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TINAMOU, *NOTHOPROCTA*
CINERASCENS

DOUGLAS A. LANCASTER

BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 127:ARTICLE 6 NEW YORK : 1964

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BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Volume 127, article 6, pages 269–314, text figures 1–22, plates 16–26

Issued November 11, 1964

Price: \$2.00 a copy

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INTRODUCTION

THE BRUSHLAND TINAMOU, *Nothoprocta cinerascens*, lives in the open and semi-open country of northwestern Argentina and adjacent areas of Bolivia and Paraguay. This species is one of about 40 that comprise a homogeneous group of birds (family Tinamidae) limited to the neotropical region. Remarkably little information is available about the biology of the various species of this family. This fact is not surprising when one considers the secretive habits and geographical distribution of tinamous.

From November 8, 1962, to January 23, 1963, my wife, Harold L. Cleveland, and I camped in a low and semi-open thorn woods in southern Tucumán Province in northwestern Argentina to collect data on the biology of the Brushland Tinamou, *Nothoprocta cinerascens*. The present paper reports on our findings.

The Brushland Tinamou is a medium-sized bird, 14 to 15 inches long, with a very short tail. The bird has a conspicuously streaked appearance. Above, it is mainly brown, each feather with two long narrow whitish streaks, black barring, and gray edging; the black areas lengthen into broad streaks on the hind neck and predominate on the crown. The breast is smoke gray and distinctly spotted with whitish; the throat and abdomen are whitish; the flanks are buffy brown barred with fuscous. The somewhat elongated crown feathers can be raised into a temporary crest.

The plumages of male and female are similar. The females are slightly larger than the males. Ten specimens collected showed a weight average of 572.8 grams for four females (540.4 grams to 615.0 grams) and 478.9 grams for six males (456.8 grams to 493.0 grams).

Nothoprocta cinerascens is recognized as a monotypic species by Hellmayr and Conover (1942). Olrog (1959), however, recently described the race *N. cinerascens parvimaclulata* from a single specimen taken in the "arid shrubby zone" of La Rioja. He differentiates this subspecies from the nominate race by the presence of smaller spots on the breast and a paler coloration, especially on the dorsal surface.

I have called this species the Brushland Tinamou (suggested by E. Eisenmann) rather than the Cinereous Tinamou, which is the name used by several authors who have translated the scientific name. My objections to the name "Cinereous" Tinamou for *N. cinerascens* are twofold: another tinamou, *Crypturellus cinereus*, has the same common name, and the term "cinereous" is misleading. Only the spotted breast is more or less ashen gray, as is true of several other tinamous; the upper parts are predominantly brownish finely streaked with white. Because of plumage similarities with other species of *Nothoprocta*, as well as with the genus *Nothura*, I have used a name that describes the most common habitat of the bird.

ACKNOWLEDGMENTS

We met many people in the Republic of Argentina who extended numerous courtesies and assistance that aided us in carrying out our study successfully. I take pleasure in expressing my gratitude to Dr. A. Willink, Director of the Instituto Miguel Lillo in Tucumán, Dr. C. C. Olrog, also of the Miguel Lillo Institute, and Mr. Pedro Leahy, all of whom helped us in many ways; to Sr. Juan B. Schädlich and Sr. Knut Lange and their families for their warm hospitality during our stay on the *estancia* where this study was accomplished; to my able field assistant, Mr. Harold L. Cleveland, whose patience and resourcefulness in the field were welcome attributes to the frustrations encountered in studying tinamous; to my wife, Billie Jean, upon whose shoulders fell the monotonous and sometimes difficult task of practical camp work, which enabled us to devote our time to the tinamou, and for her assistance in reading and typing the manuscript. I thank Dr. Dean Amadon, Mr. Eugene Eisenmann, and Dr. Wesley E. Lanyon, who read part, or all, of the manuscript and who offered a number of helpful suggestions. The study was accomplished under a postdoctoral Frank M. Chapman Fellowship from the American Museum of Natural History.

METHODS

The study was carried out in an area approximately 160 acres in size and situated 74 miles south-southwest (latitude 28° 11' N., longitude 65° 34' W.) of San Miguel de Tucumán, the capital city of Tucumán Province in northwestern Argentina. In setting up this study area, we cut a series of north-south and east-west compass lines through the brush and woods. The parallel lines were approximately 110 yards apart, as determined by pacing. We then mapped the area for plotting the location and movements of the birds. We anticipated trapping and marking the birds as necessary techniques for individual identification, but abandoned the project when it became clear that each male in the area could be easily recognized by individual call characteristics. We maintained dawn to dusk observations on the tinamous in the study area, recording calls, plotting locations and movements, and observing their behavior whenever possible. Stationing ourselves in advantageous sites partially hidden from view by surrounding vegetation was sometimes a successful method of observation, and we frequently operated from portable blinds carried about from one part of the study area to another. We methodically searched the area for nests by running string lines about 55 feet apart from one compass line to the next.

We then carefully examined the area between the string lines. This was an arduous task, since in parts of the study area dense, tall, and thorny brush made searching very difficult as well as time-consuming. We discovered a single nest, which we observed from a blind placed 25 feet away and oriented so that we could approach the blind and depart without being seen by the bird.

In addition to calls, other methods for locating birds were utilized. A number of roosting depressions were found. The tinamou's three-toed tracks in the mud following a rain were easily followed, sometimes for several hundred yards. The distinctive pellets of this species, if not more than one hour old, were useful indicators in recording exactly where a bird had been within a given time.

Prior to our field investigations we observed seven birds of the Brushland Tinamou in an aviary at the Miguel Lillo Institute in San Miguel de Tucumán during much of September and October. The birds had been in the outdoor aviary for two years, and shared it with a single Tataupa Tinamou, *Crypturellus tataupa*. A 2½-foot cement wall surrounded the aviary, in which was embedded a heavy wire mesh that formed the walls and canopy of the roughly 22 by 15-foot enclosure. All photographs showing the Brushland Tinamou were taken in the aviary.

RANGE AND HABITAT

RANGE

THE BRUSHLAND TINAMOU inhabits a portion of south-central South America that includes northern Argentina, western Paraguay, and southeastern Bolivia (figs. 1 and 2). Within the genus *Nothoprocta* this species alone inhabits the lowlands east of the Andes; the other species are found in the Andean ranges. The Andes form the western boundary of the geographical range of *N. cinerascens*. In Argentina, the Andes extend eastward as precordilleran chains of low mountains in northern Tucumán and Salta provinces and in San Luis and Córdoba provinces. It was in these mountains (Tucumán) that the Brushland Tinamou was first obtained (Burmeister, 1860). It is relatively common in these low, wooded mountains and in some of the river valleys that extend for varying distances between the mountains. Although the Brushland Tinamou has been recorded at an altitude of 6100 feet (Huafin, Catamarca), this species is essentially a lowland form, and only in the southern and extreme western parts of its range does it reach altitudes higher than 3000 feet. The highest altitude at which we encountered this species was about 3000 feet in Córdoba Province.

The range of the Brushland Tinamou includes two major types of vegetation: the northern xerophilous woodlands of the Chaco (Cárdenas, 1945; Castellanos and Perez-Moreau, 1944; Frenguelli, 1941; Parodi, 1945; Rojas and Carabia, 1945; Steinbacher, 1962), and the southern desert scrub (Castellanos and Perez-Moreau, 1944; Frenguelli, 1941; Parodi, 1945). More than one-half of the range of *N. cinerascens* includes the expansive flat and semi-open woodlands and scrub country known as the Gran Chaco. Here, because of extreme flatness and low elevation, drainage is poor and rivers flow slowly. The forests are seldom continuous or dense for broad expanses; they are, instead, rather open and interrupted by numerous and often sizable tracts of swamps and savannas. Some of the common trees of this mixed vegetation include the red quebracho (*Schinopsis balansae* and *S. Lorentzii*), the algarrobo (*Prosopis alba*, *P. nigra*), the guayacan (*Cae-*

salpinia melanocarpa), the white quebracho (*Aspidosperma quebracho-blanco*), palo borracho (*Chorisia insignis*), palo blanco (*Calyco-phyllum multiflorum*), and the palosanto (*Bulnesia sarmiente*). In the eastern portion of the Chaco are isolated stands of scattered palms (*Copernicia australis*). Dispersed among the trees are large cacti (*Cereus giganteus* and *Opuntia stenarthra*). A thorny undergrowth is present. The herbaceous fields are dominated by grasses, of which *Paspalum* spp. and *Andropogon* spp. are common. In contrast to the Chaco, the environment of the extreme western and southern part of the range of the Brushland Tinamou is occupied by a dominant xerophilous vegetation that includes thorny shrubs 1 to 3 meters in height. In this thorny brush country stand isolated trees. Grasses are scarce; the herbaceous turf, so characteristic in the Chaco, is here sparse or



FIG. 1. The range of the Brushland Tinamou, *Nothoprocta cinerascens*.

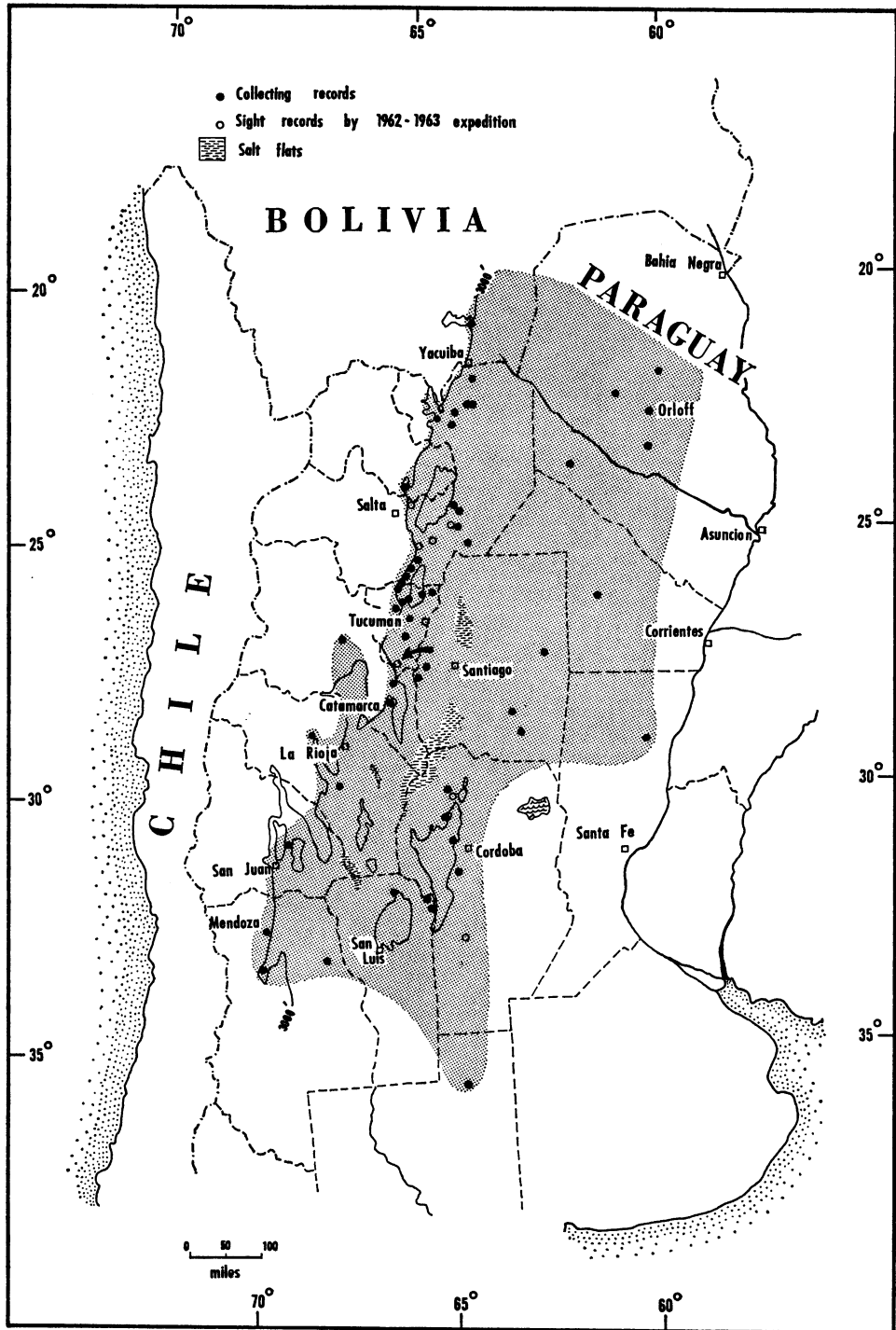


FIG. 2. The range of the Brushland Tinamou, *Nothoprocta cinerascens*. The solid lines in the western part of the range are 3000-foot contours. The arrow indicates the locale of this investigation.

totally absent. The ground is often denuded. Among the dominant shrubs in this region are *Larrea* spp., *Prosopis* spp., *Acacia* spp., *Bougainvillea* spp., *Bulnesia* sp., *Cercidium praecox*, and others. Cacti are common.

The climate of this area is semi-arid. The annual rainfall varies throughout the range of *N. cinerascens* from approximately 4 inches to 49 inches (Clayton, 1927, 1934; Conover, 1959). The dry area of western Argentina (provinces of Mendoza, San Juan, San Luis, La Rioja) receives a yearly rainfall that averages only 4 to 8 inches (with yearly variations ranging from 1 inch to 15 inches). To the north and east a more humid condition prevails, with an average yearly rainfall of 14½ inches in Catamarca, 25½ inches in Córdoba, 37½ inches in Tucumán, 28 inches in Salta, 36 inches in Yacuiba, 48½ inches in Santa Cruz, 40 inches in Bahía Negra, 32 inches at Orloff, and 49 inches in Asunción. A distinct dry season begins in April or May and lasts for five months. During this period, the average monthly rainfall does not exceed ⅔ inch in any of the Argentine localities mentioned above. The total average rainfall at these stations during the dry season is less than 3 inches. Most of the annual precipitation, therefore, falls in a seven-month period beginning in October. Even in the arid western provinces of La Rioja, San Juan, and Mendoza, there is seasonality to the rainfall. In the area of San Juan city, for example, only one-tenth of the 4.72 inches falls during the five months from April through August. Temperatures throughout the year manifest extremes of less than 0° C. and more than 40° C. in almost all parts of the range of the Brushland Tinamou.

Many parts of the Gran Chaco have not been faunally worked. Consequently, the exact limits of the range of *N. cinerascens* are not certain. The first published record of this tinamou in Paraguay was that of Brodkorb (1937). Others have since recorded it there (Laubmann, 1939; Steinbacher, 1962). The occurrence of the Brushland Tinamou in Bolivia was first mentioned by Bond and de Schauensee (1943). How far north its range extends in Paraguay and Bolivia is not known. Published reports of collections from Bolivia fail to mention this species (Gyldenstolpe, 1945; Laubmann, 1930; Peña, 1962).

However, it is noted that most of the collecting expeditions in eastern Bolivia followed, of necessity, the river courses. These tributaries are, for the most part, margined by wide gallery forests of Amazonian origin and, therefore, are not inhabited by *N. cinerascens*.

The range shown (see fig. 2) includes all literature references to collected specimens as well as specimens examined in various museums. In addition, I included our own sight records from localities not represented in the literature or in collections.

This map may not represent its present range. It is difficult to assess the status of this tinamou in many areas. In some areas, such as La Pampa, it may no longer be found, for the single, southernmost record from this province goes back to 1926 (Pereyra, 1927). There are no other records from La Pampa, nor are there any records from southern San Luis and Córdoba provinces. The Brushland Tinamou is now a rarity in parts of Mendoza Province where it was once very common. Thus, we failed to discover it in the week we spent searching for tinamous in the area of Mendoza city, Tunuyán, and San Rafael. We were told by biologists and sportsmen that the hunting pressures have forced the hunter to go far afield in search of the *perdices*. While it seems to be disappearing from some regions, there is evidence that *cinerascens* is moving into others. The mixed grasslands and low forests of the Chaco cover most of Santiago del Estero and extend eastward across northern Santa Fe Province to the gallery forests bordering the Rio Paraguay. Until Achenbach's report (1957) there had been no published records of this species from Santa Fe, and the range of the Brushland Tinamou in published treatments of birds of this region does not include this province (Berst, 1941; Holmberg, 1939; Steullet and Deautier, 1935; Wilson, 1926).

The extensive salt flats in the southwestern part of the range are not inhabited by tinamous.

HABITAT

The Brushland Tinamou is not highly restricted in its habitat preference. It does not penetrate the subtropical forests along the eastern slopes of the Andes from Tucu-

mán Province northward, or the eastern pampas of Buenos Aires and southern Santa Fe provinces. It does, however, reach into the transitional Chaco-subtropical forests in northern Tucumán and Salta provinces and into the "herbaceous steppes" (Frenguelli, 1941) and "pampas woods" (Parodi, 1945) at the western margin of the pampas. It is common in open or dense thorn woods, thorn scrub, the semi-open Chaco forests, and wooded savannas. Occasionally calls of this species are heard in grassland, but only when such areas border one of the more typical habitats mentioned above, and it is likely that this secondary habitat serves mainly as a

temporary feeding area. Where cultivation has replaced the natural vegetation, the Brushland Tinamou adapts well, nesting in bordering scrub or woodland and frequently feeding in fields of sorghum, alfalfa, and maize after the crops have grown sufficiently high to provide adequate cover.

At La Cocha, in southern Tucumán Province (indicated by an arrow in fig. 2), the environment is variable, with grassland, cultivated fields of sorghum, and thorn woods. This was the site of our study. The study area (fig. 3) included a low thorn woods from which most of the taller trees had been recently removed. Openings in the woods are

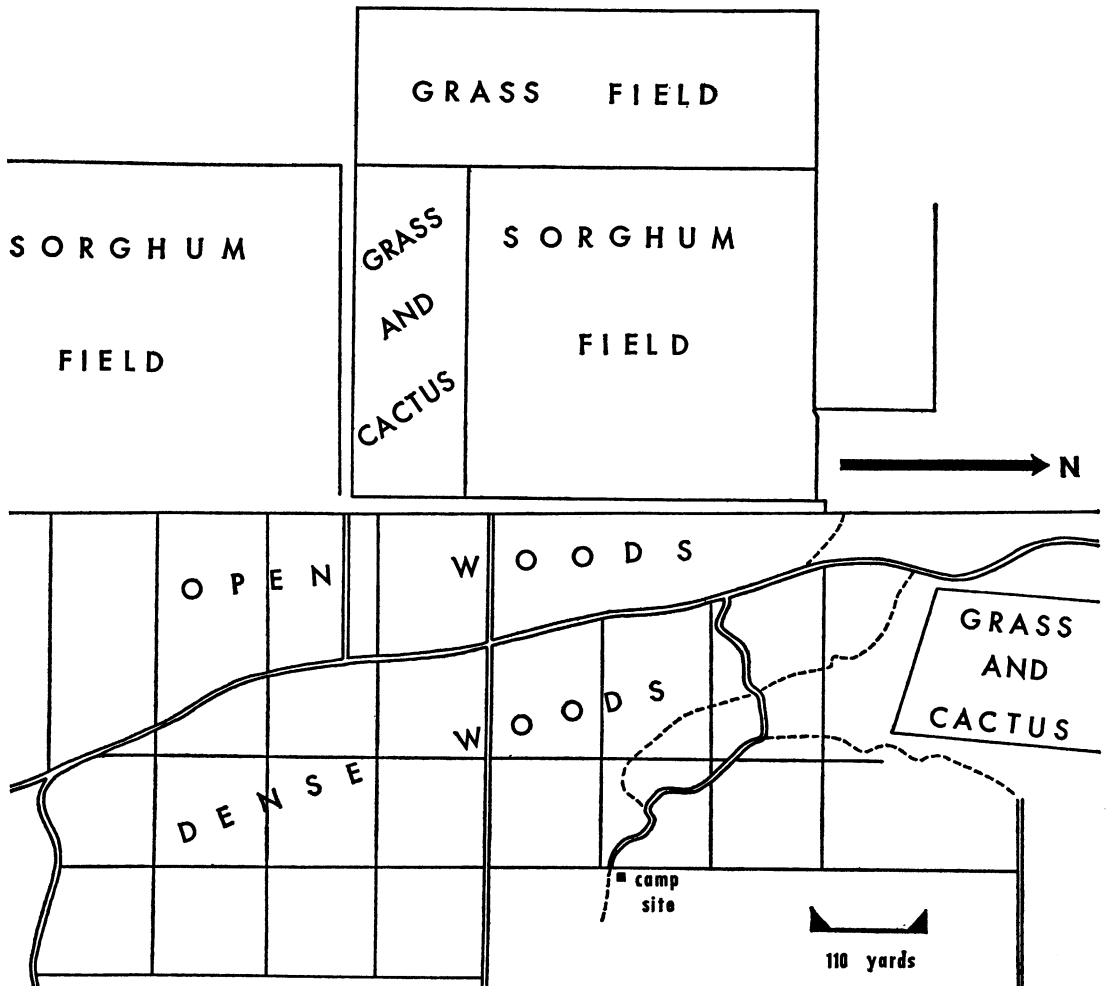


FIG. 3. Study area south of La Cocha, Tucumán Province, Argentina. Size of the area is about 160 acres. Double lines are road or section lines. Paths are indicated by dotted lines. Solid north-south and east-west lines are compass trails.

numerous, but most of these are artificial, indicating places where trees had been removed. *Mimosa* species are common, and three species of cacti are relatively abundant. The low woods provides little shade except that furnished by a sparse canopy of trees that rarely exceeds 20 feet. Cows graze throughout the woods wherever adequate forage is available. Thus numerous paths meander through the underbrush. A small road runs more or less north and south through the study area. The portion of the woods between the fields and the road is more open. Very little grass is found anywhere in the woods, even in the open expanses, where the ground cover contains, instead, herbaceous flowering plants. Two extensive fields were plowed and planted with sorghum at the end of November. A field of grass and cactus separated the two. The latter was an area frequented by male 2. We seldom recorded *cinerascens* in the newly planted sorghum fields, except at the margins. Here the birds penetrated only several yards into the fields to feed for brief periods, but when the sorghum had reached a height of more than 12 to

15 inches they entered the fields frequently to feed.

Two other species of tinamous, *Crypturellus tataupa* and *Nothura darwinii*, were noted in the study area. *Crypturellus tataupa* did not appear to be common, and we have no evidence that it was nesting there. We never heard its call. Although found in the same woods, it seemed to prefer the denser areas, never venturing into the semi-open where the Brushland Tinamou is common. In the fields adjacent to the woods, *Nothura darwinii* was common, and its calls were heard frequently, especially late in the afternoon. This smaller tinamou nested in the fields. Infrequently, it was seen or heard in the semi-open woods, but never in the denser woods. Thus the three species of tinamous found in the study area probably nest in different ecological situations and seem to prefer different feeding niches: *C. tataupa* in the denser woods and thickets; *N. darwinii* in the fields; and *N. cinerascens* in the semi-open. The last-named, however, feeds frequently in the adjacent fields and also in the denser woods.

GENERAL NON-BREEDING BEHAVIOR

ASSOCIATIONS

ALTHOUGH A NUMBER OF SPECIES share the ground-feeding environment with *N. cinerascens*, not all are restricted to this feeding level, and none of them associate with the Brushland Tinamou. In addition to the two tinamous mentioned above, some of the ground foragers encountered in the study area were *Euxenura maguari* (feeding occasionally in the sorghum fields late in the season), *Chunga burmeisteri*, *Zenaidura auriculata*, *Columbina picui*, *Metriopelia melanoptera*, *Leptotila verreauxi*, *Furnarius rufus*, *F. cristatus*, *Pseudo-seiura lophotes* (occasionally), *Turdus amaurochalinus*, and *Zonotrichia capensis*. Neither the two species of tinamous nor any other species of bird was seen in company with *N. cinerascens* at any time.

It is not known how much contact, if any, is maintained among individuals of the Brushland Tinamou in the post-nesting period. There are no reports of groups or coveys of this species during the winter.

FEEDING

When feeding, the bird holds its head and neck low as it walks slowly and erratically along. Usually items of food are picked up from the ground, but budding leaves are sometimes taken. The aviary birds were especially fond of new shoots of grass. In the study area we noticed that individuals picked fruit off plants within reach of the bill as well as off the ground, and sometimes they jumped several inches off the ground in an effort to reach fruit slightly out of reach. A fair proportion of the diet of *N. cinerascens* consists of animal matter. These birds prey upon many kinds of insects, especially ants, cicadas, and beetles. Sometimes they simply pick up and swallow the insects. Not infrequently the bird pecks repeatedly at an active insect regardless of size. Large insects, such as cicadas, are taken in the bill and beaten against the ground before being swallowed. Dinelli (1929) mentions mollusks as the most common food item in places where this species lives near irrigation canals. He also noted, as food, seeds of composites and maize.

The Brushland Tinamou frequently probes

in the soil for earthworms and insect larvae, especially when the soil is damp from a recent rain. When an individual finds an earthworm, it shakes its prey vigorously with a sidewise motion of the head, then jabs it, and finally swallows it. Birds often open the bill slightly while probing, but we never ascertained whether small bits of dirt were actually picked up. Holes, made by inserting the bill into the soil and flicking the dirt to one side, are up to 1 inch in depth. Now and then a Brushland Tinamou picked up leaves or twigs or swept them aside with its bill while looking for food. The feet are never used in feeding. Small grains of sand and pebbles are swallowed periodically, mostly when the bird is dust bathing.

After feeding or probing in damp earth, individuals often clean their bills by wiping them with a sidewise motion of the head on the ground, a rock, a twig, or a stem of grass. The bill is sometimes closed, sometimes open during this activity. The bird occasionally cleaned its bill by loosely grasping a green leaf or culmen of grass in the gape and moving the bill along the length of the stem.

BATHING

Bathing was never observed in the study area. In the aviary, however, we observed dust bathing daily. All dust bathing took place in one sandy corner of the aviary. The birds first made scraping motions with their feet and loosened the earth by probing with the bill. They settled down in their freshly made depression with a sidewise body movement. After slightly extending the wings and fluffing out the feathers, the bird inserted its bill into the sand. With a sudden backward movement of the head, first to one side of the body, then to the other, sand was swept onto the wings and back. This behavior went on intermittently from about 30 seconds to two minutes. Usually before and after this behavior, the birds picked up and swallowed a number of grains of sand and small pebbles.

Water bathing was recorded only once in the aviary, although water was always available. A female walked into one of the two small pools, drank, and then sat and rolled

over on one side. She raised the upper wing away from the body with the manus still mostly folded against the forearm (antebrachium). Then, with one side of the face in the water, the bird threw droplets onto the back with a posteriorly directed head movement. After a half-dozen or more such movements, the bird turned over on the other side and repeated the behavior.

ROOSTING

We found a number of roosting sites in the study area. These are small depressions with a depth of about 1 inch or less. Each bird prepares a site with a posteriorly directed scraping movement of first one foot, then the other. At the same time the bird turns about, pushing the dirt behind in all directions, thus producing a small depression. After forming its roosting depression, the bird sits and moves the body from side to side as if settling on eggs, and sometimes follows this action by scraping dirt and leaves against the body with the bill. In the study area all roosting sites were next to a tree or a tussock of grass and usually were situated so that they were partially concealed and mostly shaded.

In the aviary the same roosting sites were used night after night until the grass grew to a certain height. Some individuals then abandoned their old sites and roosted in the grass. We found evidence (in the form of fecal pellets) that some roosting sites were used many times. However, some males that frequently roosted in the same small area ($\frac{1}{2}$ acre) for several successive nights slept in different depressions each night. Only once did we find two roosting sites side by side (2 feet apart), which indicated that a male and female, or two females, roosted together. Males and females probably often roosted close together, however, for we usually recorded the sexes together at dusk. In the aviary all seven birds roosted near one another (1 to 2 feet apart) until the grass afforded a protective cover.

The use of depressions is not limited to roosting. Such behavior is seen in the formation of nesting sites. Our observations suggest that the roosting sites are not utilized as nesting sites. On hot afternoons we observed infrequent excavation of depressions for resting by both study-area and aviary birds.

Less-developed depressions were formed for dust bathing.

In the aviary short periods of dozing were observed in the middle of the day. At such times individuals usually dozed in a standing position. Soon they gradually retracted the neck, raised one leg, erected the body feathers, and in this position dozed for periods varying from two or three minutes to six or seven minutes. Sometimes, however, birds remained on both feet when dozing. Sometimes they sat in the shade without making any depression.

AGGRESSIVE BEHAVIOR

When an encounter between two birds took place, both birds assumed a defensive posture. In this position the body was held low to the ground as the bird crouched. The head and neck were withdrawn. This position was most frequently assumed when another bird approached from the rear. The bird in front often jumped around in one or two movements and immediately assumed the defense position, from which it sometimes struck out with its bill. Such encounters were seldom followed up with a chase. Later in the season the birds seldom assumed such defense postures. Birds then were more aggressive and faced each other in an erect attitude, with neck extended. If neither bird gave ground, then one bird jumped several inches into the air from a slightly crouched position and pecked at the head of the other bird. The wings remained against the body. When one bird jumped, the other immediately imitated the action. The encounter sometimes ended after a single attack, but sometimes four or five such leaps followed in rapid succession before one bird turned and walked away. Occasionally the victor gave chase. Such encounters involved two males or a male and a female. Sometimes a third bird entered the fray.

ALARM BEHAVIOR

Like all tinamous, *N. cinerascens* is shy and secretive. If surprised, it usually takes to the air with a noisy and rapid wing beat, emitting a high-pitched, staccato, alarm call. Although the Brushland Tinamou is not so reluctant to fly as are the forest forms, it prefers to flee on the ground. If not surprised, however, and

with advance warning of potential danger, the tinamou "freezes" in a standing position, crouches, or walks or runs into the grass or brush. In all cases an alarmed bird raises a crest.

In assessing a potential danger source, the bird assumes an erect posture and raises its crest. This action is followed by a series of jerky head and neck movements in an antero-posterior plane. With each movement, the extended neck and head are lowered several inches closer to the ground, then raised in several similar movements. In low-intensity assessment the head is not lowered beyond the horizontal of the body. If the assessment involves high-intensity behavior, the head is lowered almost to the ground. Sometimes the bird pecks at the ground with closed bill. Frequently, after assessing with one eye, the bird turns around and assesses with the other eye.

FLIGHT

The flight of the Brushland Tinamou is fast and strong. The bird rises noisily, sometimes vertically, sometimes almost straight away, depending upon the density and height of the vegetation. We observed numerous flights. They varied in height from approximately 8 to 30 feet, and carried the birds for estimated distances of 17 to 220 yards. Once the alarmed bird is airborne, the pattern of flight consists of short bursts of wing beats (less than one second to two seconds), interrupted by shorter glides on extended wings (from a fraction of a second to one second). Only twice did we flush birds that flew over the trees and out of sight with a steady beating of wings.

Most landings appeared to be fairly well controlled. Flights often terminate with a right-angle turn just before landing. This is possibly a compensation for the absence of well-developed rectrices used by other birds as a braking device when landing. Flight speed is also checked by back strokes of the wing. The landing momentum is sometimes forceful, so that a short run of several yards is necessary to brake the speed. There was no evidence of an inability to maneuver while landing or in straight-away flights. Several times individuals in flight agilely circumvented trees. A number of accounts indicate

that open-land tinamous are incapable of sustained flights and that after two or three successive flights they cannot be forced to fly again, but will only run if closely pursued (Hudson, 1920). On two occasions when I flushed a bird I ran after it, forcing it to fly within a half-minute after it landed. In both cases the second flight was much stronger and longer, and the birds flew over the trees deeper into the woods, making it impossible for me to flush them again. About one-half of the flights observed were accompanied by high-pitched, staccato, alarm notes.

The principal function of flight in tinamous is to escape from danger. Tinamous often flushed when grazing cattle, fox, rabbits, dogs, or man approached closely. But we also observed flight in other situations. Twice we observed a tinamou flying toward another that was calling. Sometimes a female flew to escape the attentions of a male. Male 1, when leaving its nest, flew away from the nesting area and sometimes back to it. In the cases in which alarm is not the cause for flight, alarm notes are never heard, and the take-off is usually accomplished without the noisy clatter of wings that accompanies escape flight.

OTHER NON-BREEDING ACTIVITIES

Sunning was observed only once in the study area and several times in the aviary. The birds involved had been sitting. They simply leaned on one side and wing, with the other wing partially extended for several minutes.

Drinking was never observed in the study area, although after a heavy rain several small pools remained for a day or more on parts of the road. Even in the aviary, where water was always available, birds drank infrequently. In doing so individuals extended the neck and inserted the distal portion of the bill. We observed about six to 12 throat movements. When swallowing, the bird withdrew but did not raise the head and neck. Other activities included head scratching ("direct") and frequent and simultaneous wing and leg stretching. When defecating, an individual crouched slightly and erected the body plumage. Bouts of preening were frequent.

PREDATORS

The only evidence of predation consisted of two destroyed nests and scattered tinamou feathers on a road in the study area. The predators of tinamous can be surmised only from the known animals of the area and their eating habits. Among the mammals, the puma (*Felis concolor*), the jaguarundi cat (*Felis yagouaroundi*), and the gray fox (*Dusicyon gymnocercus*) probably exact the greatest toll. The last-named is especially common in the study area. The skunk (*Conepatus chinga*) and the grison (*Galictis cuja*) prob-

ably destroy some nests. We encountered few snakes, but a rattlesnake (*Crotalus durissus*) is supposedly common in the area in which we studied, and it may account for some nest destruction. Man, however, is by far the greatest predator of the Brushland Tinamou. Although there is a season during which it is unlawful to shoot or trap tinamous, the statute is seldom heeded or enforced. Fortunately, many landowners of large *estancias* forbid shooting either entirely or during certain seasons. Tinamous are most abundant on such *estancias*.

BREEDING BIOLOGY

THE MATING SYSTEM of tinamous is the most interesting feature of their biology. It is unusual, but not unique, in that only the male incubates. Their breeding behavior was first investigated in captivity, and since the 1920's several species have been studied in their environments in Middle and South America.

In *N. cinerascens* the males are polygynous, mating with several females which later lay their eggs in a single nest to be incubated by the male alone. Polygyny is here defined as a mating system in which a male maintains a pair bond with two or more females simultaneously. The term "pair bond" is used in this paper to mean any positive social relation between male and female during the breeding season that lasts longer than the time involved in copulation. Both males and females of this species mate with different individuals several times during the season. Many of the males, then, may nest two or more times in one breeding season. The breeding pattern is thus complex, including polygyny and multiple matings. Although polygyny predominates, our observations indicate that promiscuity is not an uncommon feature of the breeding activity of these birds. Since the Brushland Tinamou is relatively solitary, and since, as far as I can ascertain, breeding males of this species do not come in visual contact with one another, reënforcement behavior for the maintenance of the pair bond is not highly developed. Long calling periods, bobbing displays, and frequent copulations probably serve to reënforce what pair bond does exist. I believe that the major factor in maintaining the weak pair bond is the relatively large ranges maintained by the males during the breeding season.

The breeding season commences with the calling of the males in September. As calling increases in intensity, the males adjust their territories and ranges, and mate with females that are attracted to their calls. Calling, territoriality, mating, and incubation appear sequentially and are treated below in this order.

CALLS

PRIMARY CALL

A series of clear, whistled notes with considerable carrying power constitute the primary, or advertising, call of the male. The number of notes in a single series usually varies from six to 10, but calls have been recorded with series containing as many as 22 successively rendered notes. The individual call notes last less than one second, with a shorter pause between each note. A male emits six to nine notes in five seconds. Each note is unwavering and is monosyllabic or disyllabic.

The calls of individual males were readily distinguishable one from another. Throughout the period of study each male whistled with almost no detectable variation except in the intensity of the call and the number of notes in each call. Such call constancy of individuals coupled with inter-individual call variation made the problems of this study somewhat easier, enabling us to record individual males in the short time available without resorting to methods of trapping and marking.

The call notes, depending on the particular male, may be given on one pitch, or the notes may rise slightly in pitch as the call progresses, with the last note finishing one-half to one and one-half notes higher than the first note of the call. Brief descriptions of the calls of several males will point up some of the variations.

Male 1 had the highest-pitched call in the study area. Its call was forceful and had a distinctly shrill sound unlike the calls of the other males. The number of notes per call was commonly seven to eight, sometimes fewer, and rarely as many as 10. The first three notes were rendered on the same pitch and were monosyllabic. Each of the succeeding notes rose slightly in pitch. The last note was about one full note above the starting note. The final notes were disyllabic, each slurring downward.

Male 2 had a call that began one full note

lower than the call of male 1. The number of notes in each call varied from six to 10. The call rose in pitch only one-half note from beginning to end.

The first note of the seven- to eight-note call of male 3 was whistled on the same pitch as that of male 2. The call rose about one full note, ending in a minor key, and giving the call a mournful sound. Each note rose in pitch except the final three notes, which were given on the same pitch. These latter notes were disyllabic, each note sliding downward about one-half note.

The call of male 7 was slightly lower in pitch than the other calls mentioned above. Each series contained eight to nine notes, sometimes as many as 12. The call showed only a slight rise in pitch from beginning to end.

During the incubation period male 1 and two other males suspected of incubating (males 3 and 7) sometimes called somewhat differently. They whistled more subdued and shorter calls that contained four to six notes. Furthermore, they frequently called several times (three to six) in rapid succession, only 10 to 20 seconds elapsing between calls.

Females likewise have a primary, or advertising, call that is heard frequently in the nesting season. This call is readily distinguishable from the primary call of the male. The call of the female contains fewer notes and is not so loud. Commonly, the call consists of three to four notes that lack the carrying power of the call of the male. As in the case of the call of the male, considerable individual variation is evident. The pitch of the call, the pitch of individual notes, the duration of time lapse between notes, the number of notes, and the quality of sound are characteristics by which individual variation of the female calls are manifest. Thus the call of one female may be one-half to one note higher or lower in pitch than that of another. The call may be monotonic, or may rise in pitch. The call of one female may have a notably shorter pause between notes than recorded in another female, lending a tone of urgency to the call. Other calls appeared to be rendered very slowly. Although most of the calls contained three or four notes, one female consistently whistled a five- or six-note call. In some females the primary call was harsh

sounding, in others nasal, in still others more or less clear and throaty. These characters appear to be constant for each female, with the exception of the number of notes in the call. A female whose call usually consists of three or four notes may at times whistle a two-note call, more rarely a single-note call. An aviary bird that gave a four- or five-note call sometimes rendered calls with any number of notes ranging from one to eight.

In spite of its individuality it was often difficult to attribute with certainty a given call to a particular female. The reasons are that (1) the individual differences are in themselves usually of smaller magnitude than those among the males; (2) the females do not call so often, making it more difficult to learn the calls of individual birds; and (3) the females move over a larger area, thus preventing an association-by-area as in the case of the males. Nevertheless, several females had calls distinctive enough for us to be able to keep track of them with some degree of accuracy.

OTHER CALLS

In addition to the primary call, the repertoire of vocalizations includes at least four other sounds. An alarm call consisting of a series of high-pitched staccato notes emitted at the rate of three to five per second accompanied the take-off of a frightened bird. Another call accompanies a courtship behavior pattern that involves an up-and-down bobbing of the entire body. The call consists of a series of soft "whit" sounds, three to six per second. The notes, given with bill closed, are on the same pitch. Each note slurs upward. The call is audible only within a distance of about 10 yards from the bird. A call often heard when the sexes are together is a low-pitched, guttural, quacking sound, frequently recorded when one tinamou was chasing or following another. When the male leads the chicks off the nest, he utters a series of soft, whining notes, each lasting about three-fourths of a second. Each note is on the same pitch and drops slightly at the end. All the above calls, except the recognition call of the male to the chicks, are given by both sexes. No other calls, other than those described above, were recorded in either sex.

DAILY AND SEASONAL PATTERN
OF CALLING

The calls of the Brushland Tinamou are associated only with the breeding season, beginning in late September (in Tucumán, Argentina) and continuing until March and April. Cessation of calling probably occurs earlier in males that succeed in nesting early in the season. According to our host, Mr. Lange, the study-area birds began calling about the third week in September. Our field work did not commence until November 12. After we left, Mr. Lange reported that calling continued through the months of February and March and into April. The last calls of this species that we recorded for the season were heard early in the afternoon of April 28 near Metán in the province of Salta.

The daily pattern of calling shows, as one would expect, two peaks, one in the early morning between 6:30 A.M. and 8:00 A.M. and another in the early evening between 6:00 P.M. and 7:30 P.M. Figure 4 shows the number of days during which calls were registered for

each half-hour period. These are expressed as a percentage of the total number of recording days. Depending upon the hour of day, the number of recording days varied from 54 to 61 for males and 48 to 55 for females. While the males called as often in the morning (79% of the recording days) as in the evening (78% of the recording days), the females called somewhat more frequently in the evening (53% versus 46%). The peaks for both sexes fell in the same half-hour period in the morning, but the peak calling period of the females came slightly later in the evening than for the males. A considerable amount of calling, however, occurred at all hours of the day. From the hours of 9:00 A.M. to 4:00 P.M. the calls of the Brushland Tinamou were recorded on approximately one-half of the total number of recording days.

The earliest hour at which we recorded calls was 5:28 A.M., shortly after dawn. The caller in these early hours was more often male than female. The hour at which calling began varied from day to day. Earlier in the

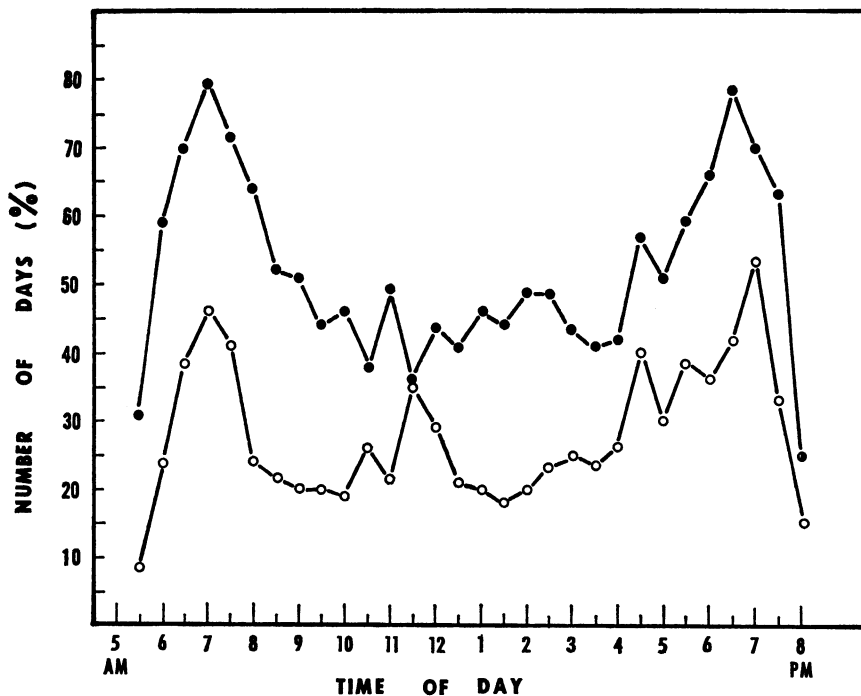


FIG. 4. The daily pattern of calling of *N. cinerascens* expressed as a percentage of the total number of days on which males (solid dots) and females (open circles) were recorded for each half-hour period of the day.

season calling began between 5:30 A.M. and 6:30 A.M., but sometimes the early morning hours passed without a sound heard from *cinerascens*. After 7:30 P.M. tinamous called on only 25 per cent of the recording days. The latest call recorded in the evening was at 8:20 P.M. as darkness set in. No calls were recorded after darkness or before dawn. In January we heard no calls prior to 6:12 A.M.

The lengthy calling periods of the males fell off in January, an occurrence that may be explained by the fact that some males were nesting and others had probably incubated two clutches of eggs by this time. While the calling periods of the males were less extensive in January, females called more frequently at this time than in November and December. Another change in January calling was evident in the daily pattern, which now showed less consistency. For example, on January 7, not a single male call was recorded. On January 9, calling began at 6:28 A.M., but on the following day calling did not commence until 11:00 A.M. On January 11, the call of a male was first heard in the late afternoon at 4:50 P.M. Frequently the day-to-day callings of males and females showed similar patterns, but such was by no means the rule.

Climatic factors, such as the degree of cloud cover, the temperature, or even light rainfall, seem to have little effect upon calling. Tinamous stop calling, however, in a heavy rain. If it is raining at dawn, calls are not heard until the rain subsides. Many extensive calling periods were carried out in the middle of the day, often at temperatures of 100° to 110° F.

We recorded calls of *N. cinerascens* on every day of our study (figs. 5 and 6). There was only one day (December 11) on which we did not hear any females. Males did not call on December 29 and January 7. There were several days during which males called almost continuously from 5:55 A.M. until 8:05 P.M. On each of 14 days between November 12 and January 19 more than 400 calls involving four to seven males were recorded. Thirteen of these heavy calling days occurred between November 12 and December 12. The other was on January 19 when four males called 417 times. The greatest number of calls recorded in a single day was on November 23. Seven males rendered 1277 calls on this day.

Two days later the same number of males called more than 1133 times, with no recording accomplished during four hours in the afternoon. On November 28 and 29 we recorded the heaviest morning calling periods with 548 calls (seven males) in less than five and one-half hours, and 436 calls (seven males) in three and one-half hours. The heaviest half-hour calling period included 124 calls beginning at 6:00 A.M. on November 25 and involving six males.

The calling pattern for individuals is more difficult to delineate. Males seemed to call most frequently during the peak hours shown in figure 4. Yet calling varied greatly from day to day among individual males (figs. 7-10). Males called more frequently in the earlier part of this study, while the reverse situation was true for the females.

Figures 7 through 10 show the daily calling pattern of four males in the study area. Unfortunately, there are some gaps in these records. Nevertheless, the figures convey an idea of the amount of time males spend in calling and how much day-to-day variation in calling is manifest. Extensive calling periods of two or more hours were recorded for the four males. Male 1 had only one such calling period; male 3 had 14. The longest calling period recorded for any male was that of male 2. This male rendered 225 calls in slightly more than five hours, an average of one call every 1.3 minutes. Even longer periods of calling were undertaken during which we did not record the actual number of calls. Thus male 2 called from dawn to dusk on January 21. Each call was usually rendered one to two minutes apart on this day, and rarely did more than five minutes elapse between calls.

The number of calls rendered by any male in a single day varied widely. Heavy calling on one day was followed by a day of light or heavy calling. No consistent correlation could be detected between the extent of daily calling and the presence or absence of females, or the calling periods of other males. Male 2 called 279 times throughout November 24, and 232 times in six hours on the preceding afternoon. We recorded 308 calls for male 3 on December 7, but did not record any calls for three and one-half hours that day. Thus male 3 probably called close to 400 times.

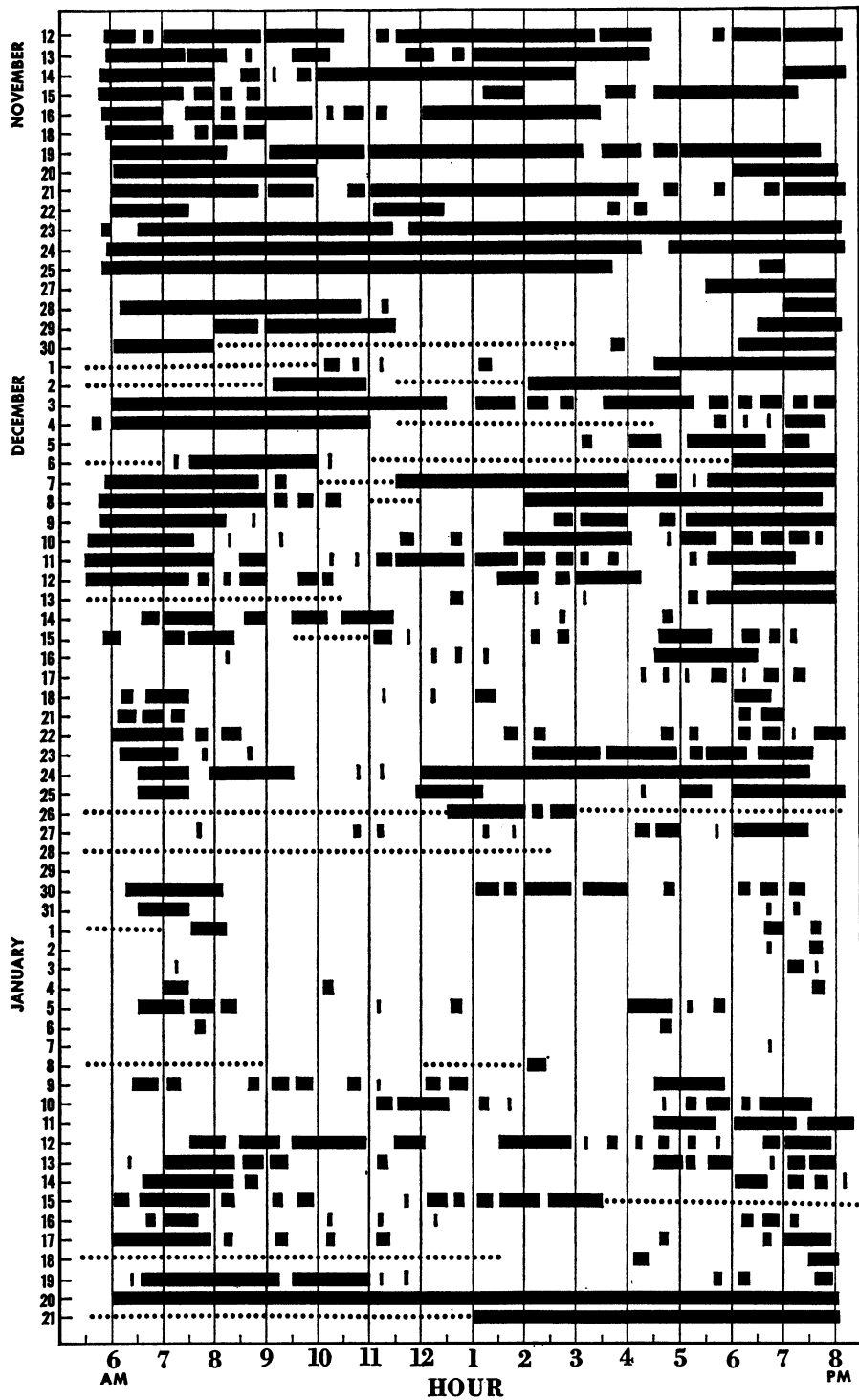


FIG. 5. Daily calling pattern of study-area males and peripheral males during period of study. Solid bars show duration of calling periods of one or more males; dotted lines, times when no calls were recorded.

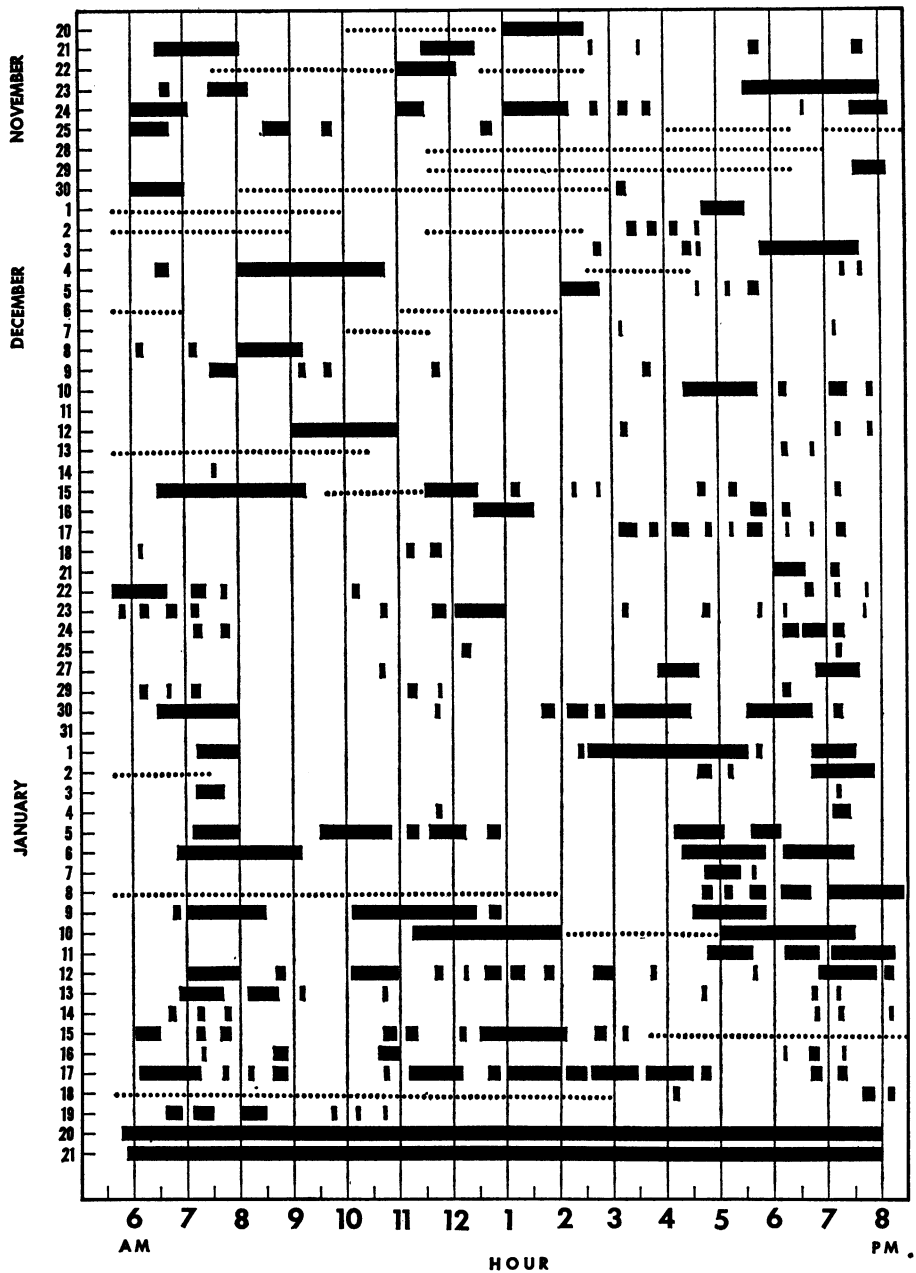


FIG. 6. Daily calling pattern of study-area females during period of investigation. Solid bars show duration of calling periods of one or more females; dotted lines, times when no calls were recorded.

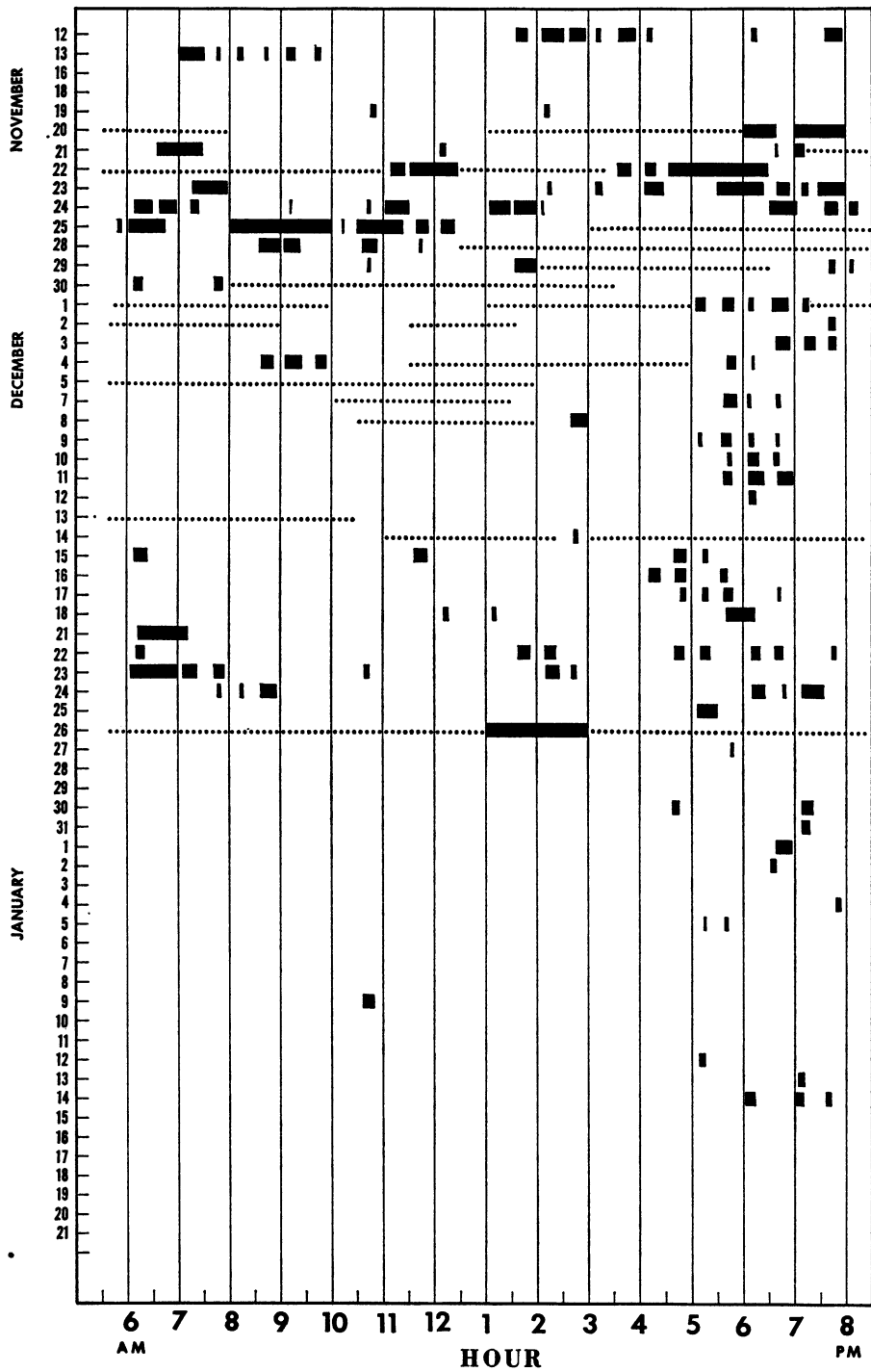


FIG. 7. Daily calling pattern of male 1. Solid bars indicate duration of calling periods; dotted lines, times when no calls were recorded.

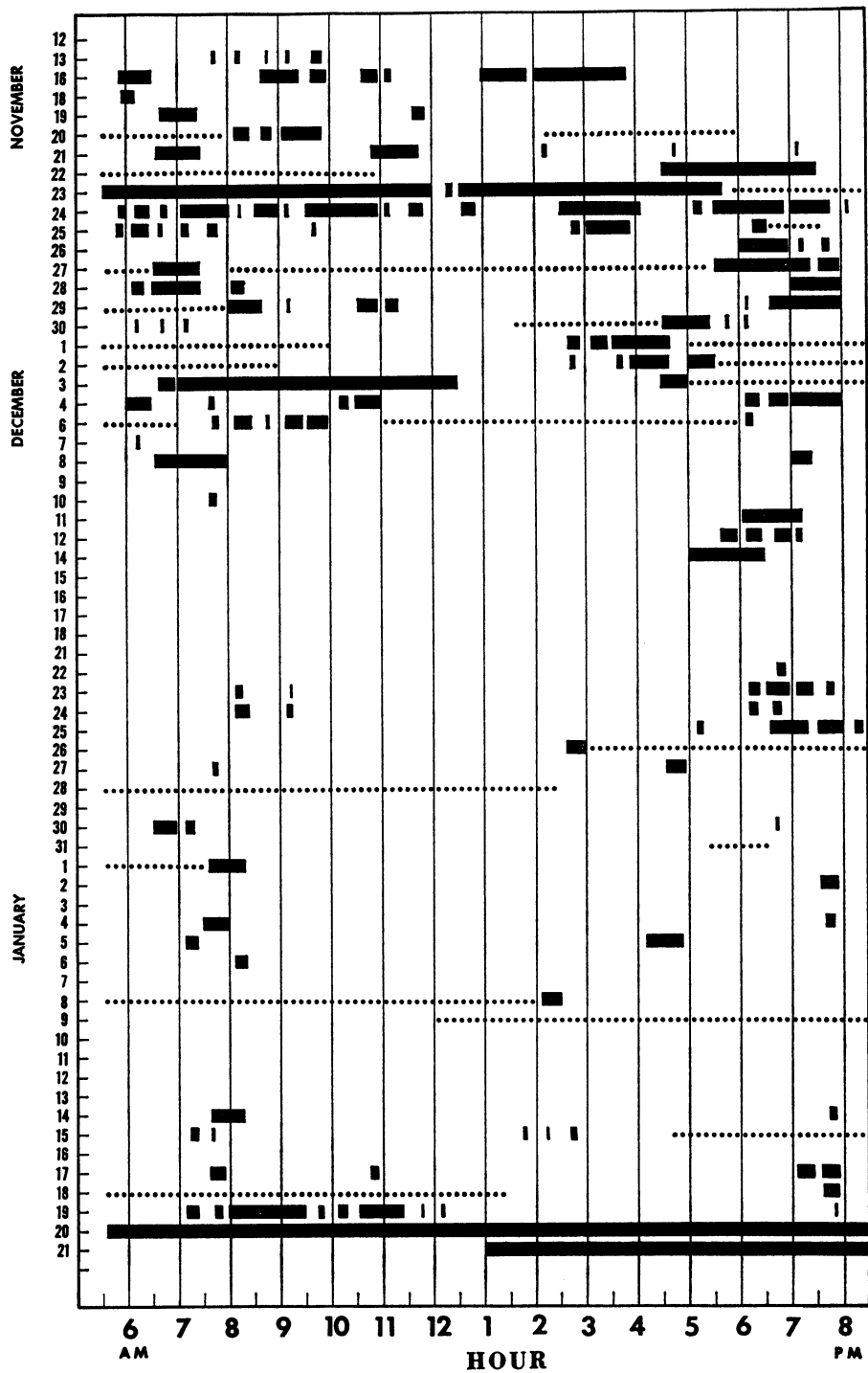


FIG. 8. Daily calling pattern of male 2. Solid bars indicate duration of calling periods; dotted lines, times when no calls were recorded.

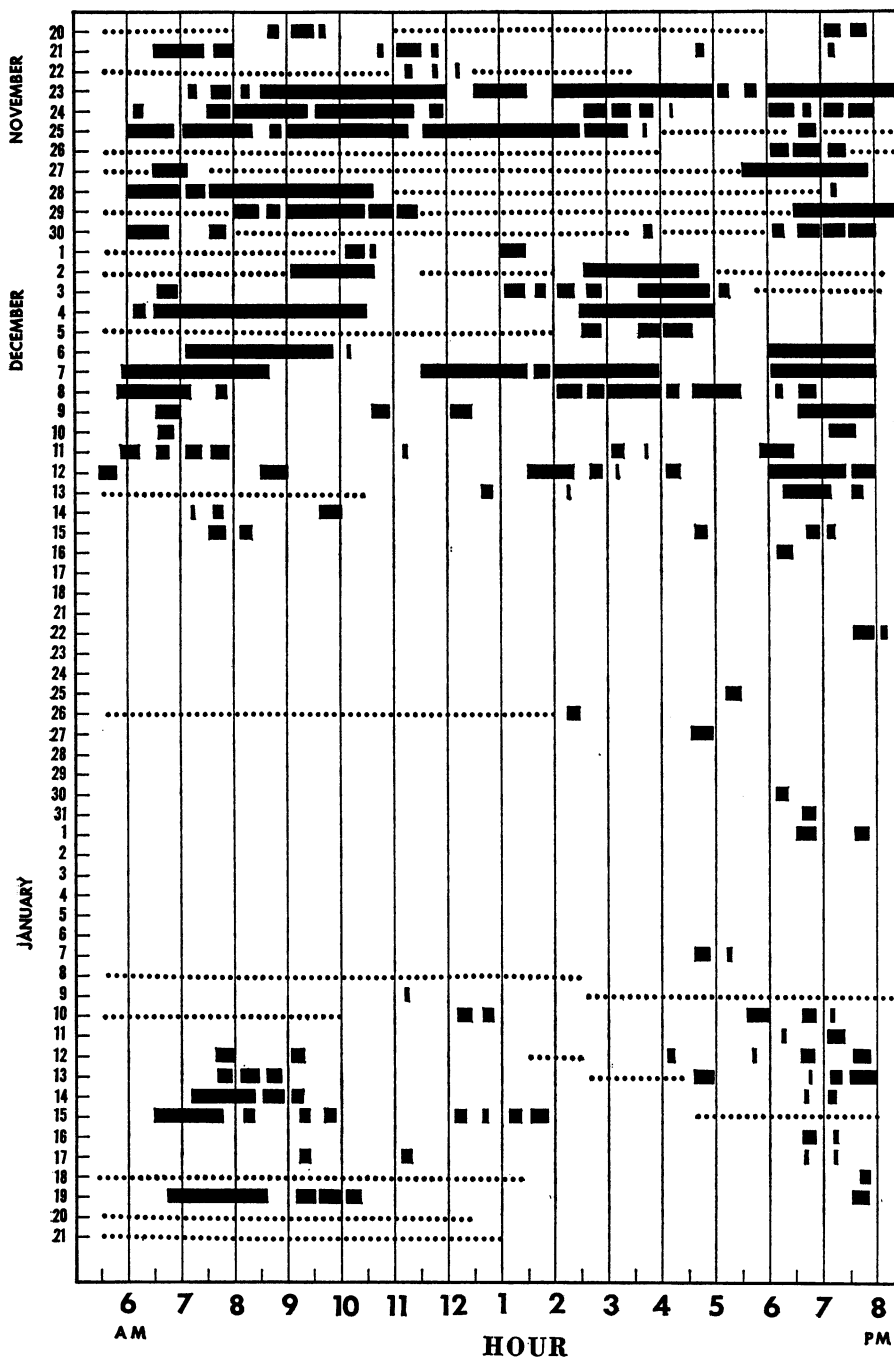


FIG. 9. Daily calling pattern of male 3. Solid bars indicate duration of calling periods; dotted lines, times when no calls were recorded.



Male Brushland Tinamou, *Nothoprocta cinerascens*



1



2

1. Calling male, *N. cinerascens*
2. An alarmed male

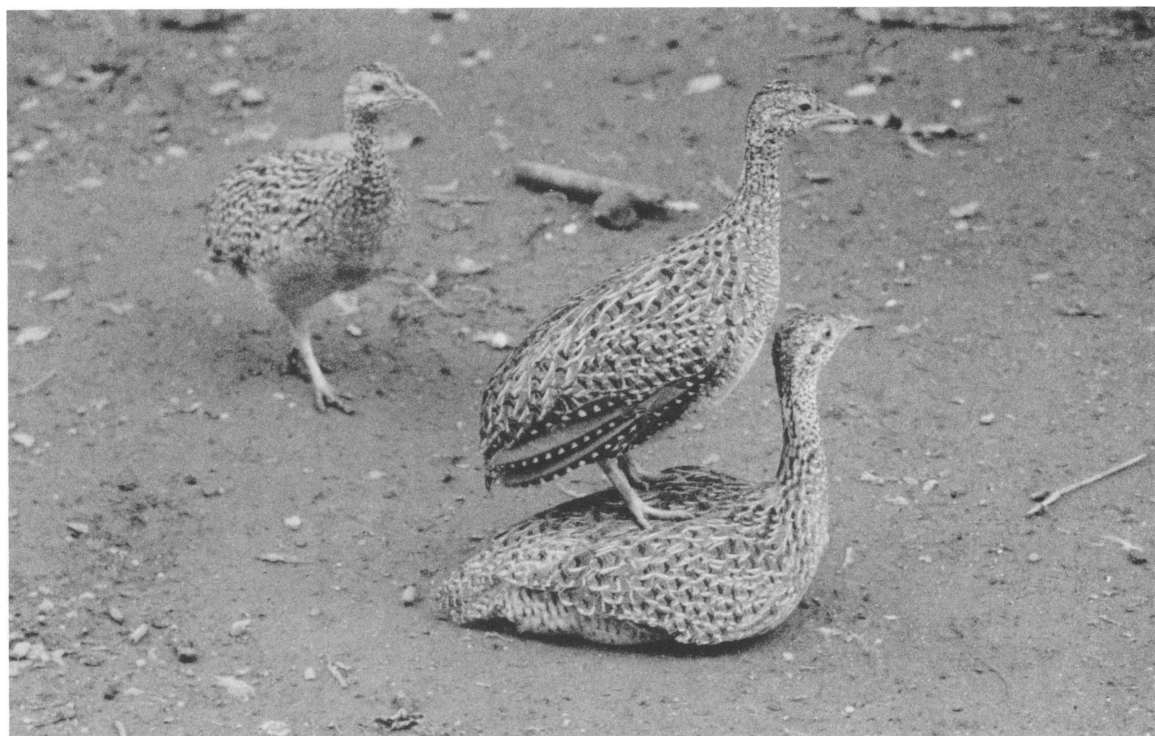


1

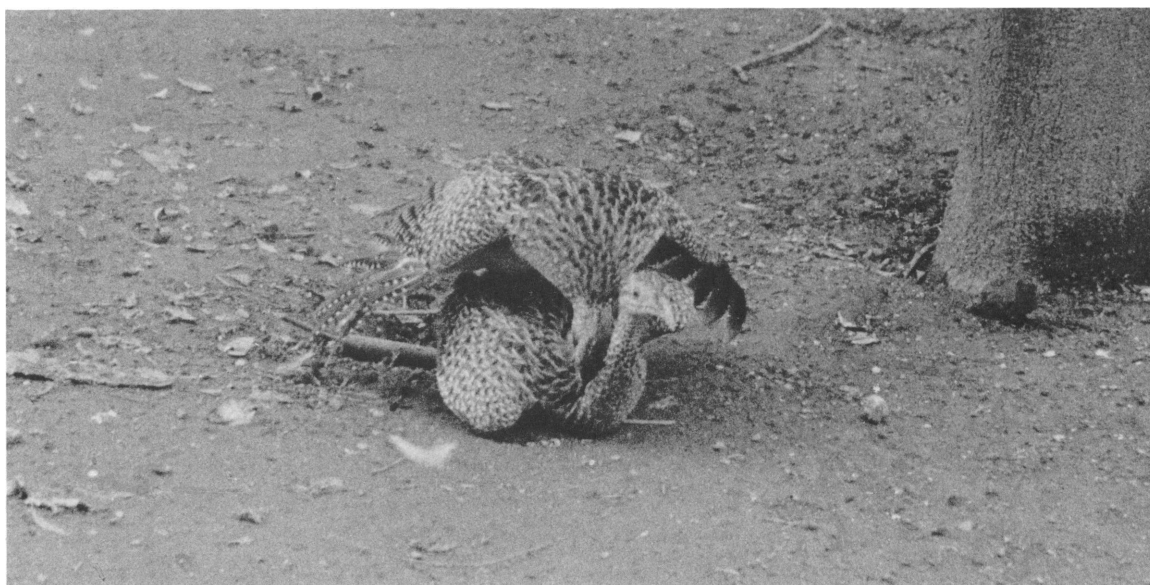


2

1. Male photographed while bobbing
2. Male mounting a soliciting female

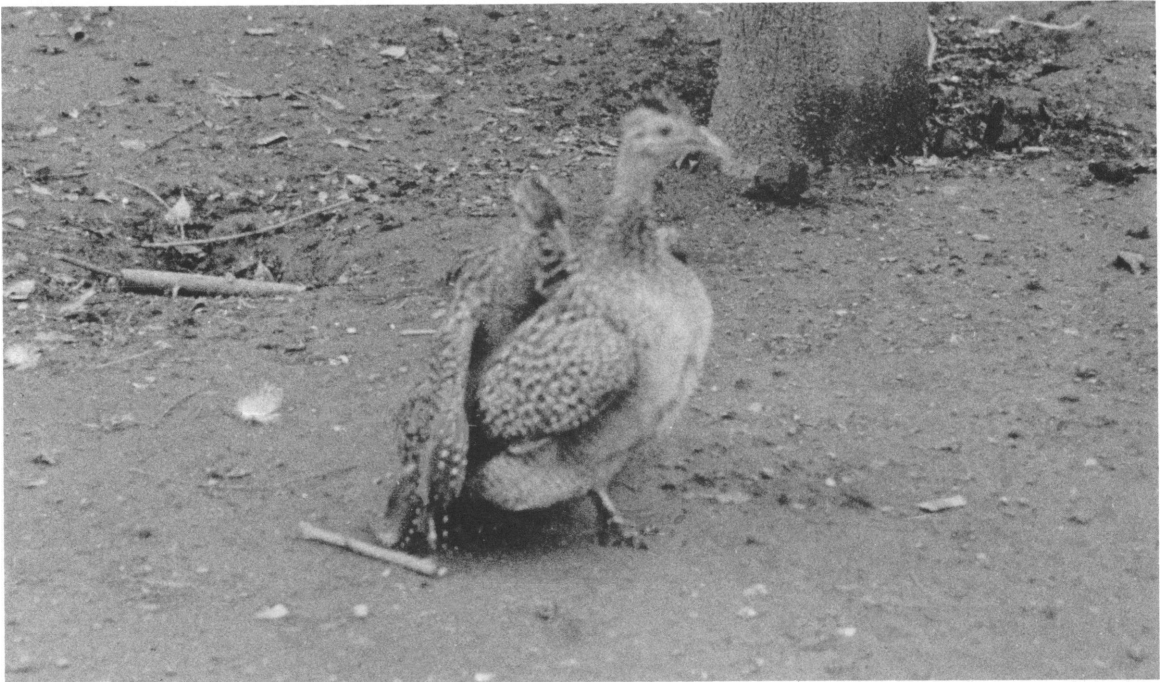


1



2

1. Mounting
2. Termination of mounting. Male shown spreading wings and pecking at the back of the female



1



2

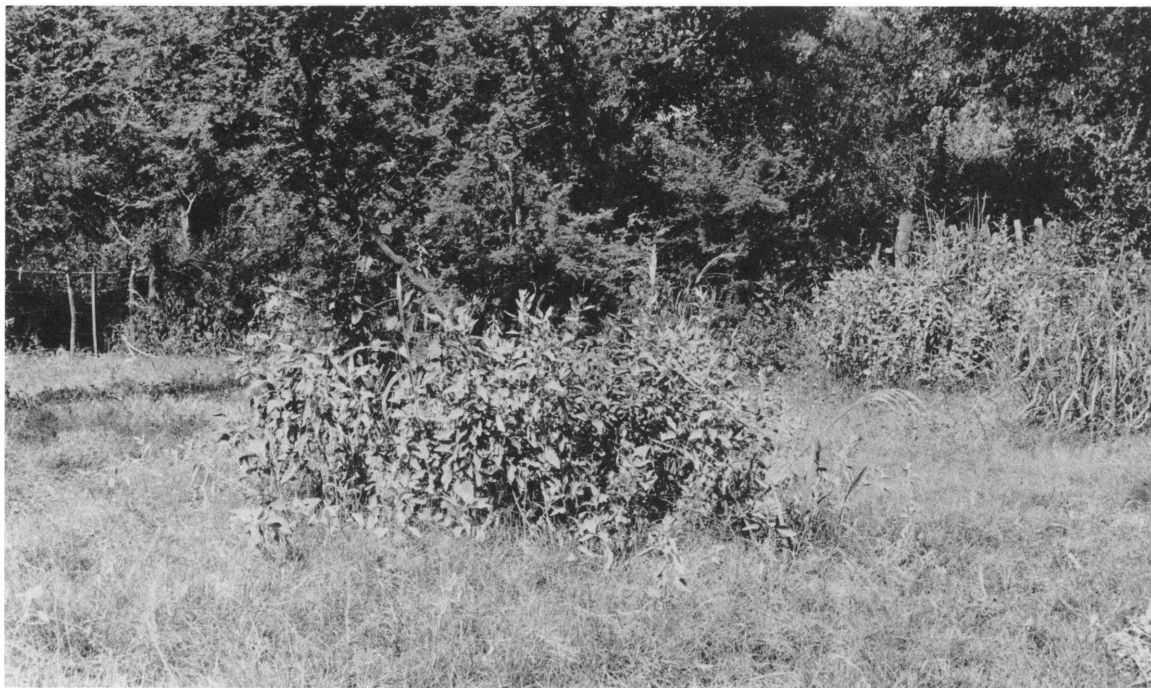
1. Copulation
2. Ejaculatory crouch of a male following an unsuccessful mounting



1. Nest of male 1
2. Location of a single *cimerascens* egg



1



2

1. Nest site of male 1 looking south. Sorghum field lies beyond the hedgerow. Woods are to the left
2. Nest site of male 1 photographed from the blind



1



2

1. Open woods near the site of the nest of male 1
2. Open woods between the sorghum field and the road



1



2

1. Looking south along the study area road
2. Looking north along the study area road

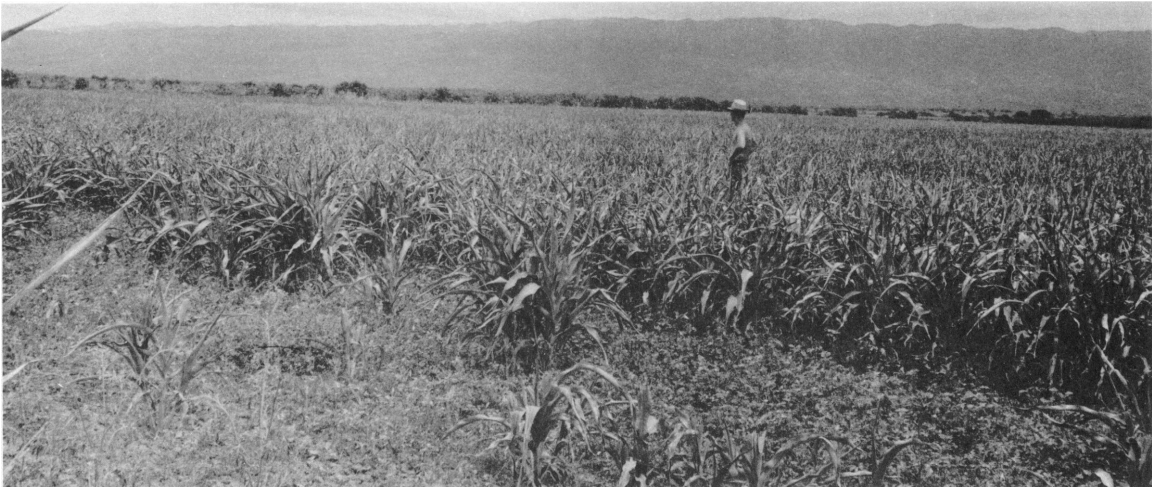


1



2

1. Dense thorn thickets
2. Cactus and grass field. Andean range to the west (in background)



1



2

- 1. Sorghum field looking west toward the low Andean range
- 2. Tall woods in the northwestern part of the study area

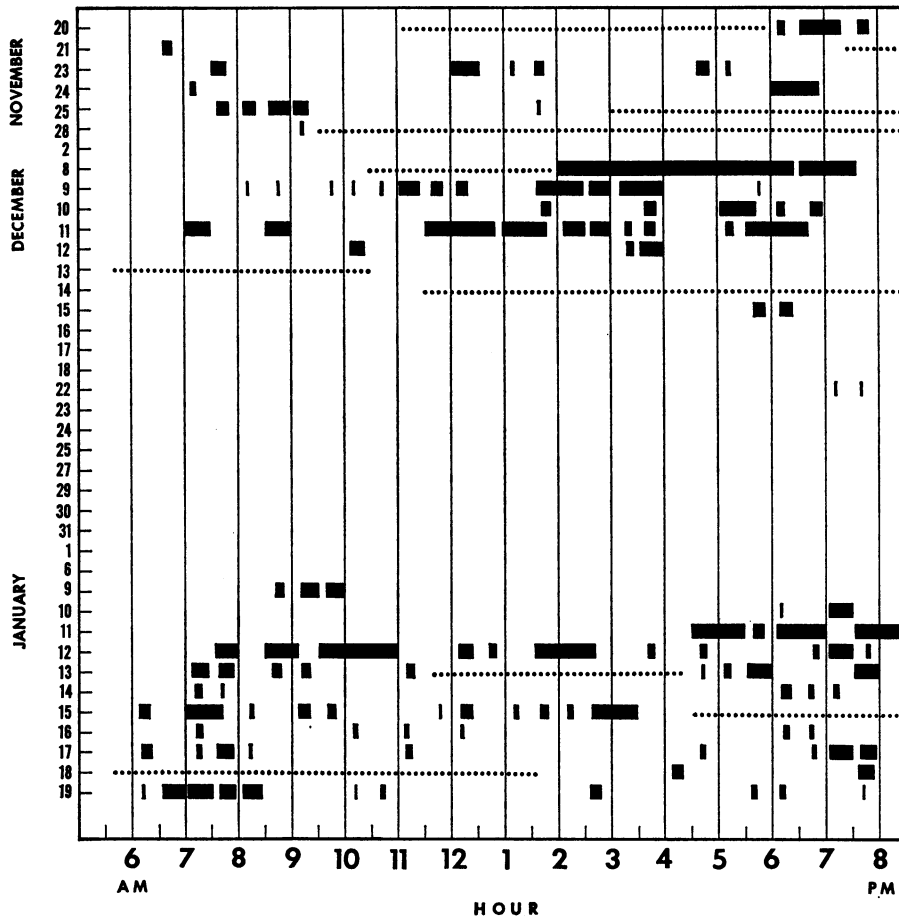


FIG. 10. Daily calling pattern of male 7. Solid bars indicate duration of calling periods; dotted lines, the times when no calls were recorded.

About 500 calls are probably the maximum number rendered by a male on a peak calling day.

The rate of calling varied from one call every 1.1 minutes to one call every 2.1 minutes for calling periods of two or more hours. Males that called for shorter periods of 30 to 90 minutes often averaged one call per minute.

Females seldom called as extensively as the males, and calls were less numerous on any given day (fig. 6). Except for December 15, we recorded no more than 90 calls a day prior to December 30. The heaviest calling day for females was recorded in January, with a peak of 634 calls on January 10. On that day females called 236 times from 12:30 P.M. to 1:30 P.M. The number of females involved

was not determined, but the calls of at least four birds were included. Heavier calling periods occurred on the final two days of the study. On both days a number of females called continuously, although we did not record the number of calls.

The extensive calling periods of the males apparently function for the establishment and maintenance of territories as well as for the advertisement for potential mates. Earlier in the study the calls of one male often stimulated another male into vocalization. This tendency, although continuing throughout the study, lessened considerably. After acquiring mates, males continued calling. But during incubation, the male did not call during attentive periods at the nest.

HOME RANGE AND MOVEMENTS

Each male moves about in a fairly large area that widely overlaps the home range of its neighbors. These areas are undoubtedly established early in the breeding season, for we noticed that during the earlier phases of the field study a male responded to the call of an adjacent male more frequently than in the later phases.

These areas varied greatly in size among the four males (males 1, 2, 3, and 7) the ranges of which included much or all of the study area (figs. 11–15). Several marginal males (males 4, 5, 6, and 8) wandered into the study area from time to time, and we often heard and recorded their calls from the sorghum fields and woods outside the study area

(fig. 16). The entire home range of male 7 was not determined, since this male moved about outside the study area almost as much as in it (fig. 12). But even within the study area the rambling of male 7 covered an area of 53 acres. The recorded total range of male 2 within the study area was about 59.5 acres (fig. 13). He actually covered a larger area, however, since on several days his calls came to us from more distant locations in the sorghum fields outside the study area. The range of male 3 was ascertained at 42.5 acres (fig. 14) and was entirely confined to the study area. It was also possible to determine the total range of male 1, which included an area of 54 acres (fig. 15).

We undoubtedly would have recorded more

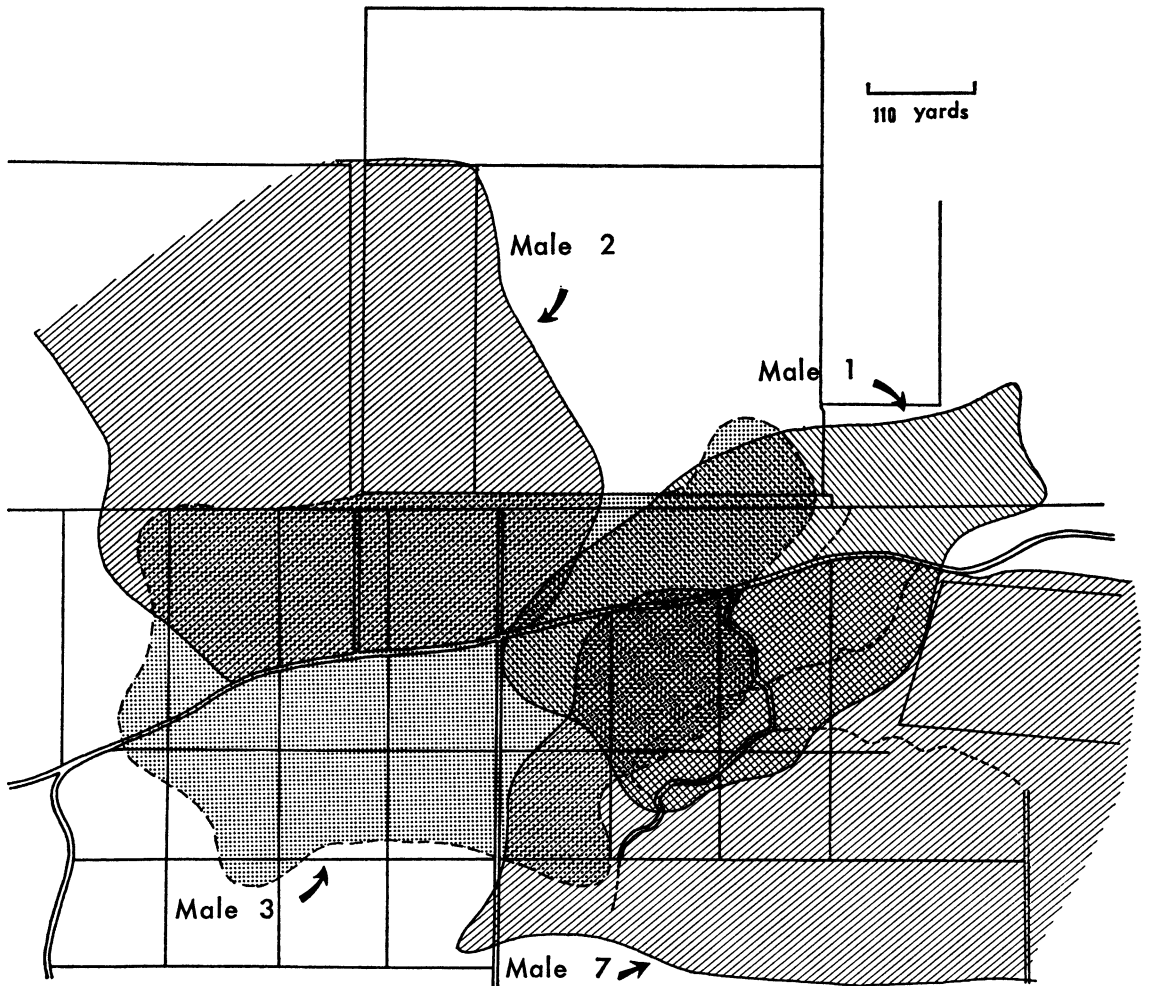


FIG. 11. The primary ranges of the four study males.

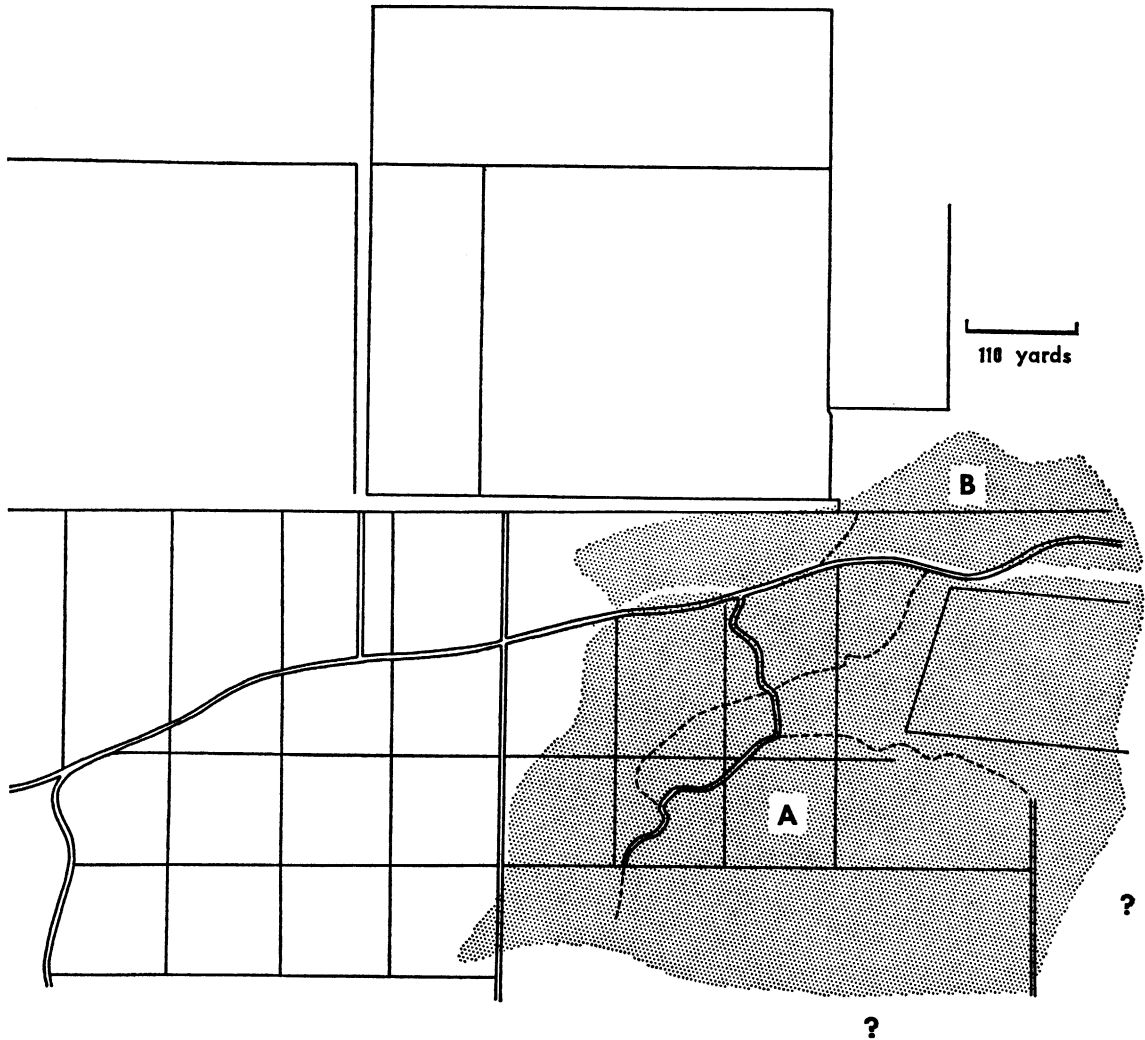


FIG. 12. Total observed range of male 7. Larger area (A) is the primary range. Male 7 was recorded west of the road (B) only from January 10 to January 16.

extensive movements and ranges of all the study-area males had we been able to keep them under surveillance for the entire season. As it is, our delineation of the home ranges was made during the relatively short period of study from November 12 to January 21. Even during the study, however, the home ranges were probably somewhat larger than observed. The particular locality in which a male was moving at any given time could be ascertained only if the male was calling. There were, of course, lengthy periods on many days when no calls were heard. The whereabouts of the males at these times was obviously unknown.

Territoriality is a weakly manifested behavior pattern in *N. cinerascens*. The fact that the males move about within such large areas probably serves to lessen competition for females. Calling males never came within sight of one another as far as we could determine; thus no territorial chases were observed. When one male ventured deeply into the territory of another male, he did so only if the proprietor was not calling, or if the calls of the latter were some distance away. The calls of an approaching defender were sufficient to cause the intruder to leave the area. Thus the only observed manifestation of territorial behavior consisted of calling duels.

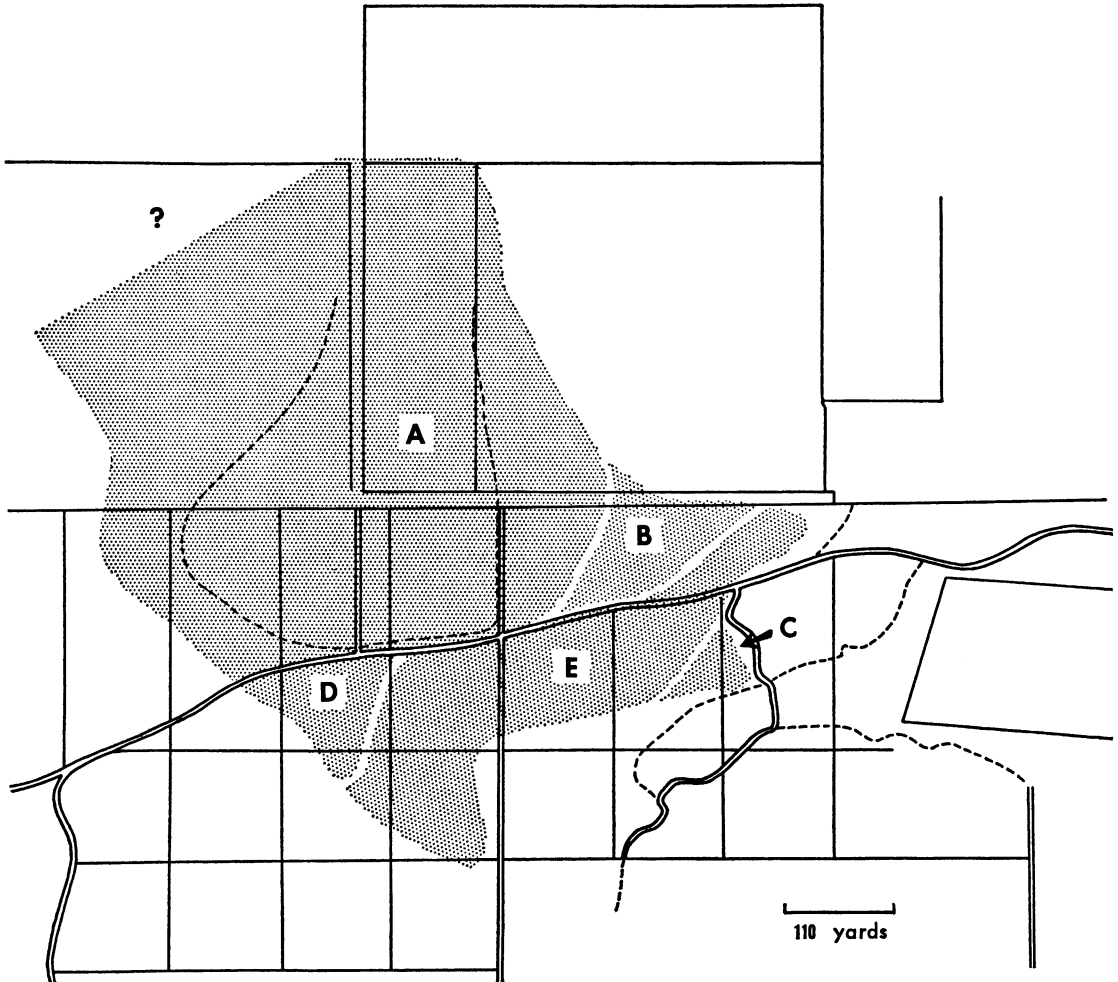


FIG. 13. Total observed range of male 2. Within the primary range (A) male 2 concentrated much of his activity within the area indicated by the dotted line. Male 2 was observed in the other areas as follows: area B, December 23 and 27; area C, December 1; area D, January 19; area E, mostly January 21, but a small portion of this area on December 1 and 23 and January 15.

There was a broad overlapping of the primary ranges of the four males, even excluding the occasional extensions that added to the total range. A small portion of the study area was traversed by all four males at some time during the period of study. Over 75 per cent of the total range of males 1, 2, and 3 included the ranges of other males. For male 7, this figure was not more than 50 per cent. For the four study-area males I designated a primary home range, an area in which most of their activities were confined, and from which on occasions they moved into adjacent areas usually for one day, sometimes longer (figs. 11-15).

Thus the primary range of male 1 consisted of about one-half (27 acres) of its total observed range. Most of the extensions were areas in which this male was observed only once. The two excursions across the sorghum field into the grass fields took place shortly before the commencement of incubation. Once incubation had begun, male 1 utilized the nearby sorghum field as a feeding area during some of his inattentive periods away from the nest (fig. 17). The largest area traversed by male 1 in a single day was a minimum of 22 acres on November 25. Several females were noted with male 1 that afternoon. His morning movements alone carried

him $1\frac{1}{2}$ miles (fig. 18). He walked well over another $\frac{1}{2}$ mile in the afternoon, covering more than 3750 yards during the entire day. On this day male 1 called more than at any other time during the study. Extensive calling periods and extensive movements were not, however, necessarily correlated. Many of the extensive calling periods of other males did not involve wide movement.

Male 2 moved in a primary range of approximately 45 acres, within a total observed range of 59.5 acres. But even within this area, male 2 seemed to have a smaller tract of concentrated activity. This 17.5-acre plot included a small portion of the sorghum field (pl. 26, fig. 1), much of the cactus field

(pl. 25, fig. 2), and the sparsely treed area west of the road (pl. 23, fig. 2). Most of the time male 2 remained west of the main north-south road. On January 19, male 2 ventured eastward and on January 21 roamed about as the only calling male in areas usually occupied by male 1, 3, or 7. Because male 2 remained within a smaller area than the other males, his recorded movements were not so extensive. The four most extensive movements were less than 1000 yards, the two longest (940 and 990 yards) taking place on January 19 and 21, respectively, the days on which male 2 moved into new areas (fig. 19).

The home range of male 3 included the

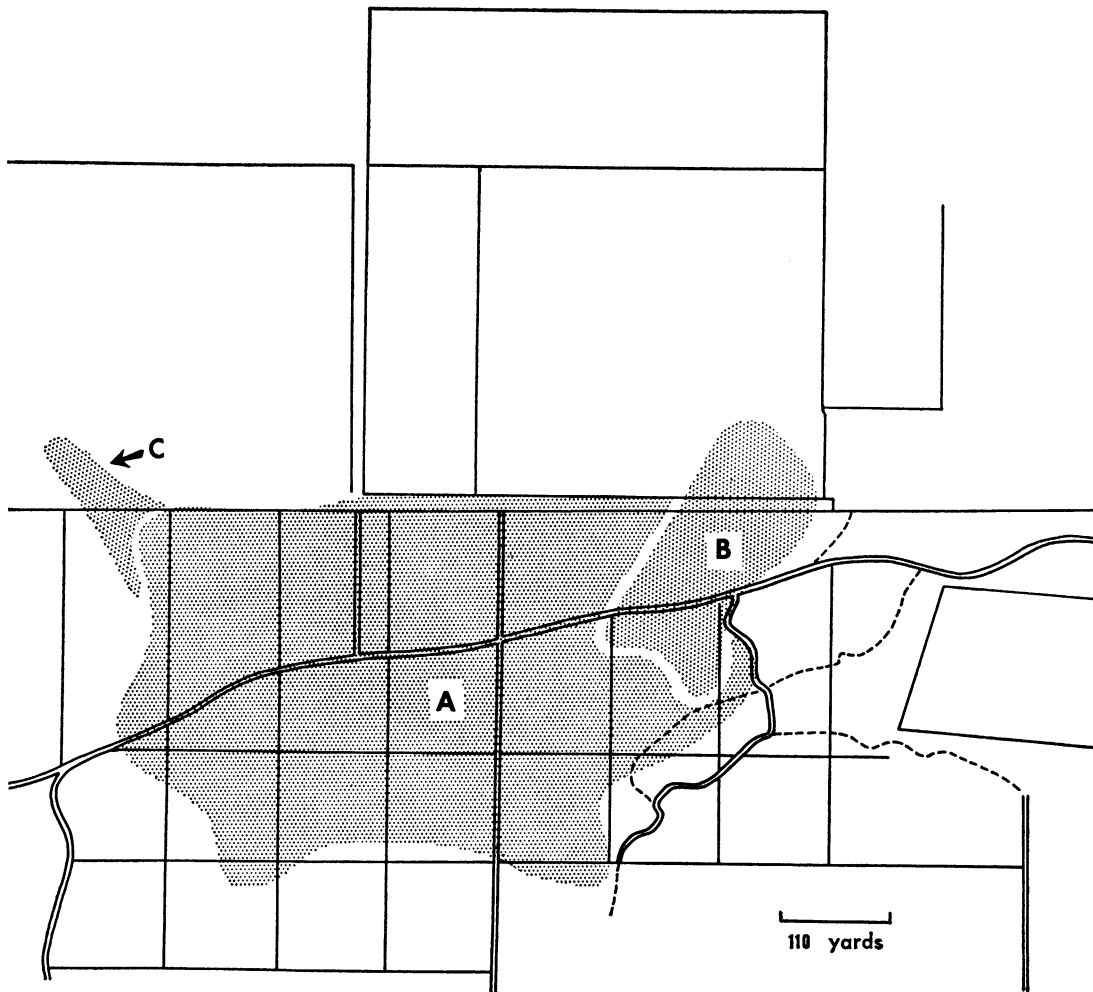


FIG. 14. Total observed range of male 3. Area A indicates the primary range. From December 25 to January 9 male 3 was found in area B, and in area C on January 15.

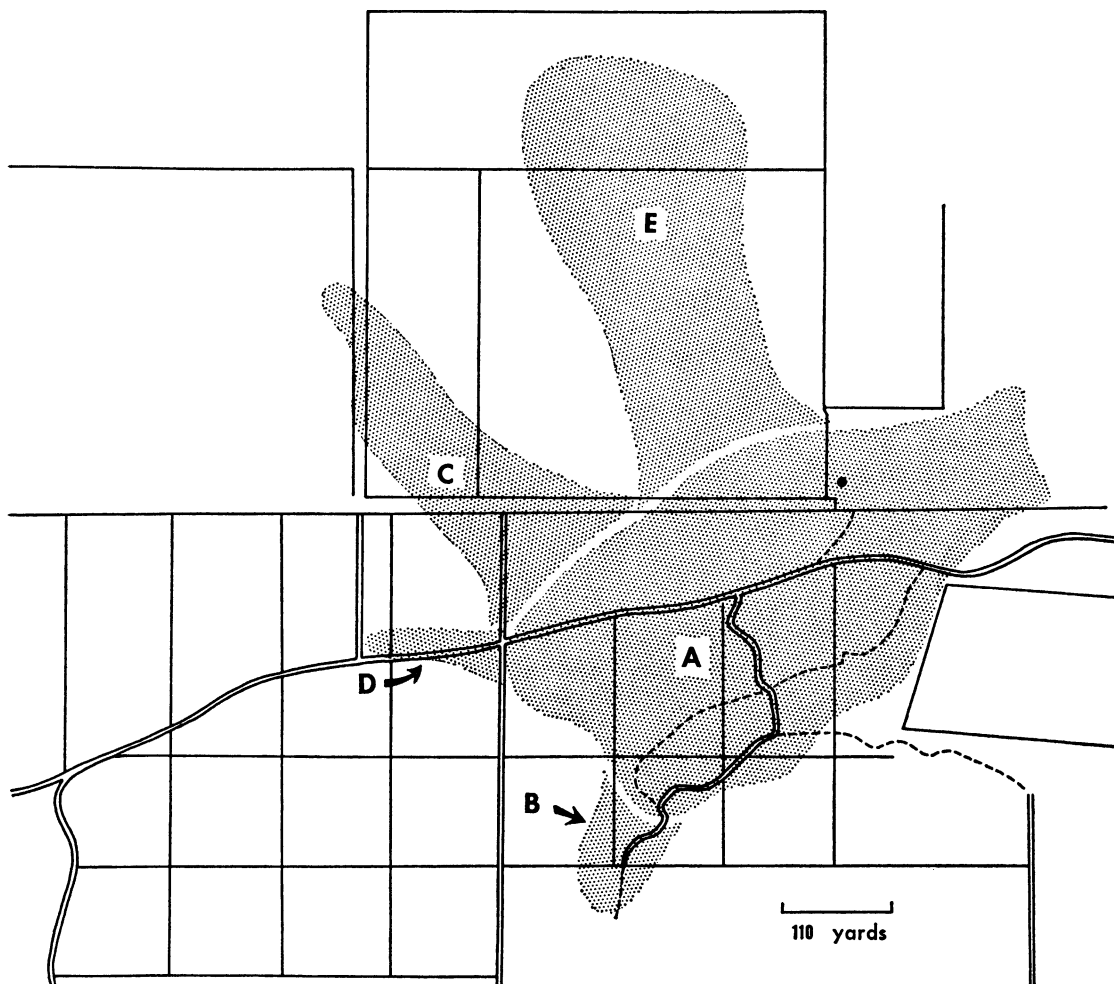


FIG. 15. Total observed range of male 1. Area A shows the primary range. Male 1 was recorded in the other areas on the following days: area B, November 12; area C, November 25; area D, December 11; area E, December 24 and 26 (grass field), December 28 and January 3, 4, and 7 (eastern portion of the sorghum field). The nest is shown as a black dot.

sparsely as well as the densely wooded areas. Seldom did this tinamou venture out into the fields. Of the total range of 42.5 acres, about 25 acres were considered the primary range. Most of the movements through December 2 were confined within this range, but thereafter male 3 was frequently recorded north of this area. For more than two weeks (December 25 to January 9) male 3 was recorded nowhere other than in the small tract of land indicated in figure 14, which included a small corner of the sorghum field. Females were also in this vicinity, for a clutch was completed for male 1 on December 28 not many

yards north of this area. Male 3 ranged widely after January 9, engaging in some of his most extensive movements. He walked into the sorghum field on January 15 where he had never before ventured. Of 10 extensive movements recorded for male 3, four were recorded between January 10 and January 19 and ranged up to 1200 yards. The longest observed daily movement by male 3 occurred on December 7 and included a minimum of 2200 yards, or approximately $1\frac{1}{4}$ miles (fig. 18).

Fewer data are available for male 7 than for the other three males, for he frequently

ranged north and east of the study area. He covered a considerable area and appeared not to concentrate his activities or movements as did the other males. However, had more data been available, a pattern of restricted activity may have unfolded. From January 10 to January 16 this male moved more extensively (at least in that part of his range that included the study area) than at any previous time. In his wanderings, he walked into the region west of the main road; he had not previously been observed there. This area was previously occupied exclusively by male 1, which was nesting at this time. Five extensive movements were recorded for male 7, all taking place from January 12 to 19. The

longest of these movements covered a minimum of 1320 yards, or $\frac{3}{4}$ mile (fig. 19).

In approximately 75 per cent of all the lengthy movements observed, one or more females were present with the male at some point along the way. Movements were sometimes accomplished in silence. At times a male observed at a particular spot in the morning ceased calling and showed up later in the day a considerable distance away. Such movements undertaken in silence are probably foraging movements. Those accompanied by frequent calling probably serve to attract females. Many movements are directional, but others seem to be somewhat erratic. In this habitat where ground vegeta-

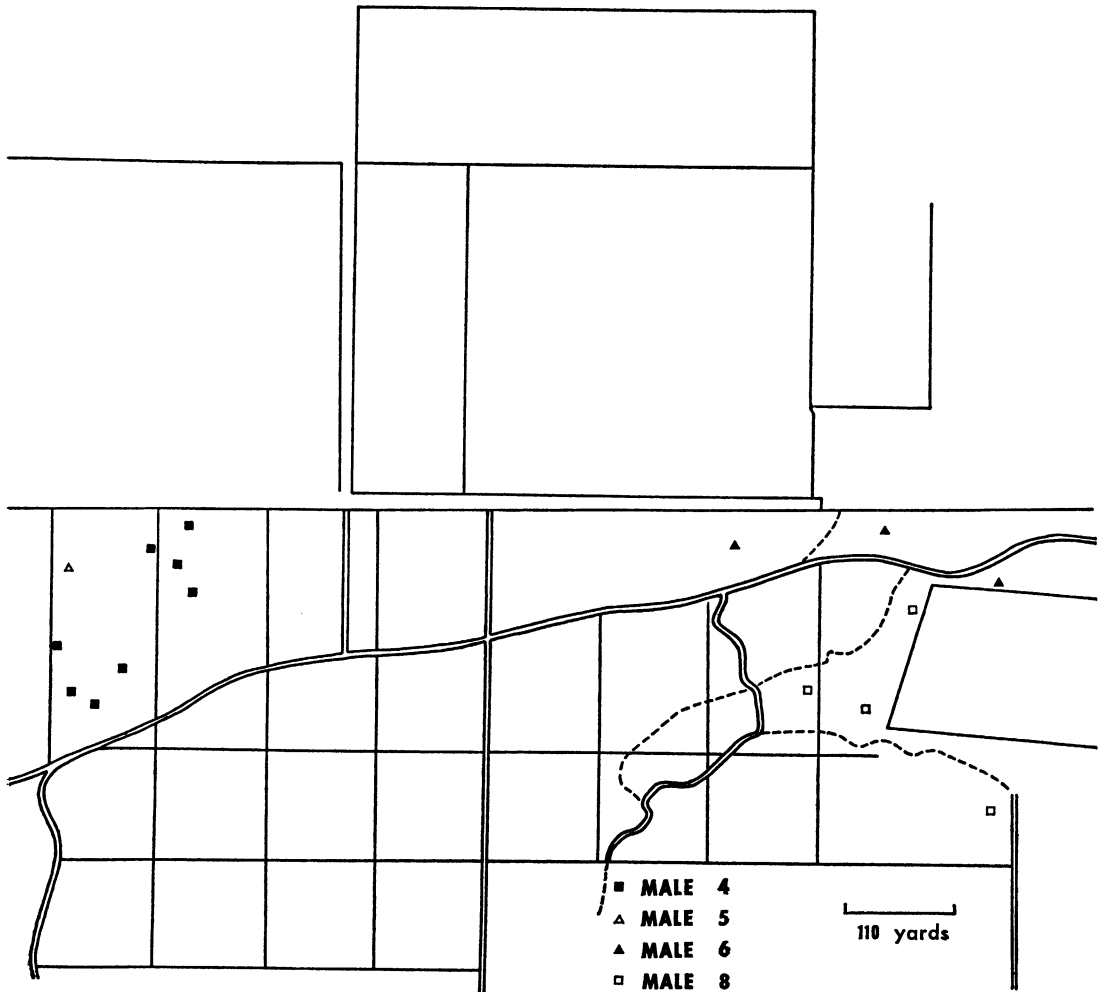


FIG. 16. Points of record within the study area of the four peripheral males.

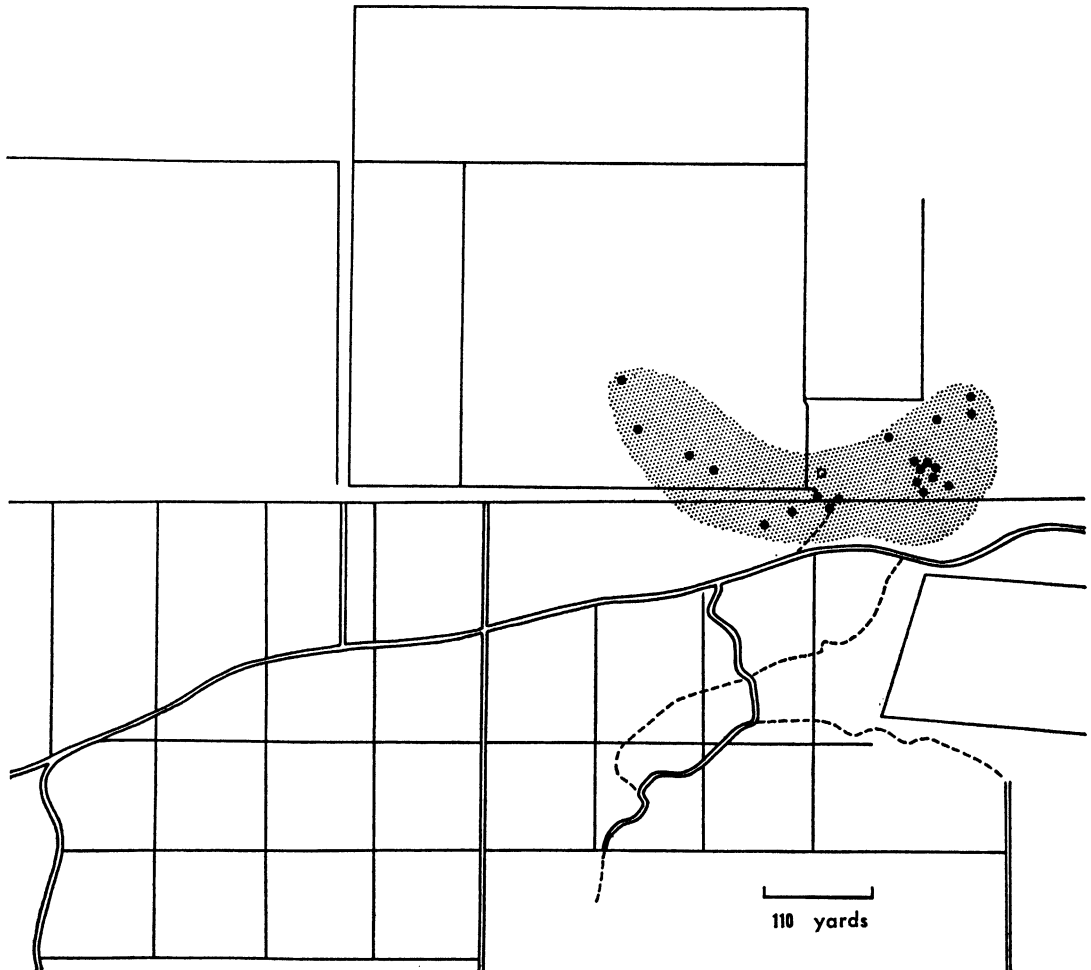


FIG. 17. Points of record for male 1 during inattentive periods. The nest is indicated by the open square.

tion is dense, we found that the birds often walk along roads or paths made by cattle or man. But our evidence disclosed no preference for special routes.

Movements are not restricted to a particular time of day. Long walks by different males were recorded at all hours from dawn to dusk. The longer movements recorded for each male took place on widely separated days except in the case of male 7; the long walks of the latter bird were observed from January 12 to January 19. In many cases males undertook long movements on two consecutive days, or several walks over a period of three or four days.

Figure 20 shows points of record for females

observed over the period of almost two and one-half months of this study. Females were recorded throughout most of the area in which the males were also recorded. Most of the time females moved in groups of two or more. When one female called, others usually answered if they were in the vicinity. Seldom were these females in sight of one another. By means of calling, they maintained contact as they moved along the floor of the woods or semi-open areas. Walking distances maintained between females varied from several yards to approximately 80 yards. One morning five females walked across the study area in a group loosely maintained by their calls.

Only the males maintain territories and

range within a given area. The females, on the other hand, manifest no territorial behavior. They move throughout a larger area, mating successively with different males.

MATING BEHAVIOR

We were not able to record the seasonal evolution of reproductive behavior in the study area, since our field investigations began at least one month after the beginning of the breeding season. Before we entered the field, however, we observed seven individuals of this species in a small aviary in the In-

stituto Migel Lillo in San Miguel de Tucumán. Here we watched the development of reproductive behavior in September and October. Although we also witnessed these behavior patterns in the field, our earlier aviary observations showed us the sequence of development of reproductive behavior. The stages of courtship behavior as they appeared in the aviary birds were as follows: chasing, following, bobbing, calling, strutting and circling, mounting, and copulation.

Prior to the breeding season there is probably no grouping of individuals. There are no

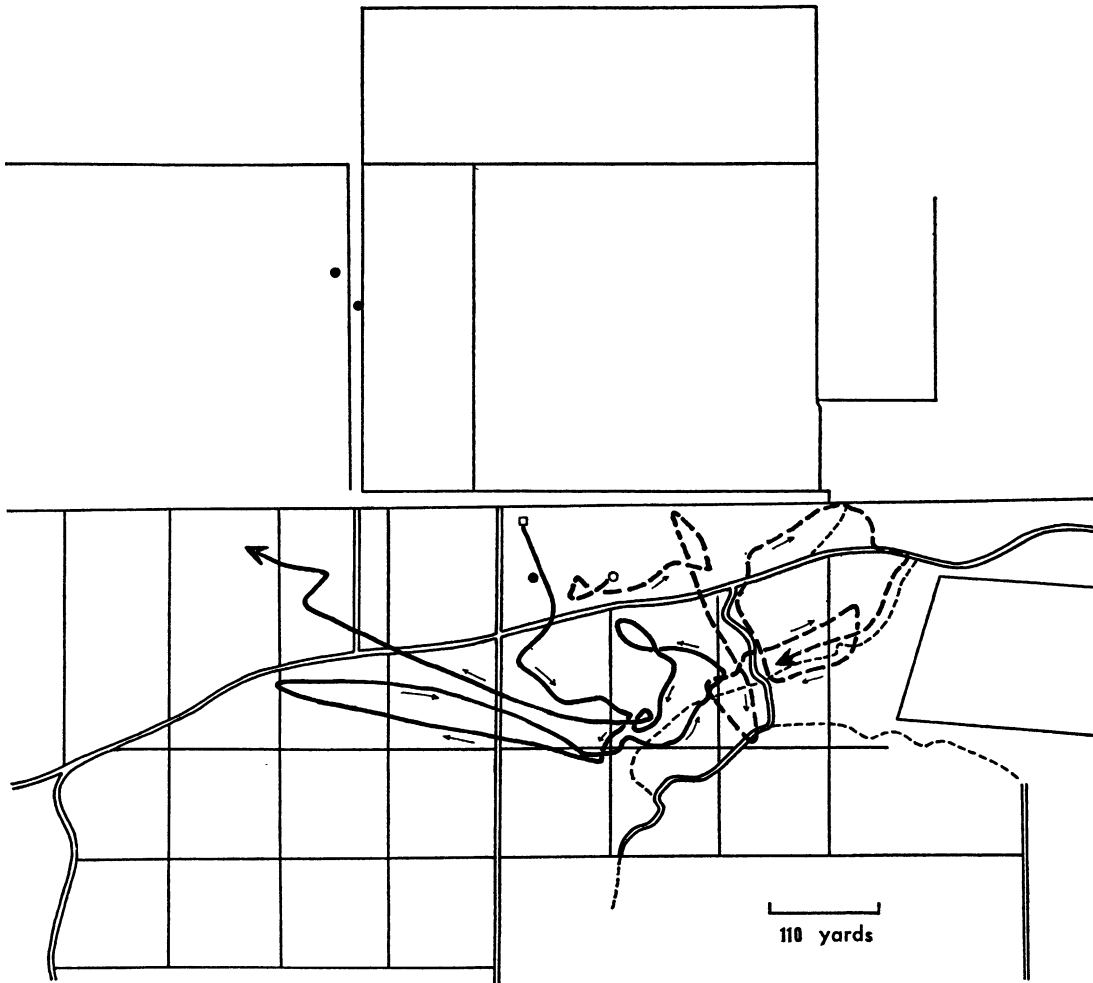


FIG. 18. Sample movements recorded for male 1 (dotted line) and male 3 (solid line). This movement by male 1 occurred on November 25 between 5:56 A.M. and 12:18 P.M. and covered 2670 yards. The solid dots indicate points of record for male 1 on the afternoon of November 25. The movement of male 3 was undertaken on December 7 from 6:05 A.M. to 7:43 P.M. and covered a minimum 2200 yards.

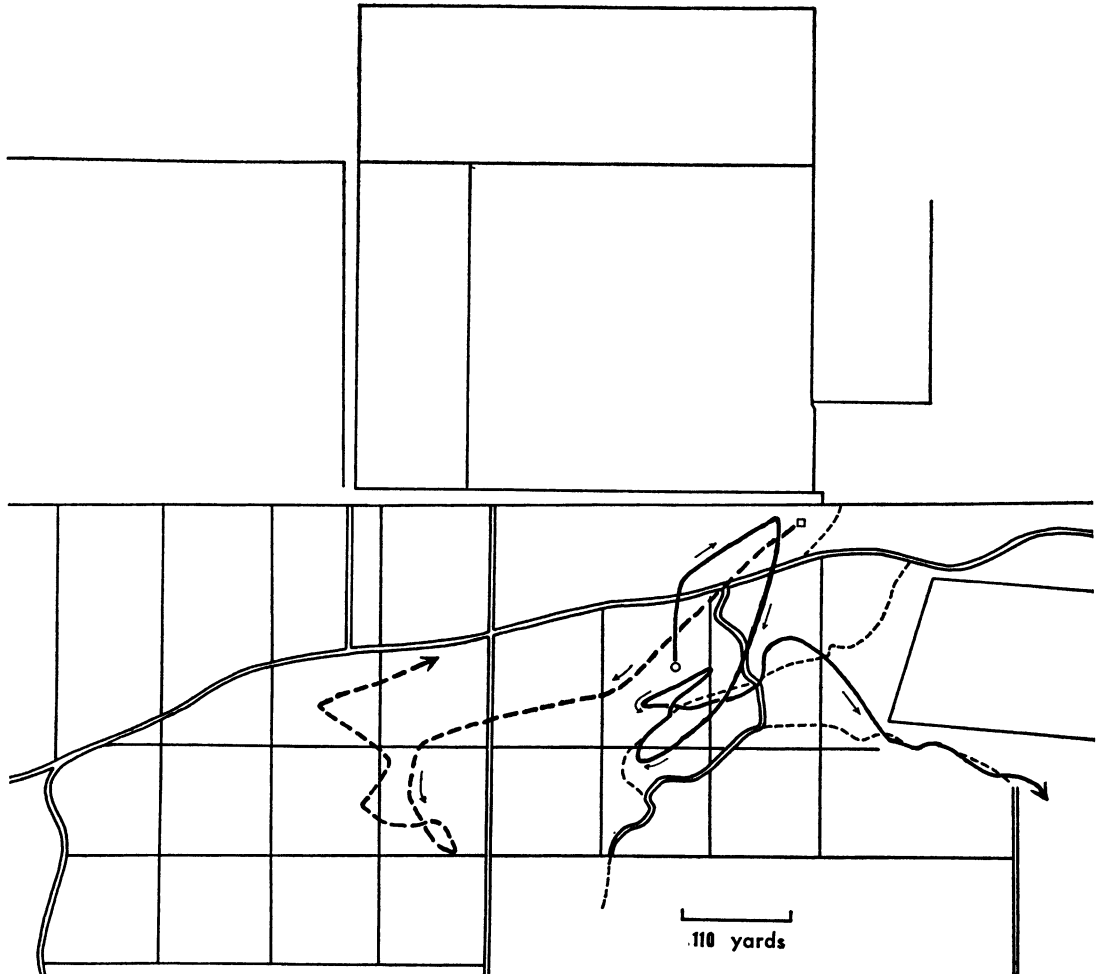


FIG. 19. Sample movements of male 2 (dotted line) and male 7 (solid line). Male 2 covered a minimum of 940 yards from 11:00 to 11:50 A.M. on January 21. Male 7 moved more than 1320 yards on January 12 from 9:30 A.M. to 7:24 P.M.

reports of the banding together of this species in small groups in the winter months, as is known to occur in some species of tinamous. In the spring, when males begin their initially infrequent calling, females are attracted to these calls. The development of breeding behavior in females lags slightly behind that of the males, as indicated by their silence and unwillingness to mate. Although attracted to the calls of the males, the females show no receptiveness toward the attempted mountings by males. This lag in reproductive development leads to chases as a male drives away an unresponsive female or a female attacks an overzealous male. Sometimes,

however, the male tolerates the female as it follows him about. Following behavior frequently provoked aggression as the follower turned on the follower. Chases and encounters (in the aviary) grew more numerous as the season progressed.

BOBBING

A behavior pattern associated with the breeding season is one in which the male performs a series of "bobs." These are accomplished by rapid down-up movements of the entire body from a slightly crouched position with the head and neck withdrawn (pl. 18, fig. 1). The crest is raised, and the movements

are accompanied by numerous soft "whit" sounds rendered with closed bill at the rate of about four per second. In the bobbing display the male assumes a posture which is not unlike the crouched defensive posture mentioned above, and which may have been derived from it.

This pattern shows variations, the most obvious involving the number of bobs. Seldom did this courtship display consist of fewer than three bobs. More frequently the number varied from four to 10 bobs, and in one instance we observed 16 successive bobs. Early in the season each bobbing display contained three to six bobs. Although bobbing displays later in the season also included these lower numbers, displays of eight or

more bobs were recorded only several weeks after the behavior pattern was first observed.

When first observed, the bobbing pattern was not completely developed. As the display increased in intensity during the first several weeks, the male gradually added components to this behavior pattern. Thus the early displays consisted of a variable number of bobs minus the crest raising and accompanying calls. The raising of the crest was the next component noted, and shortly thereafter soft "whit" notes were added.

Not only do the individual bobs tend to become more numerous, but they also increase in vigor or magnitude, so that frequently the bird actually bounces up to several inches off the ground at the peak of

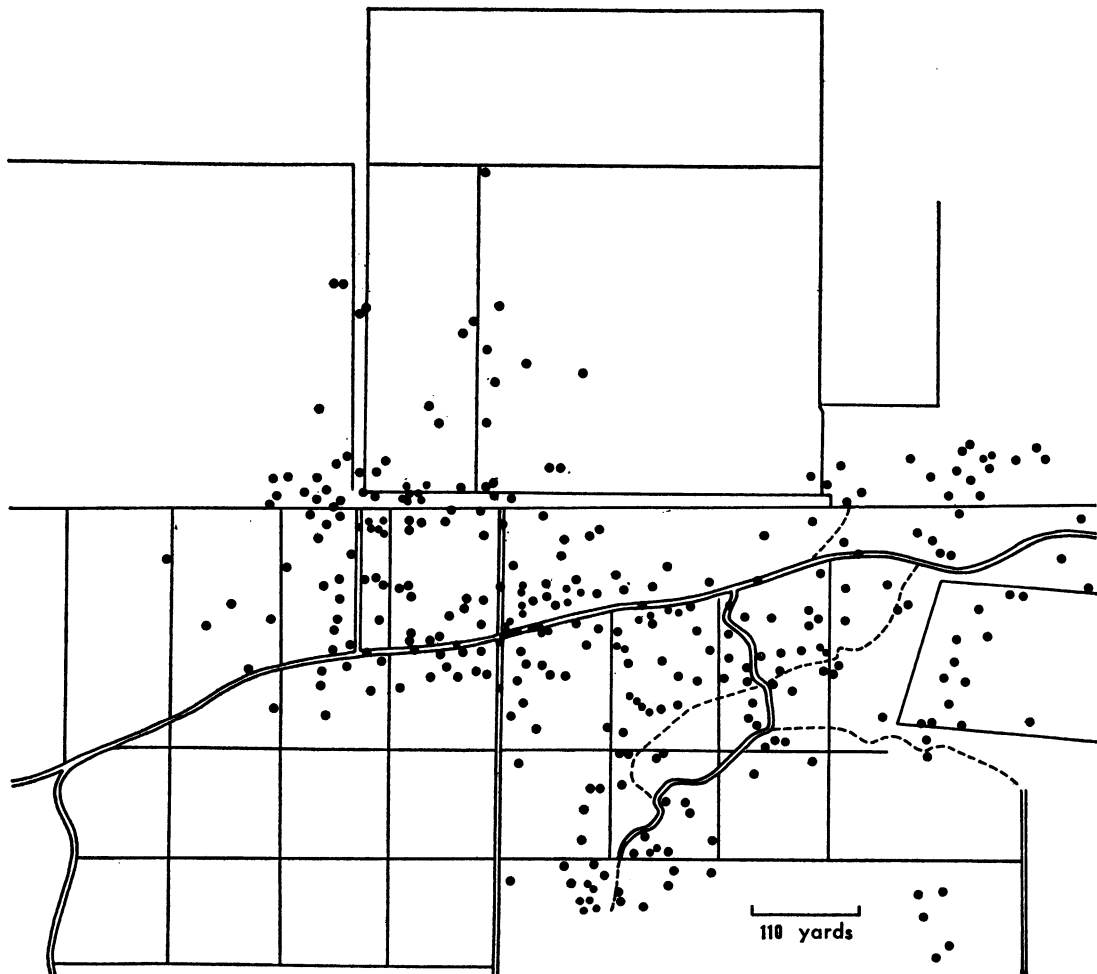


FIG. 20. Points of record of females during the course of the investigation.

each bob, and moves forward a distance of from several inches to 1 foot during the display. Bobbing displays were not always undertaken with maximum intensity at the peak of the season. Thus occasional displays lacked the "whit" sounds, and the displayer did not always leave the ground when bobbing.

We never observed a bobbing display in the females, although twice a female performed what appeared to be a single bob.

In the study area, we noted bobbing only when females were present, although Cleveland watched male 2 bob on several different occasions apparently in the absence of females. When we observed these birds, however, our field of view was usually limited, so that one or more females could have been within sight of a displaying male but not within our view. In the aviary one male often displayed to another male, and a display to one male frequently initiated a similar response by the other male.

The function of the bobbing display and the social releaser for it are not clear. It appears to be a visual stimulatory mechanism for the female. This display may function as a means of sex recognition, for it is apparently restricted to males. This display was frequently noted when two birds came together. In the aviary one or more birds were usually near the bobbing male. On one occasion in the study area, however, a male joined a female, mounted, and copulated without any indication of preliminary courtship behavior.

The behavior immediately following the bobbing display varied. No observable response attributable to the display was observed in females to which the bobbing behavior was directed. Bobbing displays commonly interrupted feeding or preening behavior that was then resumed. Sometimes the bobbing male chased the bird toward which he had displayed.

STRUTTING AND CIRCLING

A male, when ready to mount, walks up to the female and attempts to get behind her. If sufficiently motivated, she sits, permitting him to mount. If not sufficiently aroused, she turns to face the male. The male then starts to circle the female, and she keeps turning away as he circles. The posture of the male

is erect and stiff, an attitude similar to the aggressive posture assumed when two birds confront each other. His steps are shorter than the normal walking gait. While circling, the male frequently emits soft whistled notes. These notes are like those of the primary call but are more subdued.

MOUNTING AND COPULATION

Five mountings involving four males and several females were observed in the study area. Only two of these copulation attempts were consummated. In the aviary we observed 59 mountings involving two males and two females. Of these 11 terminated successfully with insemination of the female. The time involved in each mounting and copulation varied from 90 to 200 seconds, and averaged 133 seconds.

The male mounts from behind or from the side (pl. 18, fig. 2). Treading occurs only for several seconds as the male secures his balance. Thereafter, the feet are not moved. The soliciting posture of the female is a normal sitting position, except that she extends the neck upward and sometimes slightly forward. The eyes are opened widely (pl. 19, fig. 1). As soon as the male mounts, the female usually moves her head and neck from side to side in a somewhat jerky manner and often continues to do so as long as the male remains on her back.

The male, after mounting, lowers and quivers the wings. Wing quivering and wing extension are variable. Sometimes the male extends the wings so that the primaries touch the body of the female. At other times the wings may be only slightly extended downward. After a mounting has continued for a period of from 60 to 95 seconds, the female suddenly raises and lowers the tail. At approximately 10-second intervals tail raising by the female is repeated. Tail raising apparently stimulates the male, for he immediately crouches on the back of the female. In this crouched position the male convulses, and his body plumage is fluffed out as he appresses the copulatory organ against the rump of the female. Each tail raising by the female (except sometimes the first one) causes the male to crouch and ejaculate. Sometimes it appears as if the crouching of the male and the tail raising of the female occur simultane-

ously. A small patch of rump feathers of the female appear dark and matted after several ejaculations. Copulation, however, does not occur during these ejaculatory crouches on the back of the female. In fact, copulation does not occur until the male dismounts. Following a number of crouches (usually three to six, but two mountings included 14 and 15 ejaculatory crouches), the male grabs the feathers of the upper back of the female with the bill (pl. 19, fig. 2). The female immediately rises. As she does so, the male slides off immediately behind her and copulates while grasping the female at the base of the neck or upper back. During copulation (pl. 20, fig. 1) the male stands high on his toes, with wings extended downward. Tinamous are among the few families of birds that possess a well-developed copulatory organ. In *N. cinerascens* this eversible, coiled structure is inserted into the cloaca of the female after the male dismounts.

POSTCOPULATORY BEHAVIOR

Following successful copulation the male and female remain standing close together for one-half to one and one-half minutes. The female soon shakes her body feathers and begins preening. After copulation the female never faces the male directly. The male assumes a distinctive postcopulatory stance in which the body rides higher off the ground than at any other time, as a result of stiffening the legs. He stands upon the distal portions of the toes, with the rest of the foot raised well off the ground. The neck is extended. The wings are folded but held slightly away from the body. The male usually takes several slow steps toward the female and sometimes pecks at her head. The female remains submissive, turns, and walks away. The two birds then engage in postcopulatory preening.

Within minutes after a successful copulation with one of the females, a male may begin calling, and may mount the same, or another, female. Following one copulation, an aviary male mounted another female eight minutes later. We did not maintain all-day observations on the aviary birds, so that we do not know how many times in one day a captive male mounts. But a four-hour watch one morning revealed one successful copulation in

five mountings; another successful copulation in six mountings by the same male occurred in an afternoon watch of two and one-half hours on the same day. This male mounted seven times in 55 minutes one afternoon, one of which was successfully concluded.

Reverse mounting was not noted, but the intention to do so was seen once, when an aviary female strutted to a male, walked behind him, and raised one leg as if to mount. The male, however, did not sit. The female then turned away from the male and sat.

Successful copulation following a mounting was prevented in the aviary on several occasions by the approach of a second male, causing the female to rise from her sitting position and the male to dismount. Since in the natural environment breeding males seldom if ever come together, this situation probably does not arise. However, a considerable number of failures were due, not to an interfering bird, but to low sexual motivation on the part of one sex or the other. The male sometimes failed to mount, even though the soliciting behavior (sitting) of the female was the normal stimulus to do so. In this situation the male either turned and walked away from the female, or manifested agonistic behavior, striking and grabbing the back of the female. If the male did mount, he sometimes was not sufficiently stimulated to consummate with the female, so that after a short period on the female's back, he dismounted and pecked at the female.

More frequently, however, the failure to copulate was due to the low motivation of the female. The female's response to the strutting of the male depended upon the degree of sexual motivation, that is, the degree of readiness to copulate with the male. On the basis of overt behavior, I ascertained three levels of sexual motivation. If the female is not motivated when a male approaches, she walks away from him; if the male persistently follows, she turns and faces the male, and may strike out at him with her bill or give chase for a distance of several feet to several yards. At the first level of motivation, the female turns as the male circles, but neither permits him to mount nor drives him away. At the second level of sexual motivation, she sits as the male approaches or after some strutting and circling by the male. At the

third level the female herself assumes the initiative, approaches a male, and sits without any courtship behavior from the male.

We noted that there was considerable latitude in readiness even after the female sat. In the aviary a female frequently sat after precopulatory strutting and circling by the male, but then rose just before the male mounted. Or the female sat and permitted the male to mount, but rose after three to 20 seconds. Sometimes the female rose suddenly after the male had been mounted for as long as 30 to 90 seconds. Such behavior caused a variety of responses from the male. Sometimes he pecked at the rising female or chased her for a short distance, or both. Sometimes the male resumed calling within seconds after being forced to dismount by the female, and began following the same, or a different, female. If the female terminated a mounting that had continued longer than 60 seconds, we observed that the male frequently completed the copulatory pattern even after dismounting. This involved a series of ejaculatory crouches (pl. 20, fig. 2).

In the study area we recorded all five mountings in the late afternoon. However, mounting and copulation possibly occur at all hours of the day. On many occasions we observed that male and females came together in the morning, at midday, and in the afternoon. In the aviary we observed copulation in the morning as well as in the afternoon, although reproductive activity was most pronounced in the late afternoon and early evening.

The male is the more aggressive sex and usually initiates courtship behavior. Bobbing, strutting, circling, and calling are predominantly, or exclusively, male behavior patterns. Mounting sometimes takes place without the precopulatory strutting and circling. In such instances the female appears to initiate courtship activity. Without any active courtship behavior from the male, the female approaches him, turns slightly away, and sits.

In *N. cinerascens* sex recognition is primarily a vocal manifestation. The voices of the sexes are different. Breeding males probably learn one another's calls early in the spring and apparently seldom, if ever, come together in the breeding season. The females, however, move together in two's or three's or

in larger groups (five), and are attracted to the calls of the males. In the study area we noticed that when a male and female came together they did not display in any manner that would differentiate the sexes, unless the bobbing display of the male serves that function. Although this pattern (bobbing) was sometimes observed when the sexes were together, none of the few mountings observed in the study area were preceded by bobbing behavior. On one occasion Cleveland noted that a mounting took place after male 1 had called and attracted a female. Not only was no bobbing observed when male and female approached each other, but neither sex called, strutted, or circled prior to the mounting. He also noted that after this successful mounting the male walked away with the female following. The female's crest was raised; the male's was not. This distinction between the sexes was not observed in the aviary birds, and I did not notice it in the study area.

Not infrequently, one aviary male (male A) strutted and circled another male (male B) and attempted to mount, which indicated that the releasers for sex recognition are probably not highly developed. It may be that the call differences of the sexes function in maintaining the separation of reproductively active males, while attracting females to males, so that any bird approaching a calling male is likely to be a female. One would expect vocalizations to be of primary importance in species that live in areas where the vegetation prohibits distance vision. Indeed, although this species lives in semi-open country, as well as woods, the term "open" refers only to the density of trees and not to the ground vegetation, which is dense and seldom permits any vision beyond several yards except along paths and roads. Calls take on added importance, also, for species in which there are no plumage differences and in which courtship behavior is not highly developed in either sex.

BREEDING PATTERN

The mating system in *N. cinerascens* is typically polygynous. Evidence from study-area observations to support this statement is the propensity for females to move in groups, the frequency with which we noted

two or more females moving with a single male, the tendency for females to move about for a time in the area of one male, the fact that no two study-area males began nesting simultaneously (indicated by a reduction in the male's calling periods), and the contribution made by several females to the clutch of a single nest (aviary observation). Promiscuity, however, may not be uncommon. Our inconclusive evidence indicated that, among the study-area birds, females did not necessarily remain with one male until his clutch was completed but moved about with one male for only a day or two before moving on. Promiscuous behavior was noted in the aviary birds, but this, of course, was not under natural conditions.

Females tend to move together. When one female called in the study area, another, or several, usually answered nearby. Sometimes the calls indicated that the females were moving close together. At other times they were widely separated, but moving, nevertheless, in the same direction and coordinating their general movements by their calls. I kept track of a group of five calling females one morning as they slowly moved at least 540 yards across the study area, maintaining their position and movements through calling, and feeding leisurely as they walked. None of the five females seemed to be within sight of the others, and the greatest distance maintained between the first and last member of this group was, at times, 90 yards.

Frequently females did not call until they were within approximately 50 yards of a male. In the example mentioned above involving five females, however, four calls from male 2 around 7:30 A.M. were the only calls of any male heard in the study area in the morning, and these calls were rendered by a male far removed from the calling females.

These groups of two or more females were not stable. Calls indicated that group size varied. Furthermore, it seems likely that females change from one group to another, that a larger group of four or five females breaks up into two groups at times, and that small groups may consolidate. Furthermore, females sometimes moved about individually rather than in groups. We have, on occasion, heard a single female calling and have seen one male and female together. But the fact

that we found females moving together in loosely knit groups more often than not suggests polygamous behavior. Furthermore, we have seen several females with one male. Several times three females were recorded with male 1, and on one evening four females with one male.

A single female may contribute to a number of nests and mate with a number of males during the breeding season. I suspect that as many as four to seven different males and as many as 12 or more nests may be involved. It is unfortunate that the calls of the females could not be so easily differentiated from one another as the calls of the males, but the few females with distinctive call notes supplied us with valuable data. One of these females moved with at least four different males, and moved with the same males at widely separated times. Thus a female apparently mates each breeding season with different males as well as mating several times with the same male.

Females probably remain in one area, mating several times with the same group of males. Later in the season some males may no longer be available to the females, either because the males are incubating or have successfully hatched two or more clutches of eggs and no longer call. It is not unlikely that females from these areas enter and mate with males of adjoining areas. Such an occurrence was recorded on December 14: two calling females, one 20 minutes behind the other, entered the southern part of the study area, walked along the main road and entered the woods in the vicinity of male 3 and other females that were calling at the time. Both females had distinctive call notes. One of these females was later recorded near male 1 and male 7.

This explanation may account for the increase in the number of females recorded in the study area later in the investigation. No more than four females had been recorded in the study area until December 14. On the following day at least seven different females were recorded. Six were recorded on December 30, seven on January 6, five on January 9, 11 on January 10, six on January 17, and 10 on January 21, moving in three different groups (fig. 21).

During the period of egg laying, females

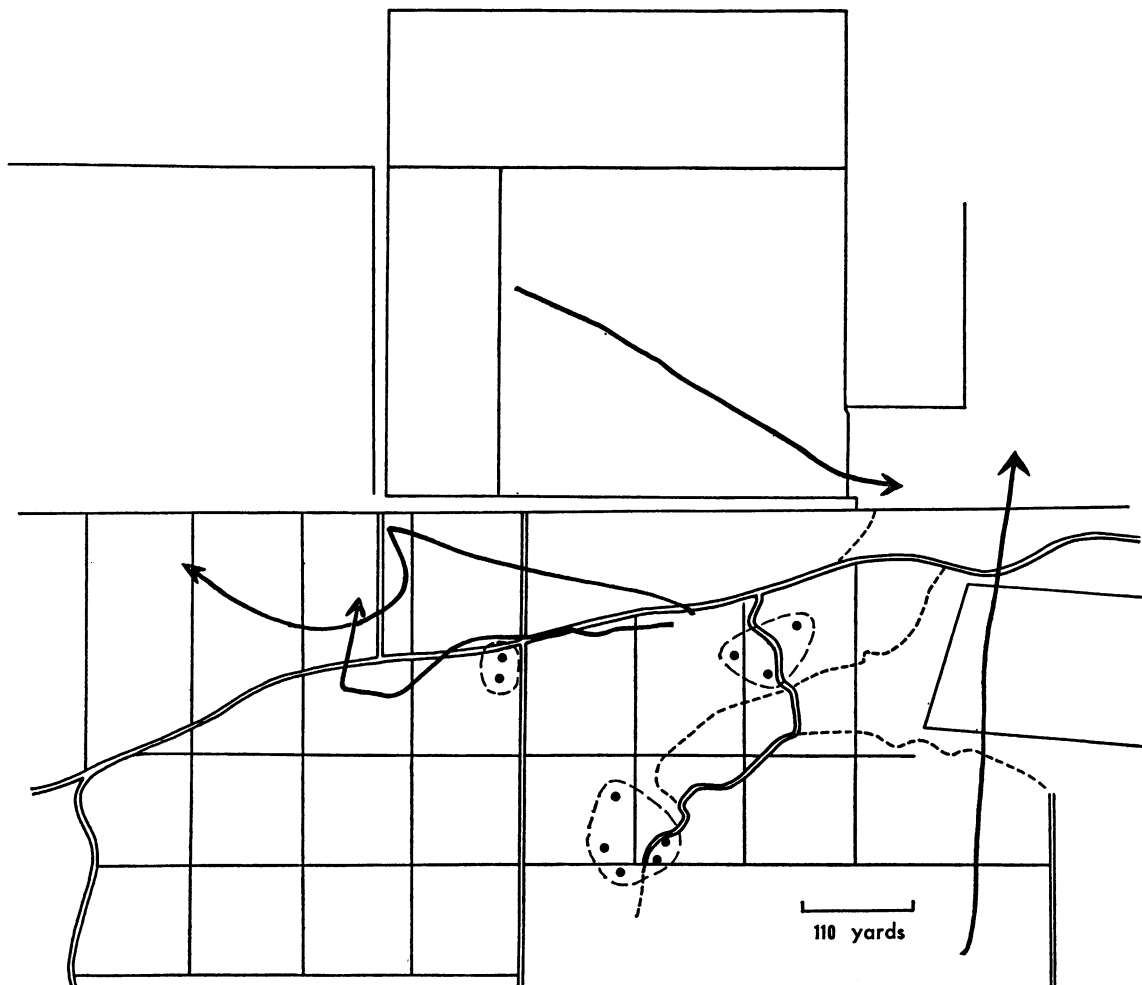


FIG. 21. Four recorded movements of single females or groups of females. Also shown are points of record of three groups of females (10 individuals) seen on January 21 within 35 minutes (1:00 to 1:35 P.M.), the second largest number of females recorded in one day.

continued to call and move in groups. But, when actually ready to lay, the female approached the nest site stealthily and quietly.

A problem remaining to be solved concerns the manner in which the male indicates to the females the location of the nest site. The aviary observations showed that the male finds and prepares the site. Here a nest site was scraped by a male on the same day that copulation was first observed. Two weeks elapsed before the commencement of egg laying. In making the nest depression, the male turned about either to the right or left and scraped the dirt behind him with each foot alternately as he turned. The body was

inclined slightly, with the breast lower. Five minutes after the male had begun to scrape a depression three females walked toward the working male and watched him. They stood only inches away. For 20 minutes the male stood, sat, and worked in this depression. After he walked away, two of the females moved into the nest depression, inspected it for some seconds, then moved off. In the two weeks that passed before the first egg was laid, two other nest sites were prepared, one of which received all the eggs.

The male, then, chooses the site and prepares it. But what mechanism is employed to communicate this site to the females? No

mechanism was detected in the aviary birds. However, the aviary is small (about 22 feet by 15 feet) and the activity of the male scraping a depression is easily detected by the females without any behavior by the male in leading the females or otherwise indicating the nest site to them. The females simply approached the male when they noted the activity in the grass. Our field evidence indicates that the communication between the sexes for the function of nest-site selection is not always efficient. For instance, twice, single eggs were found at the base of a bush in which no depression or clearing had been made (pl. 21, fig. 2). The eggs were cold, no more eggs were added, and there was no indication that the sites were visited again. On another occasion a female, moving with two other females, laid an egg in the center of the main road as she crossed it. The most logical explanations for the laying of these single eggs at unprepared sites are that the females are spontaneous ovulators and that the male with which the female had mated, if at all, had failed to communicate to the female the location of the nest.

The first mating of the year is probably the longest. As the tempo of breeding activity increases, the pair bond is probably of shorter duration as the females start laying their clutches more quickly, with less time (perhaps several days at most) elapsing between matings. Females leave the nest area soon after completing a clutch of eggs.

The pattern of activity of a male prior to incubation is not known except in the case of male 1. This male called for a considerable period on December 26 and moved west across the sorghum field into the grass field (fig. 15). He was recorded here also on December 24 but at no other time. On December 27 this male called four times between 5:30 P.M. and 5:50 P.M. His nest was discovered on December 28 at 1:10 P.M. Male 1 was sitting on the nest at the time. This nest was the only active one that we discovered. Three other sites were located, but all showed signs of predation.

NESTS

The nest of male 1 was in a relatively open area containing scattered trees and shrubs (pl. 22). Grass made up most of the

ground cover in the nest area. The nest itself was at the base of a small isolated legume (9 feet high, 2 inches in diameter) surrounded by a dense ring of woody flowering plants to a radius of 3 feet. This vegetation formed a good camouflage. The nest was lined with dead grass (pl. 21, fig. 1). Other nest sites were found at the base of a bush, in a clump of grass, and at the base of a small tree. The amount of surrounding vegetation at each of these sites varied but was sufficient to provide at least partial concealment for the unprotectively colored eggs.

EGGS

The elliptically shaped eggs of the Brushland Tinamou are dusky brown in color, with a purplish tint. They have the high glaze that typifies the eggs of the family Tinamidae. Eight eggs were found in the nest of male 1 on December 28 (pl. 21, fig. 1). Later that day a female quietly entered the nest (6:00 P.M.), completed the clutch with the laying of the ninth egg, and departed (6:08 P.M.). The size of the eggs ranged from 45.0 mm. to 50.0 mm. in length and from 37.0 mm. to 38.0 mm. in width. Average size was 47.5 mm. by 37.6 mm. We have no idea when egg laying began or how many females contributed to the nest of male 1. Two and three females were recorded with male 1 on a number of days. Castellanos (1931), Dinelli (1929), and Partridge (1953) found nests containing from eight to 10 eggs.

INCUBATION

We believe that incubation by male 1 probably began on the evening of December 27, judging on the basis of (1) the activities of male 1 prior to the discovery of his nest, (2) the completion of the clutch with the laying of the ninth egg, and (3) the hatching time of the young. If so, the duration of incubation was $19\frac{1}{2}$ days (19 days, 13-15 hours), for the hatching of the first egg took place on January 15. In an aviary at the Miguel Lillo Institute in San Miguel de Tucumán, Argentina, a clutch of seven eggs was laid in 65 hours in mid-November. Three females were probably involved. The incubation period of this clutch was 19 to 20 days.

In the study area male 1 sat close to the eggs, leaving to forage only once each day

except on January 9 and January 13. The pattern of attentiveness was set from the beginning. Each afternoon between 4:43 P.M. and 5:45 P.M. male 1 left to forage. This pattern of afternoon departure was interrupted on January 8, however, when he did not leave the nest. On January 9 male 1 departed at 10:36 A.M. after spending the preceding day on the nest. This was his first morning departure. Thereafter the pattern of attentiveness was irregular.

Weather factors were probably responsible for this change in the timing of the inattentive periods. Through January 7 the weather was clear to partly cloudy, with high temperatures and no daytime precipitation. The change in pattern of nest attentiveness coincided with the appearance of bad weather when, on the morning of January 8, high winds preceded a three-hour rain. The remainder of the day was overcast. The next five days were also overcast, with hardly a break in the clouds at any time. Light rain fell intermittently on January 9. January 10 and January 11 were the coolest days of the study period, with the temperature not exceeding 61° F. On January

10 it rained most of the morning and in the early evening. A gradual warming trend began on January 12, although it remained overcast.

The 19 periods of inattentiveness varied from a brief 43 minutes to 187 minutes (fig. 22). The average time away from the nest was 127 to 134 minutes. The male departed twice daily on January 9 and January 13, but remained at the nest on January 8 and January 15, the latter being the date on which hatching began. The attentive periods were long, ranging from five hours and six minutes (or as little as four hours, 25 minutes—see fig. 22, January 9) to 38 hours and 33 minutes, and averaging 21 hours, three to 10 minutes. Only two attentive periods were shorter than 16½ hours.

While attending the nest, the male rotated the eggs a number of times each day. Disturbances were not numerous, except for cattle that often walked within several feet of the nest.

A number of tinamous, both males and females, passed through the nest area while male 1 incubated. Some were foraging, others

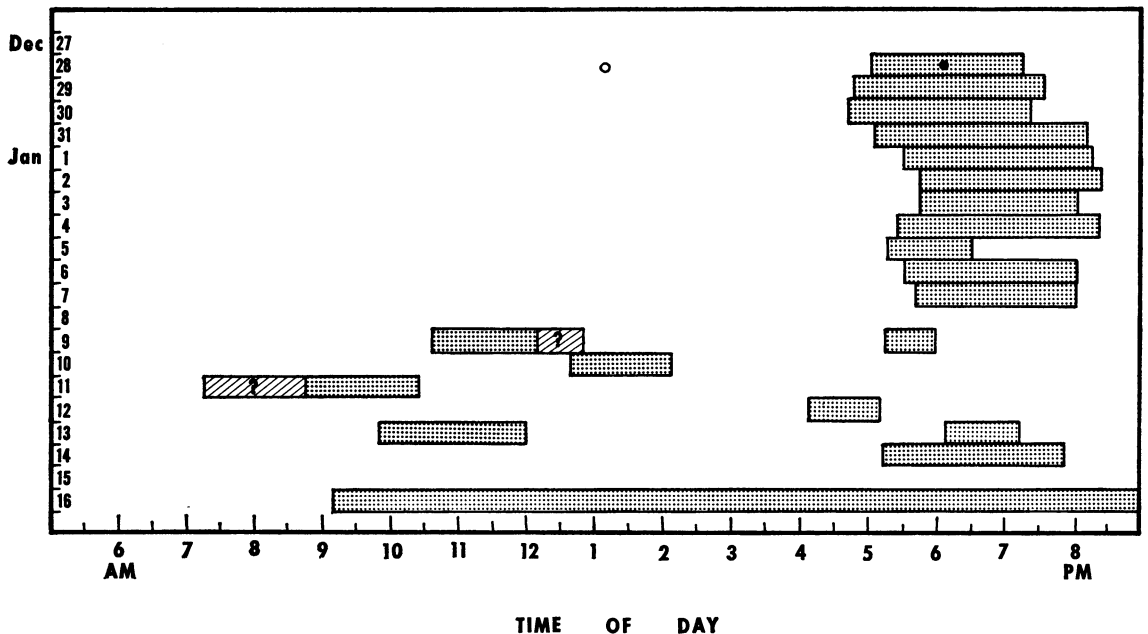


FIG. 22. Periods of inattentiveness of male 1. Open circle on December 28 represents the discovery of the nest. The solid black dot on the same day indicates the laying of the final egg. There were two short periods when the nest was not under surveillance (diagonally lined bars with question marks): a 41-minute period on January 9 and a 90-minute period on January 11.

simply walking. After the last egg was laid on the evening of December 28, only one tinamou was detected loitering in the nest area. In the early evening of December 29, a non-feeding tinamou remained for at least 25 minutes about 20 feet from the nest in the grass and near a clump of bushes. It was frightened away by a vehicle and did not return. This bird may have been a female that had laid one or more eggs in the nest and was ready to add another.

At the end of an attentive period, male 1 walked about 6 feet from the nest, looked about as he walked, stood and "assessed" his surroundings for approximately 15 to 30 seconds, then flew either to the woods or to the sorghum field. We failed to observe only one departure from the nest (January 11). Of the remaining 18 departures, the male flew to the sorghum field only four times. His flight to the field was relatively long (up to 220 yards) and low (about 15 feet). When he flew to the woods his flight was shorter (100-112 yards) but considerably higher (about 30 feet), for most of these flights were over the trees. The flights to feeding areas were notably quieter than those motivated by fear or alarm. Three times male 1 walked away from the nest instead of flying. His return to the nest after foraging was usually on foot, although several times he flew in from the sorghum field. The male usually walked to the nest with head and neck low, stopping momentarily to pick up food or to stand erect and look about for several seconds. He did not hesitate at the nest entrance, but entered it directly.

Upon leaving to forage, the male did not conceal the eggs except at the final departure before hatching. Until that time no nest concealment was detected. Only a few down feathers lay upon the eggs during each inattentive period, but their disposition seemed to be fortuitous, since most of the feathers rested between the eggs and along the margin of the nest. On January 14, however, the feathers lay directly on top of the eggs in a heap, obviously not sat upon, and clearly placed there by the male. The effect of concealment was fair, the center of the clutch being well concealed, but the margins were not well covered.

When the male was incubating, the dis-

position of the nine eggs was such that one egg was usually on top of the others. An area of eight eggs seems to be the maximum that the male is capable of covering effectively.

The movements of male 1 while inattentive remained largely unknown (fig. 17). He called on 10 of the 19 periods of inattentiveness. But the number of calls rendered on any inattentive period were few, the maximum being 10 calls on January 14. Although few, the calls were important clues as to his location. These calls, along with his movements when approaching and leaving the nest, indicated that male 1 did not feed in the same place every day. He foraged in a minimum area of 9 to 10 acres during the incubation period. Actually, his foraging movements probably covered a larger area, when the paucity of calls and the average period of time (more than two hours) away from the nest are considered.

During periods of inattentiveness, that an incubating male copulates with one or more females is a possibility. That males will call when foraging away from the nest, that the pair bond is a weak one, and that calls of females have been recorded in the proximity of inattentive males all suggest that copulation between females and incubating males is possible, if not probable. Furthermore, I observed the incubating aviary male call and copulate with a female during one of his inattentive periods, four days after incubation had begun. Males 1, 2, and 3 all called after leaving the nest. Such calls function principally in mate attraction. On December 30 male 1 called after leaving the nest. Several females in the vicinity of the male immediately responded with calls. We did not learn whether or not any of these females copulated with male 1. Again, on January 9, four females, which were scattered about in the small area in which male 1 began feeding after leaving the nest, started to call shortly after male 1 called.

HATCHING AND POST-NESTING PHASE

Hatching began in the late afternoon of January 15. On the previous day, male 1 had left to forage in the afternoon (5:12 P.M. to 7:53 P.M.) but did not leave on the day of hatching. Activity at the nest began at 5:00

P.M. and continued until dusk. Although the nest could not be viewed directly because of the surrounding vegetation, the swaying of plants some inches from the nest indicated that the chicks were moving about. Shortly after dawn, January 16, considerable activity was noted in the nest. Short spells of activity (as indicated by the movement of vegetation near the nest) were also recorded at 7:39 A.M. and 8:05 A.M. Finally, at 9:09 A.M. the male walked off the nest. Once in the open he rendered soft whining notes, one after the other, whereupon the chicks scrambled after the male. Each note of this recognition call was given on the same pitch and lasted about three-fourths of a second.

Hoping to capture several chicks, I left the blind and walked toward the departing birds when the male was about 10 feet from the nest. The male immediately turned, gave an alarm call, and ran and flew toward me, then around and behind me. As the male ran he extended and lowered one wing, then both wings, as if feigning injury. The crest was raised. He moved to within a yard of me. Finally he stood erect and walked into the grass. The display had lasted not more than 30 seconds, but that was sufficient time to allow the chicks to hide or escape. Although I searched the area carefully, I could not discover them. The alarm call that accompanied the distraction display was different from that given when an alarmed bird took flight. The series of monotonic notes were rendered about two per second; they were loud and possessed a whining quality.

Upon checking the nest after the departure of the male with the chicks, I found that most of the feathers that had been present in the nest two days previously were no longer there. The eggshells were still in the nest and were disposed in such a manner that the smaller end of each eggshell was inside the larger end.

I have no data on the activity of the male and the chicks following incubation. Male 1 returned to the nest later that morning (January 16), probably looking for his young. The following day male 1 was seen twice, probably three times. No chicks were detected. On one of these occasions the male constantly rendered the same soft, whining, recognition

calls that I heard as he left the nest with the young. But the young were not with him now. After January 17, we completely lost track of male 1 and did not succeed in locating the chicks. For male 1 we recorded no primary calls between nest abandonment (January 16) and our departure from the area (January 23). Only once did we see any chicks other than those of male 1. These were accompanying an adult across a road outside the study area.

NESTINGS OF THE STUDY-AREA MALES

Since only one nest was discovered, we can do no more than speculate on the number of study-area males that nested while we were there. Our daily observations indicate that calling falls off sharply during nesting. At this time a male calls only when off the nest. Even when inattentive, males do not call frequently, sometimes not at all.

Male 1 probably incubated two clutches of eggs from mid-November through January. His first nesting probably began on or about November 30 and continued until approximately December 18. Prior to the beginning of incubation his extensive movements were accompanied by lengthy calling periods. Thereafter, he called infrequently. Only once (December 4) during the first nesting did we discover females in the immediate vicinity of male 1. Again, the tempo of calling increased after December 18. After an interval of nine days male 1 started incubating another clutch, probably on December 27.

Male 2 also probably nested twice during the period of our study. Calling first fell off sharply after December 6. One or more females had been seen with male 2 almost every day from November 22 to December 7. Incubation may have begun on December 6 or 7, or shortly thereafter. Until December 22 calling was infrequent and almost entirely confined to the late afternoon. During this period we recorded no calls of this male for five consecutive days. Nor were any females recorded with or near male 2. Several times in the late afternoon during these middle weeks in December we observed male 2 moving toward the woods along the path that separated the sorghum and cactus fields, calling as he walked. We observed him again later in

the evening as he walked west along the same road back into the fields. These observations indicated that he was nesting in one of the fields or along one of the fence rows.

Calling increased (male 2) after December 22. One or more females moved with male 2 on five days between December 23 and December 30. Around the first of January, male 2 probably began a second incubation period, for calling was more sporadic and no females were heard or observed near this male until January 17. Calling became heavy on January 19. Until we left the study area (January 23), male 2 called and moved extensively.

Male 3 probably nested once between mid-November and the end of January. More or less heavy calling occurred until December 13, then fell off until January 10. I recorded no morning calling between December 16 and January 8. And male 3 was silent on some of these afternoons. During this period male 3's primary calls were softer and shorter, often containing only five notes. No females were observed with male 3 between December 14 and January 10.

Male 7 probably nested once. Except for several calls on the afternoon of December 22, this male remained silent and undetected from December 16 through January 6.

Males 4, 5, and 6 were recorded within the

study area only a few times, but their calls were heard and recorded throughout the study period. Each of these males underwent one lengthy period of nearly total silence.

The four regular study-area males probably nested six times from the end of November to mid-January. Some nesting may have taken place in October or early November. Reproductive activity began in September in the aviary in San Miguel de Tucumán, although copulations did not take place until the latter part of October, and the first eggs were not laid until November 9. We left the La Cocha study area before the end of the breeding season. Male 1 had ceased calling, perhaps for the rest of the season. But males 2, 3, and 7 were all calling rather heavily. According to Mr. Lange, our host, calling continued until mid-April. Some of these males undoubtedly nested again. Some late-calling tinamous may have been year-old birds that completed gonadal development rather late in the season. March 27, when we visited the study area for several hours, I heard a male that I had not heard during our residence.

No data are available on the sex ratio of this species, but, on the basis of daily observations of the relative numbers of males and females throughout this investigation, there is no evidence of an unbalanced ratio.

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