>	<u>85</u>	<u>15</u>
Total	28	3	14	10	1		

Summer -- As with the spotted tinamous, insects provided the major source of food at this season. Grasshoppers in both occurrence and volume ranked high. Many beetles were also taken but, by volume, were much less important. No moth or butterfly adults or larvae were found possibly because of the small sampling involved. One crop contained nothing but red ants.

In summer a great variety of seed and green food was taken. Eleven genera were represented in our sample though not one appears in more than two of the crops examined.

Fall -- Insects, mainly grasshoppers, still provided a quarter of the food consumed in fall. Where taken they usually represented over 50 percent of the food by volume in the crop.

Seeds from 15 genera of plants were eaten. Of these five were grasses. Vetch (Vicia), and storkbill (Erodium), were most frequently taken, the latter in considerable volume. One crop was full of Russian thistle (Salsola kali). Considerable green food was also evident.

Winter -- Plants comprised the main diet in winter though only nine genera were represented in our sample. Russian thistle (Salsola) and burning bush (Kochia) were most commonly identified and bulked large in the crops examined. Ricegrass (Piptochaetium) and leaflets of clover were occasional. Wheat, corn, and barley were also represented.

Grasshoppers, when available, were still relished but the emphasis on insects largely shifted to beetles occasionally supplemented by ants.

Table 13. Foods consumed by the Darwin's tinamou by number and percentage of occurrences for three seasons of the year

Plant ^(a)	Foods	Part eaten	Season					
			Summer		Fall		Winter	
			No.	%	No.	%	No.	%
	<u>Bromus brevis</u> - bromegrass	seeds	1	20	2	22		
	<u>Carduus nutans</u> - muck thistle	seeds	2	40	1	11		
	<u>Carex</u> sp. - sedge	corm	1	20				
	<u>Carthamus tinctorius</u>	seeds					1	8
	Curcubitaceae - melon	seeds	1	20				
	<u>Digitaria sanguinalis</u> - crabgrass	seeds			1	11		
	<u>Erigeron bonariensis</u> - fleabane	seeds			1	11		
	<u>Erodium cicutarium</u> - storksbill	seeds	1	20	3	33		
	<u>Fumaria</u> sp. - fumitory	seeds	1	20	1	11	1	8
	<u>Hordeum vulgare</u> - barley	seeds			1	11	1	8
	<u>Kochia scoparia</u> - burning bush	seeds					4	33
	<u>Medicago sativa</u> - alfalfa	seeds	2	40				
		leaflets	1	20				
	<u>Onopordum acanthium</u> - scotch thistle	seeds					1	8
	<u>Panicum bergii</u> - panicgrass				1	11		
	<u>Panicum milaceum</u> - European millet	seeds					1	8
	<u>Paspalum</u> sp. - honeygrass	seeds	1	20				
	<u>Piptochaetium napostense</u> - ricegrass	seeds			2	22	2	17
	<u>Salsola kali</u> - Russian thistle	seeds			1	11	3	26
	<u>Schkuharia pinnata</u> - fleaherb	seeds			1	11		
	<u>Stipa brachychaeta</u> - feathergrass	seeds			2	22		
	<u>Triticum aestivum</u> - wheat	seeds	2	40	2	22	2	17

Table 13 cont'd.

Foods	Part eaten	Season					
		Summer		Fall		Winter	
		No.	%	No.	%	No.	%
Plant ^(a) cont'd.							
<u>Urtica</u> sp. - nettle	seeds	1	20				
<u>Vicia graminæ</u> - vetch	seeds			1	11		
<u>Vicia</u> sp. - vetch	seeds			4	44		
<u>Zea mays</u> - corn	seeds					2	17
Unidentified							
Clover	leaflets	1	20			2	17
Grass	blades	1	20			2	17
Grass	leaves	1	20	3	33		
Seeds	seeds			2	22		
Stems	stems					1	8
Animal ^(b)							
Coleoptera							
<u>Colaspis</u> . sp.	adult					2	17
Elateridae - click beetle	larvae	1	20				
<u>Listroderes obliquus</u> - lady beetle	adult	1	20				
<u>Mitragenius degeani</u> - darkling beetle	adult					1	8
<u>Pantomorus auripes</u>	adult	1	20				
Unidentified beetle	adult	1	20	2	22		
Diptera							
Unidentified - fly		1	20				
- fly				1	11		
- fly				1	11		
Hymenoptera							
<u>Acromyrmex lundii</u> - red ant	adult	1	20				
<u>Acromyrmex</u> sp. - black ant	adult	1	20				
<u>Acromyrmex</u> sp. - black ant	adult			1	11		
<u>Acromyrmex</u> sp. - black ant	adult					1	8
Isoptera - termites	adult			1	11		
Orthoptera							
<u>Dichroplus pratensis</u> - grasshopper	adult	1	20				
<u>Dichroplus vitlatus</u> - grasshopper	adult	1	20	1	11		
<u>Neopedicus brunneri</u> - grasshopper	adult	1	20				
<u>Scyllinops brunneri</u> - grasshopper	adult			1	11		
Unidentified - grasshopper	adult	1	20	2	22	1	8

Table 13 cont'd.

<u>Foods</u>	<u>Part eaten</u>	<u>Season</u>					
		<u>Summer</u>		<u>Fall</u>		<u>Winter</u>	
		<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
Animal ^(b) Cont'd.							
Unidentified	larvae					2	17
Miscellaneous							
Quartz grit				1	11		

(a) Identified by Dr. G. Covas, Director and botanist at the Federal Agricultural Research Station (I.N.T.A.) near Santa Rosa, La Pampa.

(b) Identified by Drs. R. N. Orfila, J. Liebermann, A. Vetrano, and A. H. Oglobin, entomologists at the Federal Agricultural Research Station (I.N.T.A.) near Buenos Aires.

Other Items of Interest

Over much of the range of Darwin's tinamous grit is absent. One crop contained two small pebbles of quartzite; the rest were gritless. In captivity grit was freely utilized.

Water

Open water for drinking is seldom available and certainly not necessary for Darwin's tinamous. Neither birds nor their tracks were common along the muddy edges of the overflow from stock tanks. Small amounts of succulent green food are commonly eaten along with many soft bodied insects. Dew is normally heavy and was frequently utilized by our birds in captivity.

Summary - Salvador's Tinamous

Food habits studies of Salvador's tinamous were carried out by our associate Wayne Bohl who collected 82 crops throughout three seasons of the year. These are tabulated by number of occurrences since figures on volume are not available. A partial identification of plants and animals consumed was considerably made by botanists and entomologists associated with the University de Cuyo, Mendoza.

The food habits of Salvador's tinamous may be summarized as follows:

1. Twenty-six genera and 15 species of plants and 4 orders of insects were identified. Almost half of the plants and most of the types of insects were also eaten by Darwin's tinamous.
2. The food consumed was predominantly vegetable in origin though from half of the crops both plant and animal material was identified.
3. Exotic plants, while well represented, were less in evidence than native plants.
4. Grasses, mostly seeds, and composites provided almost half of the plant material eaten.
5. Fewer beetles but more grasshoppers and ants were consumed by Salvador's than by Darwin's or by the pampas spotted tinamous.
6. Waste grain, mostly wheat and corn and leaves of alfalfa was eaten where available, largely in fall and winter.
7. Plants most frequently eaten included bromegrass (Bromus), wild sorghum (Sorghum), Russian thistle (Salsola), and a mustard (Eruca).

Food by Seasons

The study, while incomplete, does present a picture of the changing patterns of plant versus animal foods for three seasons as presented below:

Table 14. Distribution of plant and animal foods consumed by Salvador's tinamous

<u>Season</u>	<u>No. of crops</u>		<u>Veg. and animal</u>	<u>Crop contents</u>		
	<u>Examined</u>	<u>Empty</u>		<u>Veg. only</u>	<u>Animal only</u>	<u>Crop contents not identified</u>
Spring	18	2	7	9	0	5
Summer	0	-	-	-	-	-
Fall	44	10	19	14	1	3
Winter	<u>20</u>	<u>2</u>	<u>7</u>	<u>9</u>	<u>2</u>	<u>1</u>
Total	82	14	33	32	3	9

From this, and an analysis of table 15, the major characteristics of seasonal food consumption may be determined, although without an indication of volume consumed in addition to incidence of occurrence, the relative importance of plant versus animal material is not apparent.

Spring -- There was considerable variety in spring plant foods. Most were identified from but one crop, although seeds of bromegrass and storksbill were found in three. Insects taken included ants, beetles, grasshoppers and praying mantis.

Fall -- Grass seeds led the list of items eaten in fall with bromegrass particularly in evidence. Russian thistle, sandbur and sorghum were also important. Insect food consists mainly of grasshoppers, mantis and ants.

Winter -- Among a number of plant items taken, bromegrass, nightshade, and mustard ranked high. Cultivated cereals, mostly barley and corn also were taken, where available. Ants were often eaten though the number consumed was seldom great.

Other Items of Interest

Grit was not found in any of the crops examined. In captivity this item was freely utilized.

Water

As with Darwin's tinamou, open water for drinking is uncommon over much of the range of Salvador's tinamou. Dew is usually heavy.

Table 15. Foods consumed by 68 Salvador's pale spotted tinamou by number and percentage of occurrence for each season of the year

<u>Foods</u>	<u>Season</u>							
	<u>Spring</u>		<u>Summer</u>		<u>Fall</u>		<u>Winter</u>	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
Plant ^(a)								
Amaranthaceae - Amaranthus					1	2.9		
<u>Boerhaavia paniculata</u> - spiderling	1	6.3						
<u>Bromus brevis</u> - bromegrass	3	18.3			10	29.4	5	27.8
<u>Bromus</u> sp. - bromegrass					6	17.6	2	11.1
(bur grass)								
<u>Cenchrus carolinianus</u> - sandbur					4	11.8		
<u>Centaurea</u> sp. - thistle	1	6.3						
<u>Chenopodium</u> sp. - pigweed					2	5.9		
Chenopodiaceae - pigweed					1	2.9		
Convolvulaceae - bindweed					1	2.9		

Table 15. Cont'd.

Foods	Season							
	Spring		Summer		Fall		Winter	
	No.	%	No.	%	No.	%	No.	%
Plant(a)								
<u>Erodium cicutarium</u> - storkbill	3	18.8						
<u>Eruca sativa</u> - colewort					2	5.9	5	27.8
<u>Glandularia</u> sp.	1	6.3						
Gramineae sp. - grasses					2	5.9		
<u>Helianthus annuus</u> - sunflower					1	2.9		
<u>Heliotropium</u> sp. - heliotrope					1	2.9		
<u>Hordeum</u> sp. - barley							3	16.7
<u>Kochia</u> sp. - burning bush							1	5.6
<u>Leucanophora diversifolia</u>	1	6.3						
<u>Lycium</u> sp. - lycium	1	6.3						
<u>Medicago hispida</u> - California burclover	1	6.3			2	5.9		
<u>Medicago sativa</u> - alfalfa	1	6.3					2	11.1
<u>Physalis mendocina</u> - ground cherry	2	12.5						
<u>Polygonum convolvulus</u> - black bindweed							1	5.6
<u>Salsola kali</u> - Russian thistle					4	11.8	1	5.6
<u>Schkuhria</u> sp. - fleshherb							1	5.6
<u>Setaria</u> sp. - foxtail					2	5.9		
<u>Solanum eucanthum</u> - nightshade	1	6.3						
<u>Solanum</u> sp. - nightshade	1	6.3			1	2.9	3	16.7
<u>Sorghum</u> sp. - sorghum					7	20.6		
<u>Taraxacum officinale</u> - dandelion	1	6.3						
<u>Triticum</u> sp. - wheat					2	5.9		
<u>Verbesina encelioides</u> - golden crowbeard					2	5.9		
<u>Zea mays</u> - corn					2	5.9	2	11.1
Unidentified	6	37.5			5	14.7	6	33.3
Animal								
Coleoptera - beetle	5	31.3			2	5.9	1	5.6
Hymenoptera - ant	4	25.0			3	8.8	3	16.7
Hemiptera	1	6.3						
Orthoptera								
Acrididae - grasshopper	3	18.8			16	47.0		
Mantidae - mantis	2	12.5			3	8.8		
Unidentified insects					2	5.9	3	16.7
Crustaceans	1	6.3						

(a) Crops collected by Wayne H. Bohl and contents identified by Dr. Ruiz Leal, University de Cuyo, Mendoza.

Movement and Mobility

Pale spotted tinamous are nonmigratory and usually quite sedentary. In movement and mobility they follow the general pattern previously described for spotted tinamous. But, because of their generally more semi-arid habitat, a greater tendency to shift from one covert to another was noted especially during periods of drought. For example on the rounded crest of one grassy hill in east central La Pampa we flushed seven birds in about 20 acres of cover in late spring. Rechecked the following winter, no birds and only one night roosting spot were located. In well grassed, open savannah cover we flushed nine birds in two hours in early summer. In censusing the same cover in early winter only one bird was flushed. Yet a corn field, a mile distant and well trodden by cattle held many birds from early summer through to the following spring.

Such movements seemed to be much more pronounced in the savannah and brushland types than in the western pampas where vegetation is more varied and luxurious. At two ranches located in this cover type, checked infrequently but in all seasons of the year, it was always possible to locate substantial numbers of birds. On one farm colored plastic tape was attached to the upper back of three wild-trapped Darwin's tinamous to facilitate identification. One of these birds was observed several times over a period of a week but never more than 500 feet distant from the point of trapping. It proved difficult to keep track of these birds in fairly dense grassy cover and time prohibited an intensive followup.

Flight and Wariness

All members of the spotted tinamou group (Northura) fly well and fast. If not sharply pressed, many prefer to seek escape by running. They are, in general, nervous but not particularly wary birds except where heavily hunted. We found the pale spotted tinamou to be a little more difficult to find and flush without the aid of a dog than is its spotted cousin. On the other hand Sclater and Hudson (1889) indicate that it rises more readily, with less noise and flies higher than does the pampas tinamou.

Flight distances varied from 70 to 1300 feet. The average for 11 birds was 363 feet. Pairs seldom flushed together and often flew in divergent directions. In one instance one bird flushed and flew some 200 feet into an open woods. We drove the second of the pair slowly for some 350 feet away from the woods before it too took to air and followed the first.

Between flights the birds sometimes ran considerable distances. One flushed bird flew 90 feet, landed, ran 120 feet and flushed again at 100 feet from the observer.

The flight is usually straight or in a wide arc. Dodging is impossible because of very short tail feathers. One bird, put up in open savannah, flew down wind and crashed into a small tree apparently without serious injury since we could not find it again.

Dusting and Bathing

Among our penned birds dusting and bathing appeared to be as important to pale spotted as to spotted tinamous. The behavioral characteristics involved were the same as were previously described for the latter species.

Resting and Roosting

Pale spotted tinamous rest and roost on the ground. Roosting sites were characterized by slight hollows marked by an accumulation of droppings. Between two close clumps of bunchgrass or under an overhanging canopy of drooping leaves of grass were favorite locations. It is normal for the birds to return to the same roosting spot for several nights from which they can be caught with the aid of a flashlight and a hand net. Captive birds often scraped out a hollow in the sand, usually in the corner or at the edge of the pen. Here they roosted for several weeks before changing location. The most unusual roosting spot encountered was at the bottom of a large, slanting hole some three feet deep.

The birds never covey either by day or night though roosting spots were occasionally located within a few feet of each other. Whether or not they were simultaneously occupied was not determined.

Breeding

Breeding periodicity and behavior in general conformed to that of spotted tinamous as previously described.

Period -- An examination of 29 testes or egg sacs and ova, of Darwin's tinamous collected throughout the year indicated that enlargement may take place as early as midwinter and continue well into mid-fall. During the nonbreeding season, the left testis was as small as 5 by 2 mm; the right, 4 by 1.5 mm. At the height of breeding activity the left testis may measure 18 by 12 mm; the right, 16 by 10 mm. Egg sacs in winter were often 14 by 5 mm or larger. Ova at this period were usually 0.5 to 1.5 mm in size. Even during the breeding period only one or two of these normally increase in size at any one time. Our observations are presented in table 23 in the appendix.

As for spotted tinamous the breeding season may begin as early as late winter (mid-August) with individual birds. Penned individuals began breeding on August 24. The height of the season extends from mid-October through February (midspring through late summer).

Salvador's tinamous conformed rather closely to the above pattern as indicated in table 24 in the appendix. Bohl reported one interesting record indicative of late fall breeding. The right testis of a male, weighing only 196 grams, collected on May 19 measured 19 by 9 mm; the left, 11 by 9. Two other males collected in May showed the normal regression of the testes to nonbreeding condition.

Breeding age -- The pale spotted like the spotted tinamous becomes sexually mature at an early age and certainly reproduces in the first breeding season following hatching. That early hatched birds may breed the same season is indicated by one of our hand-reared males in which the penis was fully developed and enlarged as in the breeding season at 15 weeks of age. This possibility was confirmed by George Wint (personal communication), Superintendent of the Oklahoma State Game Farm, who reported that three Darwin's tinamous, exposed to artificial light at the farm, started to lay eggs at 47, 67 and 80 days respectively after the date on which they were hatched.

Mating behavior -- Mating behavior conformed closely to that indicated for spotted tinamous. Slight variations occasionally were observed in our pens as indicated by the following notes made on the spot. "Male darwini treading female for about $2\frac{1}{2}$ minutes. The latter was squatting close to the ground with neck stretched up and head level but moving rather rapidly from side to side in an arc of 90° . The feet of the male often slipped off the back of the female and a rather precarious balance was maintained by stretching the wings outwards a little and downwards to touch the body of the female. Occasionally he would reach forward and attempt to peck the head or neck of the female, though for only a moment.

"Upon completion the female slid from under the male who grasped the feathers of her lower neck and was thus dragged for about three feet before they separated. The hen then walked around the obviously exhausted male several times then started to chase other females in the pen. These paid no obvious attention to the mating while it was in progress."

Promiscuity and homosexuality -- Neither of these traits were observed among wild birds. Both were noted among our penned birds. When several of each sex were penned together we occasionally observed a second male mount a female without observable objection from the squatting bird when the former lost his balance. A female would also accept service from two different males within the period of a few hours.

One case of homosexuality among females was observed. All penned adults were sexed anally and by eye color and marked with different colored leg bands to indicate their sex. On three separate occasions one female was observed to mount another and carry out most of the external breeding pattern. Both birds were checked several times and were unquestionably females.

Time and frequency of mating -- During spring and summer pale spotted tinamous in captivity might be seen mating at any time of day. They were most active, however, in the morning up to 9 a. m. and particularly between 4 and 6 p. m. in late afternoon.

Mating, apparently consummated between the same pair or among different birds, often occurred several times in the same day. The time interval between these was occasionally as short as two hours.

Nesting and Renesting

As with all Nothura observed, the male builds the nest and incubates the eggs. The nest is placed on the ground and is usually well concealed.

During the work in Argentina, 9 nests of Darwin's and 30 of Salvador's tinamous were located. Most nests were reported by farm folks, although on several occasions a rope was used to flush the incubating bird.

Period -- Though nests have been reported from early September through mid-March it is doubtful if many contain eggs before October. We did not search intensively for nests until after early November. The first nest was located on November 16, the last on March 12, (late spring to early fall).

Two keen observers, long resident in La Pampa, indicated that more nests were to be found from 10 to 15 days after a rain. This tendency to nest after a wet period is not unusual among other game birds of semi-arid regions.

Location -- All of the nests of pale spotted tinamous that were discovered were on the ground. Six of the nests of Darwin's tinamous were well hidden in clumps of vegetation that were from 12 to 36 inches in diameter. Two were on the northeast side and one at the eastern edge of a clump of bunchgrass.

The height of the vegetation surrounding the nest varied from 6 to 20 inches with a median of 9 inches.

In checking spotted tinamous, no nests were discovered closer than 40 feet apart. It was thus interesting to find two nests of Darwin's tinamous within 6 feet of each other in a fairly dense cover of pigweed and Russian thistle.

Nests were generally well concealed and almost impossible to locate without flushing the bird. Of the nine nests seen, one was poorly concealed, another fairly well hidden. The rest were impossible to see unless the exact location was known and the sheltering vegetation parted.

Types of cover preferred for nesting -- Grass with or without forbs was characteristic of the general type of cover surrounding each of the nine darwini nests located. Four were placed in fields openly planted to trees. One was in a field with scattered shrubs. The rest were in habitat devoid of woody growth.

The characteristics of the fields in which nests were located is presented in table 16.

Table 16. Cover characteristics of fields in which nests of Darwin's tinamous were found

No. of nests	Ground cover ^(a)					Overstory ^(b)		
	Grasses	Forbs	Alfalfa	Thistles	Av. ht.	Type	Av. ht.	Density
2		70		30	20	trees	2½	open
1		70		30	12	trees	2½	open
1	30	70			6	none		
1	50		50		6	none		
1	50	20		30	10	none		
1	95	5			8	trees	25	open
1	90	10			7	shrub	7	sparse
1	100				12	trees	25	open

(a) In percent

(b) Average height in inches for ground cover and in feet for overstory.

Most of the nests of Salvador's tinamous located by Wayne Bohl were in the irrigated or better-watered areas east of the Andes and at elevations of 2800 to 3200 feet. This may explain the relatively large number found in cultivated, orchard or plantation areas as indicated in table 17.

Table 17. Location of nests of Salvador's tinamous according to type of cover

<u>Type of cover</u>	<u>Number of nests</u>
Cultivated fields with grass and weeds	7
Pea field	2
Grass and brush	8
Pasture with forbs, brush and occasionally alfalfa	3
Orchard	4
Plantation of trees	2

Height and density of nesting cover -- Ground cover from 6 to 20 inches in height contained nests as indicated in table 16. The ground vegetation over most of the range of darwini is more open and apt to contain more bunchgrass than is the case with the habitat of spotted tinamous. Grazing by cattle or sheep is less intensive but poorer soil fertility or more arid conditions help to limit vegetation density.

Edge effect -- Nests of Darwin's tinamous were located from 7 to 600 feet from a change of vegetation type. Five of the nine nests were placed within 16 feet of an edge; only two exceeded 100 feet. An edge effect is suggested but by no means proven since the area of search contained habitats much altered and broken up by farming or ranching activities. Edge effect did not appear to influence the location of nests of spotted tinamous.

Construction and character of the nest -- The nest was merely a scrape in the ground about an inch in depth, often sparsely lined with grass and feathers. One was bare earth on which a few small twigs had been placed. In fact, four of the nine nests were lightly lined with twigs or dry stalks of bunchgrass.

Reaction of the male to the discovery of the nest -- Male birds generally sat tight on the nest until very closely approached. One, flushed by the swish of a sythe over its head, flew up hitting the operator in the chest. Another moved but three feet from a boy, then squatted, but flushed when touched.

Abandonment of the nest -- Eggs were collected for propagation from three of the nine nests of Darwin's tinamous that were found. One of the remaining six nests was apparently abandoned after it had been discovered. Nest abandonment among spotted tinamous is unusual.

Renesting -- No information on renesting was obtained from wild birds. Renesting frequently and often is the rule with spotted tinamous and there is no reason to believe that the situation described for spotted tinamous does not apply with equal force to the species under consideration.

Eggs and Egg Laying

Size, shape, weight and color -- All Argentine tinamous lay very large eggs relative to the size of the bird. Eggs of spotted and of pale spotted tinamous are slightly oval. In color they are rich chocolate brown to deep wine. The shell is weak but of a lustrous, porcelain-like texture quite unlike that of most game birds.

The characteristics of and differences in the eggs of three subspecies are detailed in table 18.



Figure 36. Good nesting cover for Salvador's pale spotted tinamous. Nest is in clump of forbs.



Figure 37. Nest and eggs of Salvador's pale spotted tinamou.

Photographs by Wayne H. Bohl



Figure 38. Pale spotted tinamou often use the same roosting site for several nights.



Figure 39. Penned Salvador's tinamou on his nest.

Photographs by Wayne H. Bohl

Table 18. Size, shape, weight and color of eggs from three subspecies of the spotted tinamou (Nothura) group

<u>Characteristics</u>	<u>Subspecies</u>		
	<u>Pampas (a)</u> <u>N. m. annectens</u>	<u>Darwin's (b)</u> <u>N. d. darwini</u>	<u>Salvadori's (c)</u> <u>N. d. salvadorii</u>
<u>Size</u>			
Average	43.6 x 31.3 mm.	42.3 x 30.8 mm.	42.3 x 30.6 mm.
Largest	47.9 x 36.1 mm.	43.4 x 31.2 mm.	45.0 x 30.5 mm.
Smallest	39.0 x 29.0 mm.	41.0 x 30.0 mm.	38.0 x 30.0 mm.
<u>Weight</u>	20 to 25 grams	19 to 23.0 grams	17 to 25.0 grams
<u>Shape</u>	Oval, slightly pointed at one end	Oval to almost round	Oval, less pointed
<u>Color</u>	Rich chocolate to deep wine; unspotted	Slightly lighter and paler with a suggestion of gray	Same as <u>d. darwini</u>

- (a) From 60 eggs from a wild nest
 (b) From 7 eggs from wild nests
 (c) From 45 eggs from wild nests

Color, size and shape of the eggs in even a single nest sometimes vary. In captivity it was often possible to identify eggs laid by different females by such differences which carried through the entire season of egg production. One nest of the Darwin's tinamou, located on February 11 contained eggs of three distinct tones of chocolate and sizes with no overlap. This almost certainly means that three females laid in this nest. This tendency was also commonly observed among our birds in captivity. In our pens a clutch of eggs was commonly completed in but 2 to 3 days.

Laying habits and egg movement -- These characteristics differ but little from those earlier described for spotted tinamou. In captivity eggs might be deposited in a nest or scattered over the pen. On October 13 a male was observed scratching out a new nest depression. This completed, using his bill, he moved one egg 2 feet and the other 6 feet across the pen into the nest. Similar movements of eggs were frequently observed.

Clutch size -- A clutch of Darwin's tinamou eggs may vary from three to nine. The median for nine nests was six eggs.

Time of laying -- Few observations indicative of the time of egg laying among penned birds were kept. Of 19 eggs, 3 were deposited before 9:00 a.m., 2 between 9:00 a.m. and 1:00 p.m. and 14 between 1:00

and 5:00 p. m. Of 23 additional eggs for which the time of laying was less well known, 8 were dropped during the morning and 15 in the afternoon. So far as we know no eggs were laid after 5 p.m.

Interval and duration -- These characteristics are the same for Darwin's as for the spotted tinamous.

Fertility -- As with most game birds, egg fertility is high. Most of the eggs gathered in the country were hatched locally so records of fertility were not kept. Of 48 eggs laid by our penned birds only 7 were infertile. Though this is an excellent percentage for eggs from first generation birds in captivity, it is probable that fertility among eggs in the wild is substantially higher.

Incubation and Hatching

In our pens only the male incubated. The female took almost no part in incubation, though we observed one instance in which a female covered the nest for one night when the male refused to further continue this responsibility.

The period of incubation is very short. In our incubators eggs of Darwin's tinamous normally hatched in 16 to 18 days.

Incubation and hatching activities with Darwin's tinamous did not differ from those mentioned earlier for spotted tinamous.

The average weight of three chicks, hatched in our incubator from eggs already partly incubated in wild nests, was 16.3 grams.

Brooding and Rearing

The male broods and rears the chicks for 3 to 4 weeks from the time of hatching until the brood becomes independent. Young Darwin's tinamous, hatched and reared in captivity, were less shy and aggressive than were the chicks of pampas spotted tinamous but otherwise behaved the same as is described for this species. They required more attention at the outset to encourage them to eat, though they adjusted quickly and well to the brooders.

Gregariousness

Pale spotted tinamous are not gregarious. In winter single birds usually were flushed. Pairs were much less commonly seen than is the case with the pampas tinamous. Of 22 Darwin's tinamous observed by our assistant, Maurice Rumboll, in late summer while driving between ranches in northeastern La Pampa, 14 were alone and 8 were in pairs.

Nor were large concentrations of birds in a very small area encountered. Old, cultivated fields often attracted many birds in winter but these, when flushed, proved to be well scattered.

Temperament

In general adult pale spotted tinamous seem to be a little less nervous, both in the field and in the pens, than are pampas tinamous. Where not intensively hunted they often flushed within 25 feet. Hand-raised birds seldom became very tame though they were easily handled in captivity. One wing-tipped wild individual, penned with hand-reared birds, became as tame as its associates within 5 months.

These birds are quick to learn and adapt readily to captivity and to new conditions. Even five birds in an enclosure only 8 feet square would be alert but disinclined to run or fly when the pen was cleaned.

Calling

The repertoire of Darwin's tinamous is more limited than is that of the spotted tinamous as previously described. Two major differences were noted. The almost ventriloquistic "trill" call, so characteristic of pampas spotted tinamous, is apparently seldom if ever given by Darwin's tinamous. In its place one commonly hears a series of loud, distinct, medium pitched, separate notes, in most respects similar to the disturbed or alert calls of the spotted tinamous but lacking the succession of 4 to 6 descending notes at the end of the call. Both in the field and in our pens the two species could be separated by this characteristic.

Field observations also suggest that the Darwin's tinamou calls less frequently, particularly on hot or cold, windy days than does the pampas tinamou. Rumboll, in La Pampa on February 7, noted no calling between 8:00 a.m. and 12:30 p.m. on a cold, cloudy day with a south wind although many birds were known to be within earshot. Several days later, under more moderate conditions many calls were noted. On March 11 no birds called between 9:00 a.m. and 7:00 p.m. in another field though a number were seen.

Calling is most frequent in the morning and in late afternoon. On a hot, sunny, windless day at the Santa Rosa Airport (La Pampa) on January 30, while waiting for a plane, the number of calls heard over a 5 minute period from 11:00 a.m. to 7:30 p.m. were recorded at half hour intervals as follows:

11:00 - 3	1:00 - 1	3:00 - 3	5:00 - 4	7:00 - 5
11:30 - 4	1:30 - 2	3:30 - 0	5:30 - 2	7:30 - 0
Noon - 2	2:00 - 1	4:00 - 1	6:00 - 11	
12:30 - 0	2:30 - 0	4:30 - 11	6:30 - 1	

On March 14, two birds were giving the alert call in the garden of a ranch at 6:00 a.m. This was 20 minutes before sunrise. The shortest

call lasted only 4 seconds, the longest 27. Calls were made up of 2 to 4 notes per second and contained from 9 to 64 notes with 15 to 25 being most common.

In our pens both sexes called as is witnessed in our notes dated August 25. We were unable to detect a difference by sex in the call though there was an impression, unsupported by definitive data, that the female called more frequently than did the male.

Interbreeding

It is interesting that the range of Darwin's and the very closely related pampas tinamous apparently meet close to a political boundary representing the eastern border of the Province of La Pampa from Jacinto Auraz north to Villa Sauce. Birds collected within 3 to 10 miles west of this boundary usually were clearly referable to darwini; those east, to the pampas tinamou. Yet in southwestern Cordoba and adjacent San Luis, Bohl noted an overlapping of range in which some individuals were apparently assignable to one species; others showed some external characteristics of both.

During the breeding season, on three separate occasions we penned Darwin's and the pampas tinamous together without observing abnormal behavior. The few eggs laid proved to be infertile.

Predation

Throughout their range pale spotted tinamous are exposed to predators in variety and numbers at least comparable to those present in the United States. Avian predators particularly some of the hawks and owls were common though less abundant than in spotted tinamou range. Interestingly, they included magpies but not crows.

Mammalian predators were abundant. Eight foxes were recorded in one night while driving 110 kms in the Jeep. Thirteen opossums were trapped about our pens near Buenos Aires in the first year of operations. Three species of armadillos were common in parts of the habitat of pale spotted tinamous. Skunks were often seen but there are no raccoons.

Yet in all our field work we recorded only one probable kill and that was by an avian predator. Some feathers were found fairly frequently but carcasses were seldom located. In general, indications of severe egg or bird losses from predators were not evident.

The inversion of nesting and brooding behavior, previously described, materially reduces the impact of predation on pale spotted tinamou populations. The male incubates and rears the brood which disperses at a relatively early age. Relieved of these duties the female is physiologically capable of egg production throughout a nesting season of about

six months. In our pens, within 11 days after eggs or youngsters up to 1 week old were separated from the male spotted tinamou, we found him on a new nest incubating a full clutch of newly laid eggs. If this is also the case under wild conditions, the effect of predation could be substantially minimized.

Summary of Reproductive Capacity

Reproductive capacity must be high judging from the abundance of pale spotted tinamous in favorable habitats. Reproductive characteristics are:

Breeding age -- Less than 1 year of age.

Number of eggs -- Normally 4 to 9.

Brood survival -- No information.

Life span -- Up to 5 years in captivity.

Sex ratio -- No evidence that it is unbalanced.

Renesting -- Common and long continued.

Second broods -- No exact information on this in the wild. Females laid eggs from October through February and male birds appeared to be interested in incubating them.

Diseases and Parasites

Diseases

No disease was noted among wild pale spotted tinamous, and only one infection was detected among our penned birds. One bird was lost from blackhead, a disease characteristic of poultry. None was lost from parasites during the 2½ years in which we worked with captive birds in Argentina. Accidents took a minimal toll, though several youngsters died from eating indigestible twigs or bits of copper wire inadvertently left on the ground.

Internal Parasites

It is not surprising to find a lower incidence of parasitism in pale spotted tinamous than in the pampas spotted tinamou. A possible reason for this is that pale spotted tinamous consume fewer insects and in general are less abundant. Of 27 Darwin's tinamous examined, 10 or 37 percent were parasite free; of the same number of Salvador's, 22 percent. Only 17 percent of the pampas spotted autopsied were free of parasites.

Most of the parasites identified to genus or species were common to both spotted and pale spotted tinamous. Several were possibly new species or subspecies. Of the 54 wild birds examined 39 were autopsied by Program biologists and 15 by Drs. Elon Byrd and Katherine Prestwood. Samples of all parasites found were forwarded to Dr. Prestwood for final identification.

Parasites encountered included coccidia, flukes, tapeworms, roundworms, and thorny-headed worms. Most common were a gizzard worm (Habronema), a cecal worm (Subulura), and a filaroid worm (Tetracheilone). Of these only Habronema seemed to seriously affect pale spotted tinamous, and then mostly young birds.

Parasites of the proventriculus and gizzard -- A nematode (Habronema sp.) was found in 26 percent of Darwin's and 19 percent of Salvador's tinamous autopsied. This was also the most common parasite identified from pampas spotted tinamous. Most birds were but lightly infected.

Parasites of the small intestine -- Although three types of parasites were identified from the small intestine, none was encountered commonly. A few coccidia, probably Eimeria sp., were present in one Salvador's tinamou. One tapeworm, (Choanotaenia sp.) and a single thorny-headed worm (Acanthocephala), were observed in Darwin's tinamous.

Parasites of the liver -- Dr. Elon Byrd identified the liver fluke (Athesmia heterolecithodes) from two Darwin's tinamous. None were located in Salvador's tinamous.

Parasites of the cecum -- Cecal worms are common parasites in pale spotted tinamous. These apparently cause little inconvenience to the bird, even when common, though it is unusual to find more than a few individuals per bird examined.

The pattern of distribution of two genera of cecal worms in Argentina is interesting. As indicated below Heterakis sp., is the common cecal worm of eastern Argentina; Subulura sp. is dominant in the west.

Birds infected with cecal worms

<u>Genera</u>	<u>Pampas spotted tinamou</u> (Eastern Arg.)		<u>Darwin's tinamou</u> (Central Arg.)		<u>Salvador's tinamou</u> (Western Arg.)	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
<u>Heterakis</u> sp.	38	37	1	4	0	0
<u>Subulura</u> sp.	17	16	5	19	13	48

Parasites of the body cavity -- A filaroid worm (Tetracheilonema quadrilabiatum), was a fairly common, though apparently benign, resident of about one fourth to one fifth of the pale spotted tinamous collected. Though usually free living in the body cavity, it was also occasionally found under the skin of the lower part of the neck.

External Parasites

Time did not permit an intensive search for external parasites. No lice or feather mites were noted on any of the pale spotted tinamous collected.

Parasites Among Birds Raised in Captivity

Among our penned birds Heterakis and Subulura were occasionally noted though causing no difficulties. Coccidia were present and kept under control by the use of a coccidiostat.

Tables 19 and 20 list the parasites identified, their location in the body, and the number and percent recorded from Darwin's and from Salvador's tinamous.



Figure 40. Detailed post mortems of dead birds were routine during the study.

Table 19. Parasites found during autopsy of 27 wild Darwin's tinamous^(a)

<u>Parasites</u>	<u>Location in body</u>	<u>Birds harboring</u>	
		<u>Number</u>	<u>Percent</u>
Trematoda (Flukes)			
<u>Athesmia heterolecithodes</u>	Liver	2	25 ^(b)
Cestoda (Tapeworms)			
<u>Choanotaenia</u> sp.	Small intestine	1	4
Probable <u>Choanotaenia</u> sp.	Small intestine	1	4
Nematoda (Roundworms)			
<u>Heterakis</u> sp.	Ceca	1	4
<u>Subulura</u> sp	Ceca	5	19
<u>Habronema</u> sp.	Proventriculus; gizzard	7	26
<u>Tetracheilonema quadrilabiatum</u>	Body cavity	7	26
Unidentified	Ceca	1	4
Acanthocephala (Thorny-headed worms)			
Unidentified	Small intestine	1	4
No parasites found		10	37

(a) Drs. Katherine Prestwood and Elon Byrd examined eight of these birds while in Argentina. The remainder were autopsied by Mrs. Bump.

(b) Only the eight birds on which post mortems were made by Drs. Prestwood and Elon Byrd were examined in detail for flukes. The percentage is adjusted accordingly.

Table 20. Parasites found during autopsy of 27 wild Salvador's tinamous^(a)

<u>Parasites</u>	<u>Location in body</u>	<u>Birds harboring</u>	
		<u>Number</u>	<u>Percent</u>
Protozoa			
<u>Eimeria</u> sp.	Small intestine	1	3
Cestoda (Tapeworms)			
Unidentified	Small intestine	3	11
Nematoda (Roundworms)			
<u>Subulura</u> sp.	Ceca	13	48
<u>Habronema</u> sp.	Proventriculus, gizzard	5	19
<u>Tetracheilonema quadrilabiatum</u>	Body cavity	5	19
Unidentified	Gizzard	1	3
	Ceca	2	7
	Body cavity	1	3
No parasites found		6	22

(a) Drs. Katherine Prestwood and Elon Byrd autopsied seven of these birds while in Argentina. The remainder were examined by Wayne H. Bohl or by Janet Bump.

Analysis of Competing Interests

Relation to Agriculture

Pale spotted tinamous are universally considered to be desirable citizens of farms or ranches in Argentina. Neither in the literature nor in field contacts was there any evidence that these birds might be unwelcome. What little grain they eat is waste grain and the intake of wild seeds is high. In addition they consume an unusually high proportion of insects.

Usefulness

As a game bird -- Pale spotted tinamous often occupy a covert along with crested or large brushland tinamous. In favorable habitats they are usually more abundant than are either of the other species mentioned but are sometimes less sought after because of their smaller size and the high cost of shotgun ammunition. In fact they provide excellent, usually clear shots though the bird possible flies slightly slower than does our bobwhite. In many though not all cases, they also sit well to a dog.

As a source of income and food -- Pale spotted tinamous have been offered for sale less commonly than are the spotted tinamous. The meat of the pale spotted tinamou is white and sweet, lacking a strong gamey flavor. It is considered a table delicacy in Argentina particularly as "perdices en escabache" or pickled tinamou. The recipe for this is as follows:

6 partridges	1 stalk celery
4 carrots	6 sprigs parsley
1 large onion	1 cup vinegar
1 slice lemon with peel removed	1½ cups olive oil
2 bay leaves	1 teaspoon peppercorns
	salt to taste

Clean tinamou well and truss. Cut all vegetables in small pieces and put all ingredients in a pot with a tight fitting cover. Cook slowly until tender or for about one hour. Serve cold as a first course or hot with mashed potatoes, as the main dish.

As a fighting bird or a pet -- None of the tinamous are pugnacious and none are kept for fighting. Darwin's tinamous are easy to keep in captivity but seldom becomes really tame. For this reason they are not normally kept as pets.

Relation to Other Game Birds

Competition between different species for territory, food and nesting sites is a law of life wherever the habitats of closely related species overlap. This may be severe in one case but have little effect in another.

Program biologists were alert to the possibilities of competition between exotic and native species. Until one actually makes and studies a successful liberation of a foreign species in a fresh environment the only other source of reference is the study of a species considered for trial in its native habitat.

Two other species of tinamou, the large brushland and the crested, are common over much of the grassland ranges occupied by pale spotted tinamou. Among these no evidence of rivalry for territory was noted. Food was usually ample and each species sufficiently catholic in its diet to make severe competition for it unlikely. Likewise there was no evident competition for nesting sites; for in predominantly grassland habitats these are legion.

Pale spotted tinamou were penned together with large brushland tinamou during part of one breeding season without apparent behavioral difficulty.

Climatically pale spotted tinamou would seem to be best adapted to those parts of the southwestern United States in which average annual precipitation does not exceed 25 inches. In this region two upland game birds, the Gambel's quail and the scaled quail, are common. Good Gambel habitat is quite different from the grass and forb types normally associated with pale spotted tinamou. Scaled quail occupy habitats in some respects similar to those suitable for pale spotted tinamou though they seldom thrive in intensively farmed or grazed areas where native brushland is scarce (Ligon, 1927). Pale spotted tinamou, while not forsaking grassy brushlands, are predominantly grazed grassland or farmland birds. Serious competition between the two species is not probable, except where grasslands are not fairly to heavily grazed and are interspersed with shrubs. For food both rely rather commonly on seeds and insects (Martin, Zim and Nelson 1951) though scaled quail appear to consume more fruits of trees and shrubs (Texas Game, Fish and Oyster Commission, 1945) and pale spotted tinamou eat more seeds of various grasses.

Breeding and Rearing

Pale spotted tinamou are a little less nervous and easier to handle in captivity than spotted tinamou. We encountered few problems in penning or in getting fertile eggs from either species grouped one male with one female, one with two or two with three, in pens 6 by 8 by 6 feet to 9 by 12 by 6 feet in size. Unless there is considerable grassy cover in the pen, the male usually refuses to incubate the eggs. A group of 10 to 15 birds may be successfully overwintered in the larger pen mentioned above. The eggs seem to be subject to sunscalding when exposed, and should be frequently collected.

Suggestions on breeding, incubation, brooding, rearing, and overwintering, with the exception of the items noted above, are the same as are presented previously for spotted tinamou.

Trapping and Marking

Trapping methods were the same for all the spotted tinamou group. It was more difficult to walk Darwin's tinamous into a snare since they usually occupied less intensively grazed pastures with fewer trails or paths along which the birds could be easily driven. Conversely, being a little less nervous than the pampas spotted tinamou, it was easier to catch them with a net or a snare while riding a horse. Our assistant, Maurice Rumboll, netted several from horseback.

Individuals, both in our pens and in the field, were marked with colored tape fastened lightly with a safety pin to the lower neck where it joined the back. Some markers of this type were lost within the first few days in our pens. Others lasted much longer. One attached in December 1964 was removed when the bird was shipped in January 1966. There was a tendency for most of these markers to hang to one side or the other which lessens their usefulness in the field.

For banding adult pale spotted tinamous size 3A is recommended. Size 3 is small and size 4 occasionally slides downwards over the foot.

REFERENCES

- Aravena, R. 1927. Notas sobre la Alimentacion de las Aves. El Hornero. Vol. IV:1. Tomas Palumbo, Buenos Aires. p. 38-49.
- "Banderas." Sporting Reminiscences of South America 1919-1921. Riddle, Smith and Duffies. London. 132 p.
- Barlow, Nora. 1933. Charles Darwin's Diary of the Voyage of H.M.S. "Beagle." University Press, Cambridge (Government Britain). 442 p.
- Besiter, H. E. and L. H. Schwarte. 1965. Diseases of Poultry. The Iowa State University Press, Ames, Iowa. 1103 p.
- Bo, N. A. 1965. Sobre la Avifauna del Noreste de San Luis. El Hornero. Rev. de la Asoc. Orn. del Plata. Vol. 10:3. Buenos Aires. p. 253-254.
- Bock, W. J. 1963. The Cranial Evidence for Rattite Affinities. Proceedings 13th Int. Ornith. Congress. p. 39-54.
- Bonetto, A., C. Pignalbari, and P. Saporito. 1961. Acerca de la Alimentacion de Nothura maculosa nigroguttata con Especial Referencia a su Actividad Entomofaga. Physis. Vol. XXII:63. p. 53-60.
- Bump, G. 1951. Game Introductions--When, Where, and How. Transactions 16th North American Wildlife Conference, March 5-7, 1951. Washington, D.C. p. 316-325.
- Bump, G. and W. H. Bohl. 1965. Interim Report on some Tinamou of Argentina. Foreign Game Investigation Program. Bureau of Sport Fisheries and Wildlife, Washington, D.C. 35 p.
- Chandler, A. C. and C. P. Read. 1961. Introduction to Parasitology. John Wiley and Sons, New York. 822 p.
- Conover, B. 1950. A Study of the Spotted Tinamous. Fieldiana - Zoology, Vol. 31:38. Chicago Natural History Museum, Chicago. p. 339-362.
- Consejo Nacional de Desarrollo. 1962. Mapas y Estadisticas de la Republica Argentina. G. Kraft (Press) Ltd., Buenos Aires. 163 p.
- Covas, G. et al. 1964 - 1965. Apuntes para la Flora de La Pampa. Inst. Nac. de Tech. Agr., Estacion Experimental Agrapecuaria de Anguil, La Pampa. Arg. No. 1-27.
- Cram, E. B. 1927. Bird Parasites of the Nematoda Suborders Strongylata, Ascaridata, and Spirurata. Bull. 140, U.S. National Museum. U. S. Government Printing Office, Washington. 465 p.

- Daguerre, Juan. 1923. Notas sobre Costumbres y Caza de Perdices. El Hornero. Rev. del Soc. Orn. del Plata. Vol. III:2. Buenos Aires. p. 195-197.
- de Costa, M.J.I.P. 1960. Perdices y martinetas. Idia no. 150 de Junio 1960. Buenos Aires. p. 86-96.
- 1963. Indice de los Nombres Vulgares de las Aves Argentinas. Buenos Aires. 67 p.
- de Schauensee, R. M. 1966. The Species of Birds in South America with their Distribution. Livingston Publishing Co., Narbeth, Pa. p. 3-10.
- El Hornero 1922. La Exportacion de Percides a Norte America. Rev. del Soc. Orn. del Plata. Vol. II:4. Buenos Aires. p. 299.
- 1923. Sigue le Exportacion de Perdices a Norte America. Rev. del Soc. Ornith. del Plata. Vol. III:2. Buenos Aires. p. 209.
- 1926. El Aquila de Cabeza Blanca Destructor de Perdices. Rev. del Soc. Ornith. del Plata. Vol. V:1. Buenos Aires. p. 108.
- Foreign Agriculture Service, U. S. Department of Agriculture 1958. Agricultural Geography of Latin America. Miscellaneous Publication 743. Washington. 96 p.
- Godoy, J. C. 1963. Fauna Silvestre. Evaluacion de los Recursos Naturales de la Argentina. Tomo VIII, Vol. 1-2. Consejo Federal de Inversiones. Republica Argentina. Buenos Aires. 527 p.
- Hellmayr, C. E. and B. Conover. 1942. Family Tinamidae. Field Museum of Natural History, Zoological Series. 13:1. p. 6-114.
- Hudson, W. H. 1920. Birds of La Plata. Vol. 2. J. M. Dent and Sons, Ltd. London.
- 1928. Las Perdices de la Argentina. El Hornero. Rev. del Soc. Orn. del Plata. Vol. IV:2. Buenos Aires. p. 174-183.
- Job, H. K. Propagation of Wild Birds. Doubleday, Page and Co. p. 91-99.
- Johnson, A. W. 1965. Birds of Chile. Vol. 1. Platt Establecimientos Graficos. Buenos Aires. 398 p.
- Lahille, F. 1921. Estudio de las Aves en Relacion con le Agricultura. El Hornero. Rev. del Soc. Orn. del Plata. Vol. II:3. Buenos Aires. p. 124-223.

- Lehman-Nitsche, R. 1922. Aclimatacion de la Perdiz Grande y de la Martineta en Alemania. El Hornero. Rev. del Soc. Orn. del Plata. Vol. II:4. Buenos Aires. p. 292-294.
- 1929. Las Aves en el Folklore Sudamericana. El Hornero. Rev. del Soc. Orn. del Plata. Vol. 4:3. Buenos Aires. p. 302-308.
- Liebermann, Jose. 1936. Monografia de las Tinamiformes Argentinas y la Problema de su Domesticacion. Edition del Autor. Buenos Aires. 99 p.
- Ligon, J. Stokley. 1927. Wildlife of New Mexico, Its Conservation and Management. State Game Commission, Dep't. of Game and Fish. Sante Fe. 212 p.
- Martin, A. C., H. S. Zim and A. L. Nelson. 1951. American Wildlife and Plants. McGraw-Hill, New York. 500 p.
- Mazza, S. A. and A. Fiora. 1931. Filarideo nuevo Sp. del Peritones de Perdiz Nothura maculosa. Vol VII Reunion Soc. Arg. Pat. Regional del Norte. Jujuy. p. 1040-1041.
- Meteorological Office. 1960. Tables of Temperatures, Relative Humidity and Precipitation. Publication M. O. 617b. Part 11. Her Majesty's Stationery Office, London. 53 p.
- Morello, Jorge. 1958. La Provincia Fitogeografica del Monte. Opera Lilloana 2. Instituto Miguel Lillo. Tucuman, Arg. 155 p.
- Olog, C. C. 1959. Las Aves Argentinas. Univ. Nac. de Tucuman, Instituto Miguel Lillo. Tucuman, Arg. 343 p.
- 1959. Tres Nuevas Subespecies de las Aves Argentinas (Tinamiformes). Neotropica Vol. 5:17. p. 39-44.
- 1963. Lista y Distribucion de las Aves Argentinas. Opera Lilloana 9. Univ. Nac. de Tucuman, Inst. Miguel Lillo Tucuman. 377 p.
- Parks, K. C. and G. A. Clark, Jr. 1966. An Additional Character Linking Ratites and Tinamous and an Interpretation of their Monophyly. The Condor. Vol. 68:5. p. 459-471.
- Partridge, W. H. 1953. Observaciones Sobre Aves de Cordoba y San Luis. El Hornero. Rev. de la As'n. Orn. del Plata. Vol. 10:1. Coni, Buenos Aires. p. 28-73.
- Pereyra, J. A. 1928. Observaciones Sobre Algunos Aves de Buenos Aires. La Perdiz chica. El Hornero. Rev. de la Soc. Orn. del Plata. Vol. 6:1. Buenos Aires. p. 74-76.

- Pereyra, J. A. 1938. Contribucion al Estudio y Observaciones Ornithologicas de la Zona Norte de la Gobernacion de La Pampa. Las Mem. de la Soc. Orn. del Plata. Vol. 7. Taller de Impresiones Oficiales. La Plata. 131 p.
- Peters, J. L. 1931. Check-List of Birds of the World. Vol. 1. Harvard Univ. Press, Cambridge. 345 p.
- Reed, C. S. 1919. Brevas Notas acerca de Nidos y Huevos de Algunas Aves de la Cordillera de Mendoza. El Hornero. Rev. de la Soc. Orn. del Plata. Vol. 1:4, Buenos Aires. p. 267-273.
- Sclater, P. L. and W. H. Hudson. 1889. Argentine Ornithology. A Descriptive Catalogue of the Birds of the Argentine Republic. Vol. II. R. H. Porter, London. 251 p.
- Serie, P. B. 1921. Sobre le Alimentacion de la Perdiz Comun. El Hornero. Rev. del Soc. Orn. del Plata. Vol. 2:3. p. 230-232.
- Servicio Meteorologico Nacional, Min. de Aeronautica. 1958. Estadisticas Climatologicas 1941-1950. Publ. Bl:3, Buenos Aires. 161 p.
- 1965. Estadisticas Climatologicas 1951-1960. Publ. Bl:6 (2nd ed.). Buenos Aires. 158 p.
- Siegmund, O. H. 1961. The Merck Veterinary Manual. (2nd Ed.) Merck and Company. Rahway, New Jersey. 1624 p.
- Stekhoven, J. H. S. 1952. Nematodos Parasitarios de Anfibios, Pajaros y Mamiferos de la Republica Argentina. Vol. 10. De Acta Zoologica Lilleona del Instituto "Miguel Lillo," Tucuman. p. 315-400.
- Stoddard, H. L. 1931. The Bobwhite Quail. Chas. Scribners and Sons, New York. 559 p.
- Texas Game, Fish and Oyster Comm. 1945. Principal Game Birds and Mammals of Texas. Austin. 149 p.
- Van Royan, W. 1954. The Agricultural Resources of the World. Vol. 1. Univ. of Maryland. New York. 258 p.
- Van Tyne, Josselyn and A. J. Burger. 1961. Fundamentals of Ornithology. John Wiley and Sons, New York. 624 p.
- Weather Bureau, U. S. Department of Commerce 1953. Climatology of the United States. No. 11. U. S. Government Printing Office, Washington, D.C.
- Wetmore, Alexander. 1926. Observations on the Birds of Argentina, Paraguay, Uruguay, and Chile. U.S. Nat. Mus. Bull. 133. Washington, D.C. 448 p.

APPENDIX

Distribution of species of tinamou in Argentina and Chile (a,b)

	Order	Tinamiformes	
	Family	Tinamidae	
<u>Genus and species</u>	<u>No. of subsp. (c)</u>	<u>Common name</u>	<u>Distribution</u>
<u>Tinamus solitarius</u>	Monotypic	Solitary tinamou	Province of Misiones. Also eastern Paraguay and southeastern Brazil.
<u>Crypturellus obsoletus</u>	6	Brown tinamou	Misiones. Also eastern Paraguay, eastern and southern Brazil.
<u>Crypturellus undulatus</u>	6	Undulated tinamou	Eastern Formosa. Also eastern Bolivia, Paraguayan Chaco and adjacent Brazil.
<u>Crypturellus parvirostris</u>	Monotypic	Small-billed tinamou	Misiones. Also eastern Peru, Bolivia, Paraguay and southern Brazil.
<u>Crypturellus tataupa</u>	4	Blue tinamou	Northwest from northern Entre Rios, Sante Fe, Cordoba, and parts of San Juan. Also southeastern Bolivia, Paraguay, and southeastern Brazil.
<u>Rynchotus rufescens</u>	4	Red-winged tinamou	Misiones south to Buenos Aires, eastern La Pampa, Cordoba, northern San Luis, Catamarca and north to Jujuy. Also southeastern Bolivia, Paraguay, Uruguay and southern Brazil.

(a) Throughout the range according to Hellmayer and Conover (1942), as modified by Conover (1950) and Olrog (1963)

(b) See figure 1 for location of Provinces here mentioned.

(c) Throughout the range

<u>Nothoprocta ornata</u>	3	Ornate tinamou	From 2,500 to 4,500 meters in northwestern Argentina. Also north-eastern Chile, Bolivia, and north to central Peru.
<u>Northoprocta perdicaria</u>	2	Chilean brush-land tinamou	From sea level through valleys and uplands of north central to south central Chile.
<u>Nothoprocta cinerascens</u>	2	Large brushland tinamou	Paraguayan Chaco south to Cordoba and northern and eastern La Pampa, west to northeastern Mendoza and north to Jujuy. Also in southern and eastern Bolivia and adjacent parts of Paraguay.
<u>Nothoprocta pentlandii</u>	3	Canyon tinamou	Cordoba west to northern Neuquen and Mendoza, and north through the mountains of Jujuy. Also northeastern Chile and southern Bolivia.
<u>Nothura darwinii</u>	5	Pale spotted tinamou	Jujuy and Salta south to northern Chubut, east through La Pampa, and Cordoba to southern Buenos Aires. Also mountains of southeastern Peru and Bolivia.
<u>Nothura maculosa</u>	7	Spotted tinamou	Salta, Formosa and Misiones south through Buenos Aires to northern and eastern Rio Negro, eastern Chubut, and northern and southeastern Neuquen. Also southern Brazil, Paraguay, and Uruguay.

<u>Eudromia elegans</u>	8	Crested tinamou	Cordoba, southern Sante Fe, western Buenos Aires south to Santa Cruz, west and north to Santiago del Estero, Tucuman and Salta. Also near Aysen in southern Chile.
<u>Eudromia formosa</u>	2	Elegant tinamou	Eastern Salta and Tucuman, western Santiago del Estero, western Chaco and Formosa. Also the Paraguayan Chaco.
<u>Tinamotis pentlandii</u> Monotypic		Puna tinamou	Jujuy and Salta to northern Catamarca from 4,000 to 4,500 meters. Also northern Chile, Bolivia and southern Peru.
<u>Tinamotis ingoufi</u> Monotypic		Patagonian tinamou	Steppes and mesas of southern Rio Negro, Chubut and Santa Cruz and in Chile between Aysen and Magallanes.

Table 21. Weight by sex and other developmental characteristics by months of the pampas spotted tinamou (Nothura m. annectens)^(a)

<u>Month/Day</u>	<u>Adults</u>						<u>Notes</u>
	<u>Weight by sex</u>		<u>Testes</u>		<u>Egg sac</u>	<u>Largest ovum</u>	
	<u>M.</u>	<u>F.</u>	<u>R.</u>	<u>L.</u>			
January 26		309				2/3rds size	laying toe and claw 31.7
January 26		x					laying
March 18	266		?	7x?			toe and claw 31.7
April 16		272					
April 17		293					toe and claw 30.5
April 17		323					toe and claw 32.0
April 17	272						
April 21		270					
April 21	269		13x?	11x?			one testis gray
April 21	268						
April 22	272						testes small
April 26			small				
April 26			small				
April 27		272	small				
April 28		307					
April 28		289					
April 28	251						
April 28	232						
April 29	265						
April 29	228		9.0x?	9.0x?			toe and claw 27.9
April 29	233						toe and claw 30.0
April 29		285					
April 29		270					
April 29	285						toe and claw 31.2
May 6	214		5.0x?	5.0x?			penis 60
May 15	239+		not found	4.0x2.0			sick bird
May 20		285			16x1	4	eyes dark
May 20	284		not found	7.0x1.2			eyes light
May 20		250			15x6	1	eyes dark
May 20	232						eyes medium
May 27	x		not found	3.7x1.7			eyes medium

Table 21. cont'd.

Month/Day	Weight by sex		Testes		Egg sac	Largest ovum	Notes
	M.	F.	R.	L.			
May 27		x			15x5	1	eyes dark
May 28		x			21x5	1	eyes dark
May 29		x					eyes dark
June 19	261		4.5x2.5/4.5x2.0				eyes medium
June 19		292			20.5x9.0	1.5	ova light
June 19		264			14x9	1.5	
June 19	294		5.5x1.5/5.5x2.0				testes gray
June 19	226		7.0x3.0/5.0x4.0				testes gray
June 19	246		6.0x3.0/5.5x3.0				toe and claw 29.8
June 19	247		5.0x2.0/4.0x2.0				testes light gray
June 19	247		6.0x2.0/5.0x3.0				testes dark gray
June 19		240			14x6	1	toe and claw 29.5
July 6	234		5.0x2.5/4.0x2.0				
July 6		262			14x8	1.5	toe and claw 31.1
July 8	265		8.0x3.0/7.5x5.0				
July 8		282			16x6	1	toe and claw 30.7 wing 135
July 22		249			13.8x5.6		
July 22	270		5.6x2.2/5.0x2.5				testes white
July 22	200		not found 3.6x2.2				young - ?
July 22	269		not found 5.5x3.7				testes white
July 22	250		5.3x3.8/6.2x3.8				testes cream
July 24		173					toe and claw 29.2
July 24	246		3.5x2.3/4.0x2.2				penis color dark toe and claw 31.1 wing 135
August 9	x		slightly enlarged				
August 19	273						toe and claw 32.0
August 21		245			17x8		oviduct dark
August 21	247		11.5x6.0 lost in collection				
September 11	217		5.0x4.5/7.0x5.0				toe and claw 29.9
September 14	x		3/4 enlarged				
September 22	x		1/4 enlarged				
September 23		x				1	
September 23	x		1/4 enlarged				
September 25	x		1/4 enlarged				

Table 21. cont'd.

Month/Day	Weight by sex		Testes		Egg sac	Largest ovum	Notes
	M.	F.	R.	L.			
September 28		x					laying
October 1	x		1/8 enlarged				
October 1		x				2	
October 1		x				3	
November 4	x		15.6x9.2/15.2x1.3				penis 125
November 6	232		20.0x18.0/18.0x16.0				
November 6	x						penis 85
<u>Young</u>							
January 26	136						2nd primary just showing age about 4 weeks
January 26		146					1st primary 21 2nd primary just showing age about 4 weeks
January 26		168					3rd primary 25 4th primary just showing age about 6 weeks
January 26		217					5th primary 25 age 8 to 10 weeks
March 10	123		3				age 4 to 6 weeks
May 28	x		4.0x2.0/3.0x2.0				5th primary $\frac{1}{2}$ out eyes medium
June 25		200			14x5	1	

(a) Weights in grams; lengths in mm. Only the middle toe and claw measured.

Table 22. Weight by sex and other developmental characteristics of the northeastern spotted tinamou (*Nothura m. maculosa*) (a)

<u>Month/Day</u>	<u>Weight by sex</u>		<u>Testes</u>		<u>Largest ovum</u>	<u>Notes</u>
	<u>M</u>	<u>F</u>	<u>R</u>	<u>L</u>		
October 11		286				Laying
October 11		238			5	oviduct enlarged
October 12		256			6	oviduct enlarged
October 12		257			10	oviduct not enlarged
October 15		290				
October 15		291				
October 15	265			13.0x?		
October 22		241				laying
October 25		290			4	

(a) Weights in grams; measurements in mm. Some birds collected 30 km. north of Curuzu Cuatia, others 20 km west of Sauce, Province of Corrientes.

Table 23. Weight by sex and other developmental characteristics of Darwin's pale spotted tinamou, (*N.d. darwini*) by months^(a)

Month/Day	Weight by sex		Testes		Egg sac	Largest ovum	Toe and claw ^(c)
	M.	F.	R.	L.			
January 18		234				hard-shelled egg	
January 18		254				full-sized ova	
February 8	222		18x12	15x10			
February 17 ^(b)		246				full-sized yolk	
March 29	200		6x?	6x?			
March 29	216		17x?	16x?			27.2
March 29	200		6x?	6x7			26.1
March 30		242				2	
March 30	205						27.0
May 11	208		small				28.6
May 28	216						26.7
May 28		247					26.7
May 29		241					
May 29		273			11x7	0.5	28.5
May 29		238			14x5	1	26.7
May 29	207		5x2	4x1.5			26.3
May 30	203						
May 30		215			15x4	1.5	
May 31		260			14x5	1	27.4
July 3	245		10x5 color	7.5x4 white			
July 4	224		5x3 color	5x3 gray			28.9
July 7		219			14x5	1	26.9
September 19		209				4	
November 13		285				18	27.6
November 13		247				20	27.8
November 13		259				17	27.3
November 13	232		18x10	16x8			29.9
December 5		217				laying	28.2
December 5	222						
Average	215	243					27.5

(a) Weight in grams; measurements in mm. Birds collected from eastern La Pampa.

(b) Collected near La Cumbria, Cordoba.

(c) Measurements refer to the middle toe and claw.

Table 24. Weight by sex and other developmental characteristics of Salvador's spotted tinamou (*N. d. salvadorii*) by months^(a)

Month/Day	Weight by sex		Testes		Egg sac	Largest ovum	Toe and claw ^(b)
	M.	F.	R.	L.			
March 20	192		3.5x3.0				
May 4	269						
May 4		308					
May 4	270						
May 4		282					
May 4	304						
May 4		278					
May 4		257					29.1
May 11	196		19x9	11x9			25.6
May 11	198						28.9
May 13	282		5x1.5	5.1.5			29.3
May 13		285			12x5	1.0	27.6
May 13	252		6x1.5	6x1.5			26.4
May 27	226						28.8
May 27	242						
May 27	213						28.5
May 27		243					24.9
May 27		288					
May 28		271					28.2
May 28		247					
May 29		197					
June 21		240					28.9
July 25	281		6x3				
July 25		288				1.0	28.3
July 25	258		5x2				
July 25		266				1.0	
July 25	252						
July 25		315					
July 25	307						
July 25		305					
July 25	270						
July 25		312					
July 25		280					
August 10	236		5x3	6x4			
August 10		239				minute	
August 17	223		3x2	3x2			28.4
August 21	252		12x5	11x5			29.7
August 21		280				3.0	29.4
August 21	227		5x3	5x4			28.3
September 1		246				2.0	
September 9		286				2.5	

Table 24 cont'd.

Month/Day	Weight by sex		Testes		Egg sac	Largest ovum	Toe and claw(c)
	M.	F.	R.	L.			
September 18	212		6x2	5x3			non- breeding
October 4	254		17x8	16x11			
October 4		244				11.0	
October 11	282		17x9	11x10			
October 11		330				22.0	Tract very large
October 11		300				4.0	Tract enlarg- ing
November 5	302		17x10	14x12			
November 5		287				10.0	
November 5	270		13x9	14x9			30.7
November 5		277				5.0	28.2
November 13	194		16x9	14x7			28.0
November 13		253			21x17		27.2
November 19	<u>240</u>	<u> </u>	18x11	16x10			<u>29.3</u>
Average	250	274					28.3

-
- (a) Weights in grams; measurements in mm; data collected mostly from the Provinces of La Pampa, San Luis, Cordoba and Mendoza by Wayne H. Bohl.
- (b) Measurements refer to the middle toe and claw.

Table 25. Color of eyes by sex and age of the pampas spotted tinamou

<u>Hand raised birds of known ages</u>									
<u>Age</u>	<u>Sex^(a)</u>	<u>Color of the eyes</u>							
		<u>Pale yellow</u>		<u>Dusky yellow</u>		<u>Borderline</u>		<u>Orange-brown</u>	
		<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
<u>Young</u>									
3 months	male	5	50	5	50	0	0	0	0
	female	1	11	3	33	5	56	0	0
4 months	male	11	42	15	58	0	0	0	0
	female	0	0	9	41	13	59	0	0
5 to 6 months	male	6	46	6	46	1	8	0	0
	female	0	0	1	17	2	33	3	50
6 to 12 months	male	9	18	40	81	0	0	0	0
	female	0	0	12	36	5	15	16	49
<u>Adults</u>									
1 year old	male	2	22	7	78	0	0	0	0
	female	0	0	5	39	2	15	6	46
2 years old	male	0		9	90	1	10	0	0
	female	0	0	2	33	1	17	3	50
<u>Wild-trapped birds ^(b)</u>									
Age unknown	male	16	15	83	80	5	5	0	0
	female	1	1	41	37	6	6	62	56

(a) Sex also determined by cloacal examination of all birds.

(b) Examined in late winter.

Table 26. Major climatic and vegetative characteristics of spotted tinamou habitats by zones in Argentina(a)

Subspecies of tinamou	Zone	Climate	Characteristic vegetation	
			Trees and shrubs	Grasses and forbs
Patagonian spotted (<u>N.m.nigroguttata</u>) and Neuquen spotted (<u>N.m.submontana</u>)	Steppe and open desert scrub	Temperate to fairly cold and dry. Annual rainfall 10" or less distributed throughout the year with long dry periods.	<u>Larrea divaricata</u>	<u>Stipa tenuis</u>
			<u>Cercidium praecox</u> <u>Zucagnia punctata</u> <u>Prosopis alpacato</u> <u>Gourliea spinosa</u>	<u>Hordeum stenostachys</u> <u>Bromus brevis</u> <u>Setaria kunzeana</u> <u>Setaria mendocina</u> <u>Trichloris crinita</u> <u>Eragrostis lugens</u> <u>Pappophorum mucronulatum</u> <u>Cottea pappophoroideis</u> <u>Digitaria californica</u> <u>Medicago minima</u>
Pampas spotted (<u>N.m.annectens</u>)	Pampas	Temperate, fairly humid. Annual rainfall 20 to 45 inches well distributed throughout the year though usually least in summer.		<u>Bromus unioloides</u> <u>Bromus brevis</u> <u>Stipa hyalina</u> <u>Stipa papposa</u> <u>Piptochaetium montevidense</u> <u>Poa bonariensis</u> <u>Lolium multiflorum</u> <u>Hordeum murinum</u> <u>Cynodon dactylon</u> <u>Cynodon hirsutus</u> <u>Trifolium repens</u> <u>Medicago polymorpha</u> <u>Medicago lupulina</u> <u>Medicago arabica</u>

Mainly a country of sparse grass and xerophytic shrubs. More humid and with more abundant grass along the coastal plain and major river valleys.

The prime grazing and cultivated lands of Argentina lie within this and the northeastern savannah zones. Grass often lush but periods of drought not infrequent.

Table 26 cont'd.

<u>Subspecies of tinamou</u>	<u>Zone</u>	<u>Climate</u>	<u>Characteristic vegetation</u>
Northeastern spotted (<u>N.m.maculosa</u>)	Northeastern savannah	Temperate to subtropical. Annual rainfall 30 to 60" mainly in fall and winter	<u>Trees and shrubs</u> <u>Grasses and forbs</u> <u>Bromus unioloides</u> <u>Stipa hyalina</u> <u>Piptochaetium stipoides</u> <u>Lolium multiflorum</u> <u>Paspalum notatum</u> <u>Panicum bergii</u> <u>Acacia cavenia</u> <u>Celtis spinosa</u> <u>Erythrina crista-galbi</u> <u>Salix humboldtiana</u>
Swamp spotted (<u>N.m.paludivaga</u>)	Eastern Chaco	Lower temperate to subtropical. Dry with annual rainfall 25 to 40" mostly in fall and winter and often heavy, with long dry periods between.	<u>Schinopsis balansae</u> <u>Aspidosperma quebracho blanco</u> <u>Prosopis nigra</u> <u>Prosopis alba</u> <u>Cloris canterai</u> <u>Pappophorum alopecuroides</u> <u>Paspalum intermedium</u> <u>Sporobolus pyramidalatus</u> <u>Stipa neesiana</u> <u>Eليونurus viridulus</u> <u>Panicum bergii</u> <u>Diplachne uninervia</u> <u>Desmodium canum</u> <u>Vigna luteola</u> <u>Phaseolus lathiroides</u>

A country mainly of grassy savannahs and scattered trees and shrubs.

A country of sparse grasses and xerophytic vegetation with high, sawgrass or sweatgrass marshes.

Table 26 cont'd

Subspecies of <u>tinamou</u>	<u>Zone</u>	<u>Climate</u>	<u>Trees and shrubs</u>	<u>Characteristic vegetation</u>	<u>Grasses and forbs</u>
Western Chaco spotted (<u>N.m.pallida</u>)	Western Chaco	Lower temperate to subtropical. Very dry with annual rainfall 10 to 20" mainly in fall and winter and occasionally heavy with long dry periods between.	<u>Schinopsis balansae</u> <u>Cesalpinia</u> <u>paraguariensis</u> <u>Aspidosperma</u> <u>quebracho blanco</u> <u>Prosopis nigra</u> <u>Prosopis alba</u> <u>Astronium balansae</u> <u>Gleditsia amorphoides</u> <u>Bulnesia sarmientoi</u> <u>Trichocereus</u> spp.	<u>Trichloris crinita</u> <u>Paspalum urvillei</u> <u>Paspalum notatum</u> <u>Sporobolus pyramidalis</u> <u>Setaria argentina</u> <u>Setaria geniculata</u> <u>Elyonurus tripsacoides</u> <u>Panicum prionitis</u> <u>Digitaria californica</u> <u>Desmodium canum</u> <u>Vigna luteola</u> <u>Phaseolus lathyroides</u>	
and Northern chaco spotted (<u>N.m.chacoensis</u>)					

This is a diversified zone of savannahs, sparsely grassed, scattered xerophytic trees and shrubs, sawgrass marshes, salt plains and desert often with a very limited flora and fauna.

(a) Largely adapted from "Mapas y Estadísticas de la Republica Argentina" published in 1962.

Table 27. Number of pampas spotted tinamous flushed by acres of cover types according to seasons and months

Cover type	Height of cover	Seasons and months															
		Spring(a)			Summer			Fall (b)			Winter						
		Sept. Acres Birds	Oct. Acres Birds	Nov. Acres Birds	Jan. Acres Birds	March Acres Birds	April Acres Birds	May Acres Birds	June Acres Birds	July Acres Birds	Winter Acres Birds	June Acres Birds	July Acres Birds				
Grass and forbs, few clumps, very heavily grazed.	2 to 4"	6	0	5	0				11	5							
Grass and forbs 80%, thistles singly or in clumps 20%, heavily grazed.	3 to 5"			60	36												
Grass, forbs, thistles, some clumps, heavily grazed.	24 to 36"	18	6	16	30		4	10									
Mostly grass, some forbs and thistles, moderately grazed.	4 to 8"			11	8												
Mostly grass, some forbs and thistles, moderately grazed.	4 to 12"	15	3														
Grass and forbs, 13 to 24" moderately grazed.	4 to 12"	15	10	10	8						80	41					9
		6	2	6	2												10
				6	4												8
Grass, forbs, thistles with 5 to 30% alfalfa, heavily grazed.	4 to 12"	48	31	10	0												27
		30	12	8	23												102
		9	1														45
		13	3														176
		11	2														7

Table 27. Continued.

Cover type	Height of cover	Spring (a)		Nov.	Summer		Fall (b)		May	June	July
		Oct.	Acres Birds		Jan.	Acres Birds	March	Acres Birds			
Grass, forbs, thistles with 5 to 30% alfalfa, moderately grazed.	13 to 24"	15	3	5	2		12	6			
Grass and forbs 25%, pigweed and thistles 75% moderately grazed.	4 to 12"								3	1	5
Bunch grass with heavily grazed grass and forbs between.	24 to 30"	61	37	39	28						
		20	13	10	7				5	1	
				9	7						
				12	8						
				6	8						
Bunch grass with moderately grazed grass and forbs between.	24 to 36"					65	36		2	2	
Grass and forbs 20%, alfalfa 40%, rye 40%, heavily grazed.	4 to 8"										85 198
											50 65
Alfalfa, young, recently cut or grazed down, some grass and forbs, fairly open.	4 to 10"	8	2	14	4						
		7	19								20 14

Table 27. Continued.

Cover type	Height of cover	Sept.		Spring ^(a)		Nov.		Summer		Seasons and months					
		Acres	Birds	Acres	Birds	Acres	Birds	Acres	Birds	Acres	Birds	Fall (b)		Winter	
												Oct.	Nov.	Jan.	March
Alfalfa, some grass and forbs, fairly dense.	11 to 20"	8	10	12	12	10	3								
				21	32										
				22	6										
				22	14										
				6	7										
				15	14										
				22	2(c)										
				30	18(d)										
				7	20										
				32	30										
Alfalfa, some grass and forbs, high and dense.	21 to 30"			150	42	51	58				1½	6			
				50	71										
				10	6										
				4	2										
Cultivation, corn, 10 to 20" wheat, oats, rye, barley or millet.		3	6	5	2	6	7								
				6	2										
				8	3										
Cultivation, mature wheat.	30 to 40"					4	0								
Cut grain field with stems 8 to 12" high, some grass and forbs.	8 to 12"												8	12	
													8	8	
													9	7	
													7	6	

(a) Spring and summer census obtained by sweeping the fields with a rope while searching for nests.

(b) Fall and winter census obtained by using 1 to 4 men and a good pointer except for June when birds were flushed by a cable pulled by 2 horses and followed by 9 to 11 hunters.

(c) Middle section of field

(d) Within 300' of the edges of the field

Figure 41. Form used for nest survey

<u>Nests</u>	
Species	<u>Nothura m. annectens</u>
Nest no.	15
Date	11/9/64
Place	La Serena, Zarate
No. of eggs	6
Rechecked	11/11/64
No. of eggs	6
<hr/>	
Immediate situation	In a clump of vegetation
Height	18"
Size	15"
Composition	Thistle surrounded by grass
Side of clump	North
Vegetation surrounding clump or, if absent, the nest	
Grass	80 percent
Forbs	15
Thistles	5
Clumpgrass	0
Alfalfa	0
Other	0
Average height	12"
<hr/>	
Distance from type change and type	350' to heavily grazed pasture
Bird	
Flushed by	Rope
Distance from	1'
Flight distance	225'
<hr/>	
Nest	
Depth	2"
Lining	Grass and 5 feathers
Concealment	Fair
<hr/>	
Disposition of eggs	
Taken for propagation	Yes
Left	
Destroyed by	
<hr/>	

Notes - This is the 7th nest found in this field. Size about 75 acres. Entire field pulled with a rope at least once. 17 birds flushed, 7 from nests.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
WASHINGTON, D.C. 20240



POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR