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SUMMER ECOLOGY OF THE LARK BUNTING

PAWNEE SITE

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GRASSLANDS BIOME

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SECTION I: NEST SITE REQUIREMENTS

INTRODUCTION

The selection of a nesting site by birds is described by Tinbergen (1939) and Burns (Pettingill 1964) as instinctive behavior. Tinbergen refers to it as maturing instinctive behavior as a result of selection tours terminating in final selection. Burns termed the selection of a nest site an instinctive impulse in an orderly sequence of mating behavior. The selection proper may come only after a prolonged period of incipient nesting or "scrape making" as it is called by Nethersole-Thompson (1943) and described by Jehl (1968) and Coutlee (1968). Lorenz (1965) believes that these behavior patterns can be changed through learning. These changes in the "genetic blueprint" are possible, due to a certain amount of openness in these patterns. The term openness means that these responses can be changed as a result of learning.

Protection from predators and the elements is thought to have a bearing on the final site selection. The ruffed grouse builds its nest so as to get maximum protection from intruders. Edminster's (1947) study shows that the grouse utilizes a stump or tree for protection of the back side of its nest and relies on a clear view of the rest of the surrounding terrain for protection from other sides.

In the selection of their nest sites, birds appear to choose sites that apparently afford them protection from the elements. The weather tends to restrict or at least influence the nest site in many birds (Nethersole-Thompson 1943). Horvath (1964) tells of the rufous hummingbird changing its nest location at different times of the nesting season to take advantage of the evapotranspiration of deciduous trees in the summer to cool the nest. The physical characteristics of the plant providing the protective substrate for the nest may be the factors influential in location of a nest, as Beecher (1942) and Wiens (1966) have stated.

Nest site selection of the lark bunting (*Calamospiza melanocorys* Stejneger) is examined in this paper. The problem is to determine what factors the bird is responding to when it selects a site for its nest. The procedure is to examine each situation where a nest is found. Vegetation has been sampled to determine if a correlation exists between site selection and height of associated plant species or a type of plant. Location of the nest in relation to its immediate cover is scrutinized in an attempt to find any effect of weather (wind) on nest placement. Nest success in the different stand classes will be examined to determine trends that may exist between nest success and type of stand.

Lark buntings arrive in Colorado in mid-April, according to Baumgarten (1968), and courtship behavior occurs while the birds are still in flocks (Langdon 1933). Nests are located on the ground, usually under sagebrush (*Artemisia*) in Montana, according to Woolfolk (1945). Both sexes are reported to share in incubation chores (Baumgarten 1968), but this is discounted by others (Langdon 1933 and Roberts 1932). The return to the wintering grounds following the nesting season in northern Colorado begins in late July and continues on into August (Bailey and Niedrach 1965).

STUDY AREA

The study was conducted in the Pawnee National Grasslands, located on the high plains of north central Colorado approximately 30 miles east of the

Rocky Mountain Front Range. Ten study plots were located on and around the Central Plains Experimental Range, which is situated in the northeast corner of the national grasslands.

The Central Plains Experimental Range receives an average annual precipitation of 12 inches with 8 1/3 inches of this amount coming in the summer months from April to September (Bement 1969). The mean high monthly summer temperature ranges from 62°F in May to 76°F in August. The hottest month during the summer is July, which has a mean daily temperature of 82°F. Winds are predominantly from the northwest.

The 10 study plots, ranging in size from a quarter section to one full section, have varying amounts of browse type vegetation in them. Browse type vegetation includes the woody plants, saltbrush (*Atriplex canescens*) and rabbit brush (*Chrysothamnus nauseosus*), cactus (*Opuntia polyacantha*), yucca (*Yucca glauca*) and umbrella plant (*Eriogonum effusum*). The plots were divided into three groups according to the relative frequencies of browse vegetation present (see Table 1). The first group was designated Class I (0.01 to 0.05 relative browse frequency). The second group was called Class II with little browse (0.05 to 0.12 relative browse frequency), and the third was Class III (0.12 to 0.25 relative browse frequency).

The terrain is rolling, with a few cottonwood trees (*Populus* sp.) in areas 1 and 2. All but three of the plots have water sources within their borders. These water sources include windmill tanks and a lake. The areas are used for controlled grazing experiments.

The avifauna observed during the summer of 1968 on the Pawnee Site included members of 17 families. The fringillids and one member of the alaudids were the two groups most often seen. The first of these families (Fringillidae) was represented by the lark bunting, the chestnut-collared longspur (*Calcarius ornatus*), the McCown's longspur (*Rhynchophanes mccownii*) and other sparrows; and the second family (Alaudidae) was represented by the horned lark (*Eremophila alpestris*). The larger, more conspicuous birds of prey included the golden eagle (*Aquila chrysaetos*), marsh hawk (*Circus cyaneus*), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), sparrow hawk (*Falco sparverius*), and prairie falcon (*Falco mexicanus*). Other birds seen included the eastern and western kingbirds (*Tyrannus tyrannus* and *T. verticalis*), the loggerhead shrike (*Lanius ludovicianus*), and the burrowing and short-eared owls (*Speotyto cunicularia* and *Asio flammeus*), among others.

MATERIALS AND METHODS

The vegetation was sampled to distinguish differences in vegetation among the different plots that had been selected. The dominant plants, i.e., those most conspicuous, were the plants used to set up a division among the stands.

The quadrat used in the sampling of the vegetation was 16 inches square. The 25 quadrats used in each stand were placed randomly by selection of points from a random numbers table. A plant's presence was recorded for each quadrat in which it appeared, and a frequency value was calculated for each species of plant in each plot. The plant names are based on Harrington (1954).

Roadside lark bunting counts were made from a car before and after the nesting period to determine general population trends during these early and late periods. These counts were made along a predetermined route through the study area; the number of birds seen per mile was recorded.

Lark buntings were censused periodically during the nesting period in each of the 10 plots. A modified strip census method was used in taking these censuses. Each strip was 200 yards wide and varied from one to two miles in length. Birds perched on fences were not included in the count because four of the areas do not have fences and a bias in numbers of birds would have been introduced in favor of those stands with fences if fence-perched birds had been counted. The censuses probably gave underestimates, since birds on the fences probably were drawn from areas censused as well as from areas not being censused. The distance from bird to observer was recorded in paces (one pace equalled 2.6 ft) for each bird when flushed. Sex, age as adult or juvenile, and data as to whether the bird was seen or heard first also were recorded. A t-test was used to test the significance in differences found in mean flushing distances of the adult males and females.

A nest survey was taken for each study plot, and information on vegetation at each nest site was recorded. A 100-ft rope was attached to a stake at the center of each quadrat used for the vegetative counts. The rope then was dragged in a circle around the point of attachment. This procedure was repeated 25 times for each study plot. Weights were not used on the rope, but care was taken to keep the rope on the ground. When the rope passed over a nest, the bird in attendance flushed. A search along the rope usually revealed the nest.

When a nest was located, it was marked with engineer's flagging at a distance of one to three feet, and the location was indicated on a map. Height of plants associated with the nest was measured and recorded. The sex of the bird flushed from the nest and the number of eggs or young were recorded. Eighteen of the 37 nests found in 1968 were located by this method; the other nests were found while taking bird censuses.

Most of the nests were revisited periodically, and the progress of each nest was recorded along with sex and behavior of the bird flushed. A record of the hatching success of each nest was made in an attempt to discover any appreciable difference in the suitability of the three types of plots.

RESULTS

Roadside lark bunting counts were made in May 1968 with the first count on May 5. Birds seen per mile averaged 6.5. The largest flock observed was made up of 22 birds. One week later, an average of 21 birds per mile was recorded. One flock of more than 100 birds was seen in a roadside sunflower (*Helianthus annuus*) patch. On May 18, a third roadside count was taken, and the average number of birds seen per mile had increased to almost 26. The one large flock (approximately 100 birds) seen on this last count was approximately 30% female, indicating that pairing would soon occur. An inspection along roadsides June 2 indicated that the flocks were breaking up, and that the lark buntings were moving into the fields.

Bird censuses were taken on 16 different days from June 23 to August 13 on the 10 plots, in addition to the road counts before and after these dates. All the birds had arrived by the time of the first stand census. The first birds arrived during the first four days in May 1968. The first plot census (Plots 1 and 2) showed 31% of birds flushed to be females. The female birds became less conspicuous in the census counts during the rest of the summer.

The birds often were seen feeding as individuals, apparently on ants on ground devoid of vegetation. These barren spots probably were due to ant colonies in the ground beneath them. Flocks of lark buntings were observed feeding in the taller grass areas throughout the months of June and July and in the first part of August.

By July 22, flocks of 20 to 50 birds were gathering on fence rows. The number of adult males observed in the population had decreased. Some of this decrease may be due to the investigators' inability to distinguish male from female readily after the postnuptial molt. The postnuptial molt begins in late July and is completed usually by August (Roberts 1932). On July 29, the grass stands had been almost abandoned. Large flocks appeared again on some of the different grass stands (Class II) on August 3.

Forty-nine percent of the nests were located in the Class III areas, 39% in the Class II areas, and 12% in the Class I areas. The nest densities in the three classes of areas were Class I (0.06 nests per acre), Class II (0.10 nests per acre), and Class III (0.125 nests per acre).

A plant was found in close association with each of these nests, the nest being located under this plant. In this paper, the plant is referred to as the associated or protective plant. Other plants, such as smaller grasses and sedges, surrounded the nest, but the nest and these grasses and sedges were shaded by the associated plant. The eight species of plants found to be associated with the nest of the lark bunting on the study area are listed in Table 2. These eight species included four browse, two grass and two annual forb species (Table 4). The lark bunting nest was associated with saltbrush most often, as approximately one-half the nests were found to be shaded with saltbrush. Twenty-nine percent of the nests were found adjacent to other browse plants. Saltbrush, rabbit brush and umbrella plant were recorded much more often than the prickly pear cactus. Altogether, browse plants were associated with the nests approximately three-fourths of the time.

Of the two grasses found in the role of associated plants, the red three-awn (*Aristida longiseta*) was located next to the lark bunting nest much more often than the blue grama (*Bouteloua gracilis*). The two grasses were associated with 16% of the nests.

Plants in the annual forb group were protecting the nest in only 8% of the cases. Yellow sweet clover (*Melilotus officinalis*) was found at two of 37 nests, while the scurf pea (*Psoralea tenuiflora*), a perennial included in this group because of its similar form, was found once.

Nests were associated most often with plants from 6 to 11 inches in height as is shown in Fig. 1. Seventy-eight percent of the 37 nests were associated with this range of height.

The nests generally were located on the east side of the associated plant. Thirty-two of the 37 nests were situated in this way. The orientation of each nest in relation to its protective plant is indicated in Table 2.

The nests were cup-shaped and placed in a depression in the ground. Nests were found both with and without the rim extending above the level of the ground. The lining consisted in most cases of very fine grass strands. A few nests were found to be lined with hair, probably of horses.

The hatch success, i.e., percent of eggs laid that hatched, in the Class III plots (74%) tended to be somewhat higher than in the Class II areas (58%). The success, however, in the Class I plots was 92%. Additional data are needed before correlations between success and stand type can be made.

Both males and females were observed incubating the eggs and brooding the young nestlings, although the females appeared to spend a much greater amount of time on the nest. Females were flushed from the nest more often than males.

The nestling period, from hatching to evacuation of nest, was found to be eight or nine days in the lark bunting (Table 3). This nestling period approximates that in similar birds. The nestlings of the lark bunting were unable to fly when they first left the nest; the flight feathers still were partly enclosed in the feather sheaths.

The sexes of the lark bunting exhibited different flushing behavior when the nest was approached. The mean flushing distance, i.e., distance from observer to nest at the moment the bird left, of the male lark bunting (11.05 ft ± 3.9 SD) was significantly larger than the mean flushing distance of the female (4.7 ft ± 1.36 SD).

Upon leaving the nest when disturbed, the male invariably flew a short distance and perched on a plant or on the ground. He repeated this action if pursued. The female when disturbed, however, usually walked four to five feet from the nest. She then tried to distract the intruder by dragging both wings and running a short distance. If followed, she again ran with wings dragging and continued these short bursts of running until about 30 to 40 paces away from the nest; then she flew to a safe distance. Once, a male reacted similarly to a female when flushed.

Wind data obtained from the Agriculture Research Service for the year 1959 show a predominantly northwest wind. This is the only information available on wind direction for the immediate area. Wind velocity data were available also for the summer of 1968 (Bement and Hyder 1969). The average wind velocity for the summer months (May to August) was 5.8 mph.

DISCUSSION

The lark bunting nest was associated most often with saltbrush, a browse species which averaged 8.9 inches in height. Saltbrush is a short, brushy plant that probably provides more shade than other plants in the study area. Several jackrabbits, both whitetail (*Lepus townsendii*) and blacktail (*Lepus californicus*), were flushed during the day from under the saltbrush, where they apparently were sheltered from the hot sun.

Other browse species associated with lark bunting nests were rabbit brush and umbrella plant which provide less shade, but still provide more than the fourth browse species, prickly pear cactus. Woolfolk (1945) and Cary in 1902 (Baumgarten 1968) reported nests located under sagebrush.

Other plants associated with lark bunting nests included two grasses and two annual forbs. The taller grass was found associated with the lark bunting nest more often than the shorter grass, and it probably provides more shade than the shorter grass. Other authors have reported a variety of protective plants (Baumgarten 1968). Other plants mentioned included tumble weed (*Cycloloma atriplicifolium*), acacia and two crop plants, corn and alfalfa.

Physical characteristics of the associated plant probably are important in the nest site selection, as Horvath (1964) and Edminster (1947) have indicated.

Characteristics that might serve as stimuli for the selection of a nest site may include: height of associated plant, type of plant, mass or area of associated plant, or space available at base of associated plant.

Height appears to be an important factor in nest site selection. The height, however, does not remain the same in all of the associated plants throughout the nesting cycle. The initial response to a particular height (for selection of a nest site) would have little to do with any protection afforded later in the nesting period, if the height changed appreciably during this period of time.

The type of plant used most often for nest association is the browse species. These plants, with the exception of the prickly pear cactus, are bushy. Browse species, with the exception of umbrella plant, show little change in height throughout the nesting cycle of the lark bunting.

The mass of the associated plants changes throughout the period in which the nests are active. Change in mass, or bushiness, is due primarily to leaf growth in the woody plants and stem and leaf growth in the herbaceous plants.

The remaining possible stimulus then is the availability of space at base of plant for the nest, so that the nest may be protected by an overhang of the associated plant.

The lark bunting may have nest location requirements similar to those of the ruffed grouse, as described by Edminster (1947); namely a clear field of vision in one direction, while other approaches to the nest are blocked by the associated plant. Both plot Classes II and III would provide this open field of vision. The overall taller characteristic of the vegetation in the Class I plot probably would not allow a clear vision of more than a few feet.

The more frequent "use" of the saltbrush may result from the better protection afforded on the side where the associated plant is located. The other protective plants associated with nests less often may afford less protection. The nest density is higher in Class II and III plots than in the Class I plots, as one would expect when considering the requirement for a clear field of vision.

The bushier nature of the browse plants, except for the cactus, allows also for more effective concealment of the nest than the long stalked form of the annual forb group of protective plants. The clumped base of the grass protective plants also provides more concealment than the annual forb plants.

Apparent adaptations made to selective pressures against ground nesting indicated that concealment of the nest must play a large part in choice of the nest site. This is evidenced by the quick flushing of the male and the relatively short nesting period as compared to nesting periods of bush- and tree-nesting birds.

The flushing distance of the conspicuous male lark bunting is greater than that of the inconspicuous female, both on and off the nest. This is seen as an adaptation either to self-preservation or to insure safety of the nest. The selection pressure against the highly visible male has produced modifications in its flushing and subsequent behavior. The male flies away from the immediate vicinity of the nest before attempting any distraction behavior. Association of the nest with saltbrush may allow the male lark bunting to share the nesting chores (incubation and brooding) with the female. The associated saltbrush shades the nest, so that the black color of the male is not as easily seen on the nest as it would be without shade.

The entire nesting cycle of the lark bunting is completed relatively quickly. The incubation period was reported by Cameron in 1908 (Baumgarten 1968) to be 12 days. Allowing three to seven days (one egg laid per day) for laying of the eggs and eight to nine days as has been found for the nestling period, the nesting cycle can be completed in 23 to 28 days.

The short time spent by lark bunting nestlings on the ground nest as compared to longer periods with bush and tree nesting passerines (10 to 19 days) (Baldwin 1968, Erickson 1968, Spiers 1968, Sprunt 1968, Woods 1968) indicates that the ground at best is a poor site for nesting. The early departure of young is interpreted as an adaptation to relatively high predation pressure at the ground nest.

Note on predation by Phillip Creighton:

The major nest predator is, most likely, the 13-line ground squirrel (*Spermophilus tridecemlineatus*). These mammals may have followed scent trails to the nests which were under observation; therefore, the effects of daily visits to the nests on the rate of predation is not known. To counter the theory that mammal predators were following a human scent trail to the nest, naphthalene flakes were scattered on the path of approach and in a circle around the nest. The nests which were treated in this way were not preyed upon, although nests not treated, in the same general areas, were. Snap traps were set as false nests which also were visited daily. In four unbaited traps which were set, three ground squirrels were caught in two days.

Ground nesters need maximal protection for the short time during which the young are growing rapidly in the nest. The factors present at a potential nest site that determine its choice by the lark bunting probably will change but slightly in the short period of nest occupancy following the site selection.

SUMMARY

Through investigation of the characteristics of the vegetation at the nest site, some of the characteristics of nest site selection have been shown for the lark bunting for the shortgrass plains. In this environment, a protective plant is found by each nest. Saltbrush is "used" more often in this plant and nest association than any other plant. It is associated nearly as much as all the rest of the plants together, apparently because of greater protective value afforded by its generally dense foliage and the resulting shade and concealment. Browse type vegetation is associated with the nest in a protective role more often than grass and the annual forb types. The birds' nests are associated most often with plants from 6 to 11 inches in height.

The placement of nests on the lee side of the protective plant reduces impact of the physical environment.

Nest densities were highest in the Class III areas (bush and grass). The Class III areas were followed by Class II (shortgrass), and finally by Class I areas (generally taller vegetation). The nest densities were 0.125, 0.10, and 0.06 birds per acre.

The young spend less time (eight to nine days) on the nest than do comparable bush- and tree-nesting passerines (10 to 19 days). This is indicative of the relative insecurity of nests on the ground, as compared with nests located above the ground.

Shading of the nest by an associated plant allows the highly visible, darkly-colored male to participate to considerable extent in the nesting activities. The male was found to share incubation and brooding with the female.

SECTION II: LAYING, NEST CARE, AND FEEDING HABITS

INTRODUCTION

The lark bunting (*Calamospiza melanocorys*) is one of the principal avian consumers during the summer on the plains of north central Colorado. Because this species feeds on both seeds and insects, it has a major role as both a primary and secondary consumer in the food chain of the grassland community. The lark bunting was chosen for study because of this influence in the food chain of the grasslands, and adequate data could be obtained on its principal foods.

Although important studies of the feeding ecology of other finches have been made in the field by Newton (1957) and in the laboratory by Kendeigh (1963), little work has been done specifically on the lark bunting. A small amount of published data is available on the foods eaten by lark buntings, for example, by Henderson (1927), Knowlton (1947), Cohen and Rever (1966), and Anderson and Anderson (1963). The purpose of this study is to gather data concerning the feeding ecology of the lark bunting and the role it plays as a consumer in the grassland ecosystem.

Lark buntings are migratory, being resident for about five months in north central Colorado. Flocks arrive during late April and early May, and depart by late September. In Colorado, lark buntings reside predominantly in the shortgrass prairie east of the Rocky Mountains, although Bailey and Niedrach (1965) reported sightings in mountain meadows to about 9,000 ft. For the purpose of this study, only the birds that are resident at the Central Plains Experimental Range have been considered.

PROCEDURES

The arrival date of the lark buntings at the CPER was determined by visits to the study area in late April and by coordination of sightings of lark buntings by other observers near the study area. The length of occupancy was determined by daily visits to the site until late September, when lark buntings no longer were seen. During these daily visits by car and on foot, observations were recorded concerning concentrations of lark buntings and the vegetation most often frequented.

Determination of breeding density was attempted initially by censusing displaying males, but this was abandoned when it was decided that all displaying males were not necessarily mated, and that mated males seldom displayed. A more satisfactory method was a concentration upon the location of active nests within a specific area; this was accomplished by following females returning to the area of their nests. When returning, the females usually gave a characteristic "chittering call," that was easily recognized.

After a nest was located, attempts were made to mist net, color-mark and band the adult pair. To do this, an eight-foot segment of mist net was attached to two aluminum poles, each 15 ft long. Because the flushing distance of the adults was usually less than 15 ft, it was possible to entangle the adults on the nest by carefully placing the net over that area. The males were dyed on the white shoulder patches, and the females marked on the breast and on the buffy shoulders, both according to color schemes based on the half-section in which their nest was found. If these marked birds were then sighted away from the nest, it was possible to identify them as to the area from which they came, and to determine the distance from that area.

To learn the foods utilized by the lark buntings, approximately 10 birds were collected by shotgun each week from the last of April to the middle of September. Efforts were made to collect five birds of each sex, but this was not always possible due to sexual differences in seasonal arrival and departure times. After each specimen was shot, 3/4 cc of 75% ethyl alcohol was placed in the digestive tract, via the mouth, to slow bacterial and digestive action. The collected birds were frozen until ready for analysis of the stomach contents, reproductive condition, and body fat.

To obtain food samples from the nestlings, four methods were used with varying success:

1. Stomach pump. This method involved placing a neoprene tube, fitted to a syringe filled with one milliliter of distilled water, down the throat of a nestling. The water was discharged and the sample withdrawn.

2. Pipe-cleaner collars. This consisted of knotting pipe-cleaners around the necks of the nestlings, preventing them from swallowing the food samples. Initially the collars were used *au naturel*, but later the collars were dyed brown, the more closely to match the nestlings' coloration.

3. Thread collars. Number 3 white thread was knotted around the nestlings' necks until samples were obtained.

4. Artificial nestling. A model was fashioned out of a four-dram vial and substituted for a live nestling in the nest. The live nestling was fed while the artificial "gape" was in the nest, and returned after the sampling period.

After the samples were obtained from the nestlings, the food was placed in a vial with five milliliters of 75% alcohol until analysis.

Qualitative observations were made on the feeding behavior of the adult birds by following them as they fed, and observing areas where they were feeding. The marking of the individual adults from the nests, with colors visible in the field, greatly eased the problem of following the birds. Apparent sexual differences in feeding behavior were noted, although no quantitative feeding behavior data were gathered.

Whenever possible, the behavior of the birds was described for synthesis into an ethogram for the species. In addition to the feeding behavior observations, primary observations concerning the breeding and the nesting behavior of the adult were made.

All birds were banded with Department of Interior bands. Nestlings were banded in the nests and, when possible, the adults were captured and banded, using the procedure outlined above. Five mist nets were used in August to capture lark buntings and other grassland birds. All birds were marked with white plastic leg bands for easy identification. Clover-leaf and Sherman live traps also were tried, but with less success.

STUDY AREA

The study areas were located on the Central Plains Experimental Range on the Pawnee National Grasslands, principally in Range 66 West and Township 10 North. The area is seven miles north of Nunn, Colorado, in Weld County. Concentrated attention was placed on Sections 22, 23, and 24, which are characterized by representative shortgrass prairie. All collecting also was done within the confines of the Pawnee Site.

LAYING AND HATCHING

Lark buntings were first sighted on the study area on May 1, 1969. This and other early flocks were predominantly males, although a female was collected on May 4. Also on May 4, some individual males were seen separate from the flocks. These males were observed giving flight-songs and singing from shrubs and fences.

By May 9, most of the lark buntings observed were seen individually, and only an occasional large flock was seen. By May 30, flocks of males were not seen, although females were seen in small flocks until June 5. Reproductive status and bird condition are shown in Fig. 2-5.

The average number of eggs laid in the 43 nests that were found was 3.58 eggs (Table 5). These numbers ranged from one to five eggs. One egg was laid per day, except in one case when one egg was laid in the early morning and another in the late afternoon on the same day. The incubation period of the lark bunting is 12 days, with ranges from 10 to 14 days. In the 43 nests, 154 eggs were laid; of these, 96 (64.94%) hatched, 39 (25.32%) were taken by predators, and 15 eggs (9.74%) did not hatch.

The length of a wing feather, the first primary, was measured as a way of standardizing a growth curve. After the second day from hatching, the length increased by approximately four millimeters per day. The young were ready to leave the nest 8 to 10 days after hatching, or when the first primary measured 24 mm. In the 43 nests, 59 birds were fledged and were to leave the nest. Based on this figure, the fledgling success was 38.31% of the total number of eggs laid. The first young fully capable of flight was seen and collected June 20.

NESTLING FEEDING

Food samples were taken from the nestlings two or three days after hatching at the earliest, so as not to endanger the young. The method first tried to obtain nestling food samples was that of the stomach-pump as described in Procedures. Although the stomach-pump method was been shown successful for nestlings of larger species by Browning (1959), the small size of the lark bunting nestlings restricts usefulness of the stomach pump.

The second procedure tried was the use of pipe-cleaners as collars on the necks of the young. Although the cleaners were difficult to tighten, and the knot often caught folds of loose skin on the necks of the nestlings, satisfactory samples were obtained. The major reason for not continuing their use was that the adults would remove the nestlings with the collars from the nest, presumably as fecal sacs. On two occasions the adults were observed carrying the young off by the white pipe-cleaner.

The third procedure was the use of thread collars. This was the most successful method of obtaining food from the young. The knot could be tightened easily, the small size of the thread made it inconspicuous, and the knot could be tied and the thread removed without wrenching the necks of the young.

The fourth method, that of the artificial nestling, also promises to be successful. The only difficulty was that it was necessary to remove and feed a nestling while the artificial "gape" was substituted in the nest. Thus observations of the nest could not be made while the "gape" was being fed.

With the four above methods, 50 samples were obtained with no observed ill effects to any of the nestlings (Table 6). Fifty animal food items and no plant food items were recovered from nestlings at different nests. Grasshoppers, with mean length of 13 mm constituted 84% of the prey fed to young; the remainder were Diptera, Odonata, and Coleoptera.

For the majority of times observed, the adults obtained food for the nestlings near the nest-site, i.e., within a 15-ft radius of the nest. The bird which fed the young then would stay on the nest until relieved by its mate. For a timed period of two hours and 9 1/2 minutes of the birds' nest attention activities, the male was on the nest for a total of 65.5 minutes (50.7%), the female for 48.5 minutes (37.5%), and the nest was unattended for 15.5 minutes (11.8%). The nest contained, during this timed period, four nestlings two days old.

When an adult left the nest, it usually flew some distance away before landing. For the birds that were color-marked, these distances measured approximately 100 yards to one-fourth mile away from the nest area. After feeding, usually with several other lark buntings, the adult would return to the nest area, fly over the nest while giving the "chittering call," and land 10 to 15 ft from the nest. It then would make its way on the ground or by short flights to the nest. The adult which had been on the nest would leave when the chittering call was being given. Females were flushed from the nest 79 times at an average distance of 6.0 feet. Males were flushed 34 times at an average distance of 6.4 ft. When leaving the nest, occasionally both adults would give a "broken-wing" display, although the display of the female was more exaggerated than that of the male.

There is an apparent difference in feeding methods of the male and female lark bunting. The female moves more rapidly, covering more ground in a direct path, while the male forages in one place and moves forward slowly. The female often "hawks" flying insects, while the male seldom was seen trying to catch an insect in the air. Although the times of feeding per unit area were not measured, differences of food procurement surely do exist. Both adults continued feeding the young after they had left the nest.

By censusing specific areas frequently, it was possible to find most of the active nests in that area. Primary attention to nest densities was placed in the southwest part of Section 24. In an area of 75 yards x 880 yards of 13.6 acres, 10 active lark bunting nests were found. This is a density of 1.36 acres/nest or 0.74 nests/acre. Nests were found as close as 35 ft from each other, and one lark bunting nest was only 15 ft from a western meadowlark's nest. Once a male mated, no overt territory defense was observed.

ADULT FEEDING HABITS

Results on adult feeding habits are based on weekly collections of lark buntings and associated environmental data during the summer of 1969. During the first eight weeks (May and June) feeding relationships were as indicated in Tables 7, 8, 9, and 10.

In addition to the insect families shown in the tables, 22 other families of insects and spiders were utilized as prey. Assuming that the remains present in the stomach reveal the food eaten in one meal, the lark buntings ate 12.9 insects per meal (3.5 weevils, 3.4 ants, 1.7 grasshoppers, 0.9 scarab beetles, and 3.4 invertebrates of other sorts).

The length of food specimens, measured at the time of identifying the prey, will serve in the determination of biomass eaten. The lengths will be calibrated with weights of whole specimens of corresponding lengths.

The determination of amounts of prey eaten daily is done indirectly. Measurements have been made of resting metabolic rates in similar birds, and the gross energy intake needed to sustain certain levels of activity has been determined in the laboratory. From such work, predictions can be made as to daily gross energy requirements of lark buntings.

Food consumption then can be predicted on a population basis, assuming that the stomach analyses show what proportion of the daily food is contributed by each component of the diet. The food intake may be expressed either as biomass or numbers of individual items.

The plant food averages 36% of the diet, consisting almost entirely of seeds and grains, with mere traces of leafy matter. Prominent among the seeds found were wheat, buffalo grass (*Buchloe dactyloides*), sunflower (*Helianthus annuus*), and sedge (*Carex* sp.).

The animal food represented 64% of the diet in the adult lark buntings examined. The proportion of each prey species was determined from its relative biomass.

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Table 1. The relative frequency of browse, grass, and annual forbs in the stands on plots.

Stand Class	Plot Number	Relative Frequency of Browse	Average Relative Frequency		
			Browse	Grass	Annual Forb
I	2	0.014			
	1	0.024	0.019	0.528	0.453
II	3	0.094			
	4	0.054			
	5	0.092			
	9	0.103	0.086	0.713	0.201
III	6	0.235			
	7	0.292			
	8	0.128			
	10	0.152	0.202	0.502	0.296

Table 2. The type and height of protective plants and the nest orientation in relation to plant.

Number of Nest	Number of Plot	Protecting Plant Species	Plant Height (inches)	Direction: Plant to Nest
1	1	*Atriplex canescens*	6	SE
2	3	*Aristida longiseta*	8	E
3	6	*Eriogonum effusum*	8	E
4	10	*Atriplex canescens*	12	E
5	1	*Melilotus officinalis*	8	SE
6	1	*Chrysothamnus nauseosus*	6	SE
7	2	*Melilotus officinalis*	12	SE
8	3	*Aristida longiseta*	6	E
9	3	*Bouteloua gracilis*	5	E
10	4	*Eriogonum effusum*	8	SE
11	4	*Aristida longiseta*	9	E
12	5	*Eriogonum effusum*	7	SE
13	6	*Atriplex canescens*	6	SE
14	6	*Atriplex canescens*	8	NE
15	6	*Atriplex canescens*	10	NW
16	10	*Aristida longiseta*	10	SE
17	10	*Atriplex canescens*	7	SE
18	10	*Atriplex canescens*	12	SE
19	10	*Atriplex canescens*	6	NE
20	10	*Atriplex canescens*	9	SE
21	7	*Atriplex canescens*	12	SE
22	8	*Opuntia polyacantha*	4	SE
23	8	*Atriplex canescens*	7	SE
24	8	*Eriogonum effusum*	8	E
25	9	*Chrysothamnus nauseosus*	8	SE
26	9	*Aristida longiseta*	4	SE
27	9	*Atriplex canescens*	10	SE
28	6	*Atriplex canescens*	6	NW
29	6	*Atriplex canescens*	8	NE
30	6	*Eriogonum effusum*	10	SE
31	3	*Atriplex canescens*	11	SE
32	8	*Chrysothamnus nauseosus*	10	NW
33	9	*Chrysothamnus nauseosus*	9	E
34	3	*Psoralea tenuiflora*	10	E
35	4	*Eriogonum effusum*	11	NW
36	5	*Atriplex canescens*	8	SW
37	8	*Atriplex canescens*	13	NE

Table 3. The hatching and fledging dates at four lark bunting nests in 1968.

Nest	Number of Eggs	Dates of Hatch	Date of First Fledging[1/]	Date Fledging Completed	Nestling Period[2/]
23	4	7/18 7/19	7/24	7/25	8
24	4	7/19 7/20	7/27	7/27	9
28	4	7/18 7/19	7/25	7/25	8
29	4	7/28 7/29	8/2	8/4	8

1/ Date of fledging is the day on which the young were believed to have left the nest.

2/ Day on which hatching occurred was taken as Day 1 of the nestling period.

Table 4. Nest association with species and types of plants.

Plant Type	Plant Species	Number of Nests	Average Height (inches)	Occurrence of Nests with Plant[1/]	
				Species	Type
Grass	*Aristida longiseta*	5	7.4	0.14	
	Bouteloua gracilis	1	5.0	0.02	0.16
Browse	*Opuntia polyacantha*	1	4.0	0.02	
	Atriplex canescens	17	8.9	0.47	
	Chrysothamnus nauseosus	4	8.3	0.11	
	Eriogonum effusum	6	8.7	0.16	0.76
Annual Forb	*Melilotus officinalis*	2	10.0	0.06	
	Psoralea tenuiflora	1	10.0	0.02	0.08

1/ Total number of nests per number of nests associated.

Table 5. Nesting data summary, 1969.

	Number of eggs laid	Number of eggs hatched	Number not hatched	Number of fledglings	Number of eggs preyed on	Number of young preyed on
	154	100	15	59	39	20
% of total		64.94	9.74	38.31	25.32	20.00
Av./nest	3.58	2.33	0.35	1.39	0.91	0.47
S.D.	0.80	2.55	0.32	1.70	2.16	1.22

Nesting density in 13.6 acres (75 yards x 880 yards) was 0.74 nests/acre, or 1.36 acres/nest (10 nests present).

Table 6. Food composition from 50 nestling samples.

FAMILY	Occurrence	% Occurrence
Acrididae	42	84
Subfamily		
Acridinae	18	42.9
Oedipodinae	12	28.6
Cyrtacanthacridinae	9	21.4
Unidentified	3	7.1
Asilidae	3	6
Libellulidae	2	4
Endomychidae	1	2
Unidentified	2	4

Table 7. Type of food in adult lark buntings.

Number of seeds per stomach

		May				June			
		1-7 1/	8-14	15-21	22-28	29-4	5-11	12-18	19-25	Overall weighted mean
Seeds	♂	(9) 12.2	(10) 46.2	(9) 24.4	(8) 21.6	(6) 28.5	(8) 17.8	(4) 31.2	(2) 10.0	
	♀	(1) 8	--	(1) 2	(2) 18.0	(4) 20.7	(2) 14.5	(6) 36.6	(1) 28	
	Weighted mean	11.8	46.2	22.2	19.1	25.4	17.2	34.5	16.0	(73) 17.6

% Plant vs. % animal biomass 2/ in stomachs of adult lark buntings

		1-7	8-14	15-21	22-28	29-4	5-11	12-18	19-25	Overall weighted mean
Plant %	♂	(7) 41.1	(10) 47.5	(9) 29.7	(8) 40.0	(6) 20.8	(7) 32.1	(4) 77.0	(2) 17.0	
	♀	(1) 5	--	(1) 3	(2) 63.0	(4) 8.2	(2) 32.5	(5) 42.4	(1) 35.0	
	Weighted mean	36.6	47.5	20.1	46.5	15.8	32.2	57.8	23.0	(69) 35.8
Animal %	♂	58.9	52.5	70.3	60.0	79.2	67.9	23.0	83.0	
	♀	95.0	--	97.0	27.0	91.8	67.5	57.6	65.0	
	Weighted mean	63.4	52.5	79.9	53.5	84.2	67.8	42.2	77.0	(69) 64.2

1/ Sample size upper left

2/ Visual estimates

The numbers of seeds occurring per stomach week by week will no doubt be found to change. The data presented are intended merely as a quick indication of level of consumption of this form of food. When identifications of seeds have been completed, similar summaries will be possible for the various species of seeds consumed. The length and width of seeds found in the stomachs have been recorded; however, biomass determinations can be made readily from numbers of seeds tallied along with measurements of their volume from fresh seeds in the reference collection.

The percent of plant versus percent of animal biomass is a figure needed for calculating the proportion of daily food intake represented by each component food species in the diet.

Table 8. Major prey of 74 lark buntings.[1/]

Family of prey	Prey consumed: Number of prey consumed [2/]	Relative occurrence [3/]	Length (mean and range), mm
Curculionidae (weevils)	260	82	5.7 (2.5-10)
Formicidae (ants)	256	45	4.8 (2.5-7)
Acrididae (grasshoppers)	130	61	15.1 (5-25)
Scarabaeidae (scarab beetles)	64	19	4.8 (1.5-15)

1/ Adult lark buntings. No difference was noted in male and female diets; the sample included 56 males and 18 females.

2/ Total from 74 stomachs.

3/ Percent of 74 stomachs in which item was found.

Table 9. Animal food of adult lark bunting.[1/]

Order	[2/] No.	% 74	[3/] No.	% 317	% 74
Orthroptera	45	60.5	49	15.5	66.0
Hemiptera	15	20.5	16	5.1	21.6
Homoptera	12	16.2	12	3.8	16.2
Coleoptera	73	98.5	142	44.7	192.0
Lepidoptera	9	12.1	10	3.2	13.5
Diptera	8	10.8	12	3.8	16.2
Hymenoptera	49	66.0	65	20.4	87.6
Araneida	11	14.8	11	3.5	14.9
			317	100.0	428.0

Family	[2/] No.	% 317	% 74
Acrididae	45	14.2	60.7
Curculionidae	61	19.3	82.2
Formicidae	33	10.8	44.7
Scarabaeidae	14	4.4	18.9
		48.7	206.5

1/ Period from May 3, to June 20, 1969.

2/ Number of stomachs in which the taxon was recorded. Number of stomachs examined = 74.

3/ Sum of records for occurrence of each family in the order plus the records for the order itself when not identified to family. Indicates diversity.

Table 10. Animal food of adult lark bunting.[1/]

Male vs. Female

Order	No. ♂ [2/]	% 56	No. ♂ [3/]	% 216	% 56	No. ♀ [2/]	% 18	No. ♀ [3/]	% 92	% 18
Orthoptera	34	66.5	37	17.2	65.8	11	61.0	11	11.9	61.1
Hemiptera	9	16.1	10	4.5	17.8	6	33.5	6	6.3	33.5
Homoptera	8	14.3	8	3.6	14.3	4	22.2	4	4.3	22.2
Coleoptera	56	100.0	101	47.0	181.0	17	94.5	37	40.0	206.0
Lepidoptera	5	8.8	5	2.3	8.9	4	22.2	5	5.3	27.8
Diptera	3	5.3	4	1.8	7.1	6	33.5	7	7.5	39.0
Hymenoptera	35	62.5	44	20.4	78.5	14	78.0	18	19.4	100.0
Araneida	7	12.5	7	3.2	12.5	4	22.2	4	5.3	22.2
			216	100.0	386.1			92	100.0	511.8

Family	No. ♂ [2/]	% 216	% 56	No. ♀ [2/]	% 92	% 18
Acrididae	34	15.8	60.5	11	11.9	61.1
Curculionidae	45	20.9	80.1	16	17.3	88.9
Formicidae	25	11.6	44.5	8	8.7	44.6
Scarabaeidae	9	4.2	16.1	5	5.3	27.8
		52.5	201.2		43.2	222.4

1/ Period from May 3, to June 20, 1969

2/ Number of stomachs in which the taxon was recorded. (Male = 56, female = 18).

3/ Sum of records for occurrence of each family in the order plus the records for the order itself when not identified to family. Indicates diversity.

These tables show the relative occurrence of the orders and families of insects as prey items in lark bunting stomachs in late spring after arrival of the birds on their breeding grounds. The data will permit summarizing the occurrence of prey by weeks, also. Furthermore, it will be possible to group the taxa according to ecological criteria, as primary consumers, etc., so we may see how bird feeding impinges upon functional groups in the ecosystem.

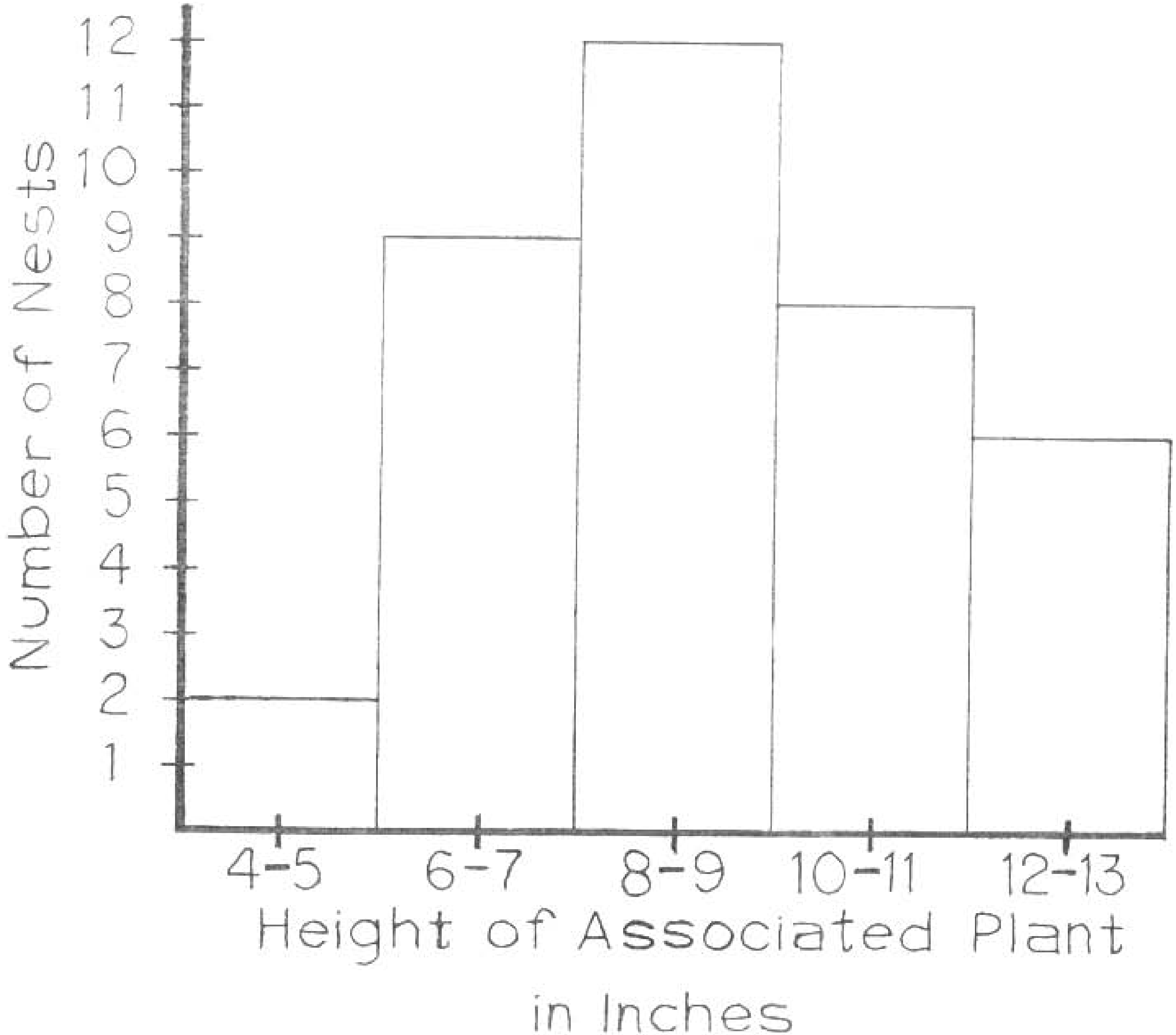
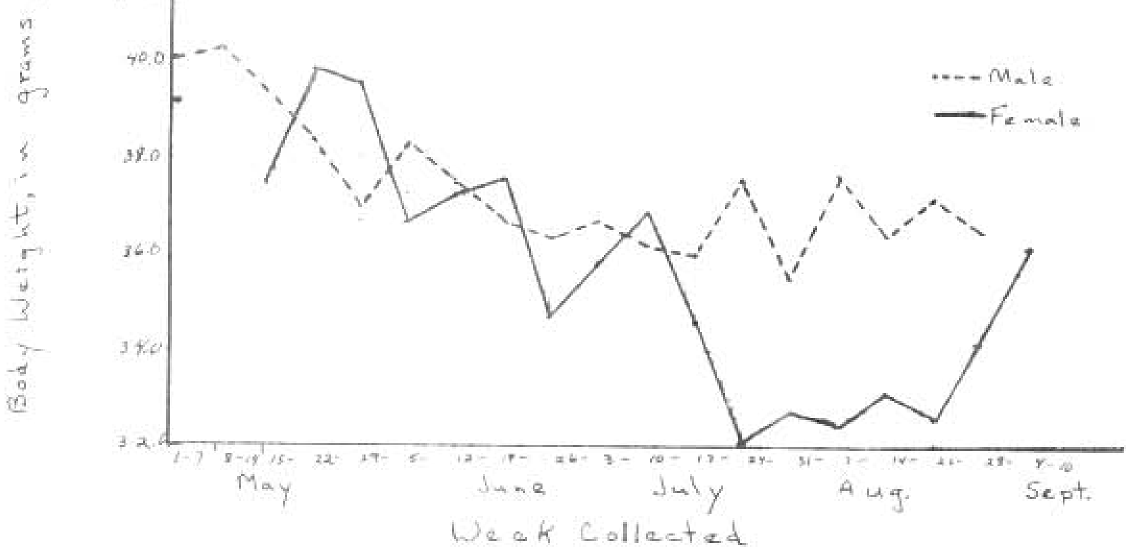


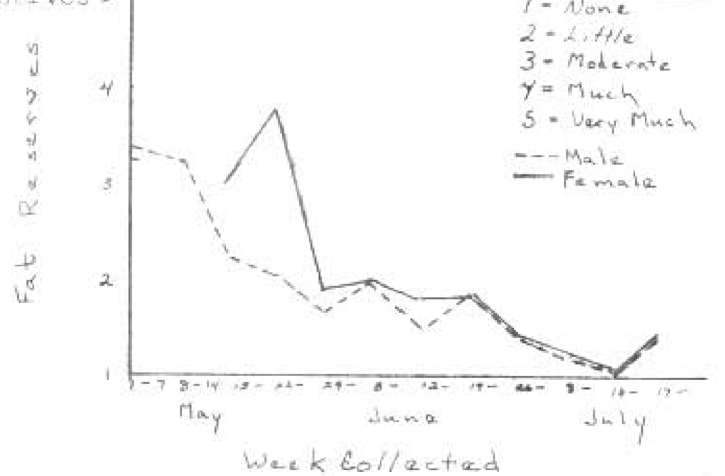
Fig. 1. The height of [illegible]nts associated with lark bunting nests at time of discovery [illegible]ly 1968).

POPULATION DATA FOR LARK BUNTINGS

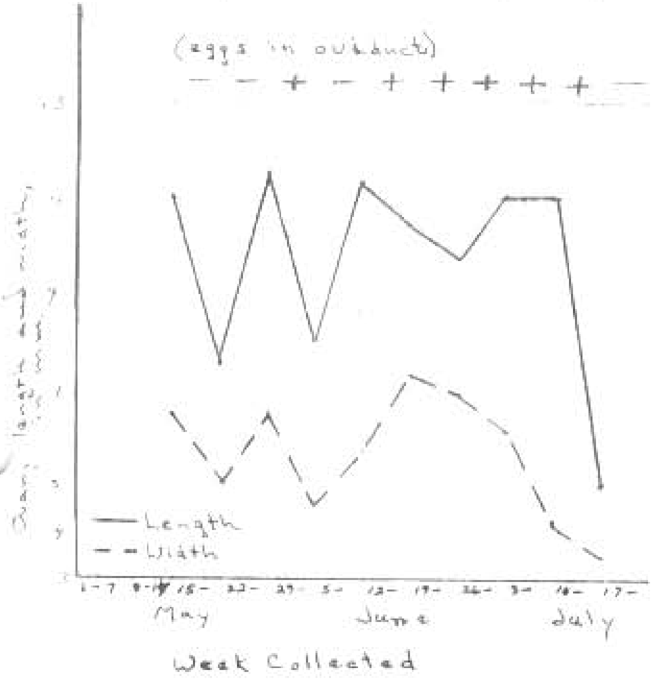
Body weight



Fat reserves



Female reproductive status, ovary and oviduct



Male reproductive status, testes