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FOOD CONSUMPTION AND FEEDING RATES IN THE LARK BUNTING

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ABSTRACT

The foods of Lark Buntings from the Pawnee area were analyzed quantitatively in terms of kilocalories. The seasonal patterns of food intake by male and female adult Lark Buntings were similar yet they differed statistically at certain parts of the summer. These differences corresponded mainly to shifting values for consumption of animal versus plant foods. In cumulative consumption of foods over the entire breeding season, May through August, the intake of food by females exceeded that of males by 15.2 per cent. The body weights of male and female adults decreased in early summer but increased sharply in late July (males) and in August (females). Rates of food intake were expressed in units of kcal/bird-day. Rates were deduced from relationships among mean caloric content of stomach samples, calculated existence energies, and calculated activity energies. Activity energies were markedly higher for females than for males, notably from late May through early July. Mean feeding rate from May through August for males was 39.50 kcal/bird-day and for females 44.11, the latter 11.7 per cent higher. Time of day had little effect on pattern of food intake, except that more animal food was eaten in the period, 1200-1400 hours. Juveniles when first out of the nest ate entirely animal food; they increased the amount of seed food taken in successive biweekly periods until at the end of August they ate animal and plant foods in the same proportions as did adults. Time of day produced no striking differences between feeding patterns of adults and juveniles.

Tables

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Figures

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INTRODUCTION

The object of this report is to examine food intake of a small grassland bird, the Lark Bunting, with the expectation of determining patterns of feeding characteristic of the birds during their residence on the breeding range, i.e., from May through August. This survey of the feeding process is specifically to reveal quantitative relationships; qualitative phases of the investigations are not included here, except as unavoidable to permit presentation of the quantitative.

We shall deal with food in terms of its potential energy content and in units of calories. We shall compare the use of natural foods by the two sexes of adult Lark Buntings as influenced by season and by time of day. Finally we shall determine feeding rates and explore the pattern of variation in feeding rates through the eight, biweekly seasonal periods.

The Lark Bunting was chosen as the subject for analysis in this report because it is the most abundant small, ground-feeding bird of the Pawnee Site. Collections could be made gradually over a few years at localities beyond the periphery of the Pawnee Site without visible effect on populations. The number of stomach samples obtained permitted quantitative analysis to the degree attempted here with fair statistical reliability. First collections were made in May 1968 and the last in August 1972.

METHODS

The analysis is carried out in terms of kilocalories; therefore, an indication is in order of how the energy content of dietary items was estimated. Contents of the stomach were examined and identified under the dissecting microscope. The animal foods were essentially all arthropods. The length of individual animals found in the samples was measured or estimated and an appropriate value for dry weight was determined from oven-dried examples of animals of similar form and size. Caloric content was estimated on the basis of 6.0 kilocalories per gram of dry weight. Seeds were handled in the same manner, except that caloric conversions were made with values for caloric content per gram of dry weight reported in the literature (Kendeigh and West, 1965) for taxonomically similar seeds, and these values ranged from approximately 4120 to 6080 calories per gram.

Seasonal variation in amounts of animal and plant foods eaten

In this section the levels of food intake over the spring and summer season are examined. The data used here are mean calories per stomach sample for biweekly periods extending from the first two weeks of May (period 1) to the last two weeks of August (period 8).

The data on caloric intake are presented separately for all adults, for male adults and for female adults. Analysis of variance was employed to show whether or not points significantly different from others were present. Subsequently, means were compared by t-tests and least significant differences (LSD).

For all adults, the means, sample sizes, standard deviations and standard errors of the mean are given in table 1; graphs of the means are shown in figure 1. The total food intake levels shown include significant differences ($p<.0220$). The first period, lowest of all, differed (by LSD) from all other periods except the eighth. The seventh period, highest of all, differed from periods 1 and 5, the two lowest periods. By t-test, period 1 was significantly different from period 2 ($p<.001$), while all other periods are not significantly different as tested in consecutive order. Possible influences on the total food intake vary through the season. Period 1 appeared to be low, and several reasons may apply. The birds may have been living partly on stored energy; local foods may have been hard to find due to scarcity or to environmental obstacles to foraging; finding success may have been low because of lack of recent experience in foraging at this locality; search images may not have been well developed; the birds may have been too engaged in establishing territories and searching for mates. Periods

Table 1. Summary of mean caloric content of foods from stomachs of Lark Bunting during biweekly periods from May through August.

Food	Biweekly period	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	1	21	.6866	.4146	.0830
	2	31	1.4843	.8297	.1490
	3	24	1.3625	.8673	.1770
	4	23	1.5323	.7484	.1561
	5	42	1.0953	1.0018	.1546
	6	27	1.0524	.8322	.1602
	7	28	.8683	.6413	.1212
	8	12	.8520	.8179	.2361
Plant food	1	21	.3300	.2942	.0642
	2	31	.3697	.3642	.0654
	3	24	.5140	.4769	.0973
	4	23	.2404	.1818	.0379
	5	42	.4552	.3992	.0616
	6	27	.8554	.6866	.1321
	7	28	1.1784	.8682	.1641
	8	12	.7573	.6891	.1989
Total food	1	21	1.0166	.5639	.1231
	2	31	1.8540	.7817	.1404
	3	24	1.8765	.9501	.1939
	4	23	1.7727	.6952	.1450
	5	42	1.5505	1.0882	.1679
	6	27	1.9078	.8861	.1705
	7	28	2.0467	1.0518	.1988
	8	12	1.6093	1.2590	.3634

Entries in the column headed "mean kilocalories" are mean caloric content of foods represented in n stomach samples for each period.

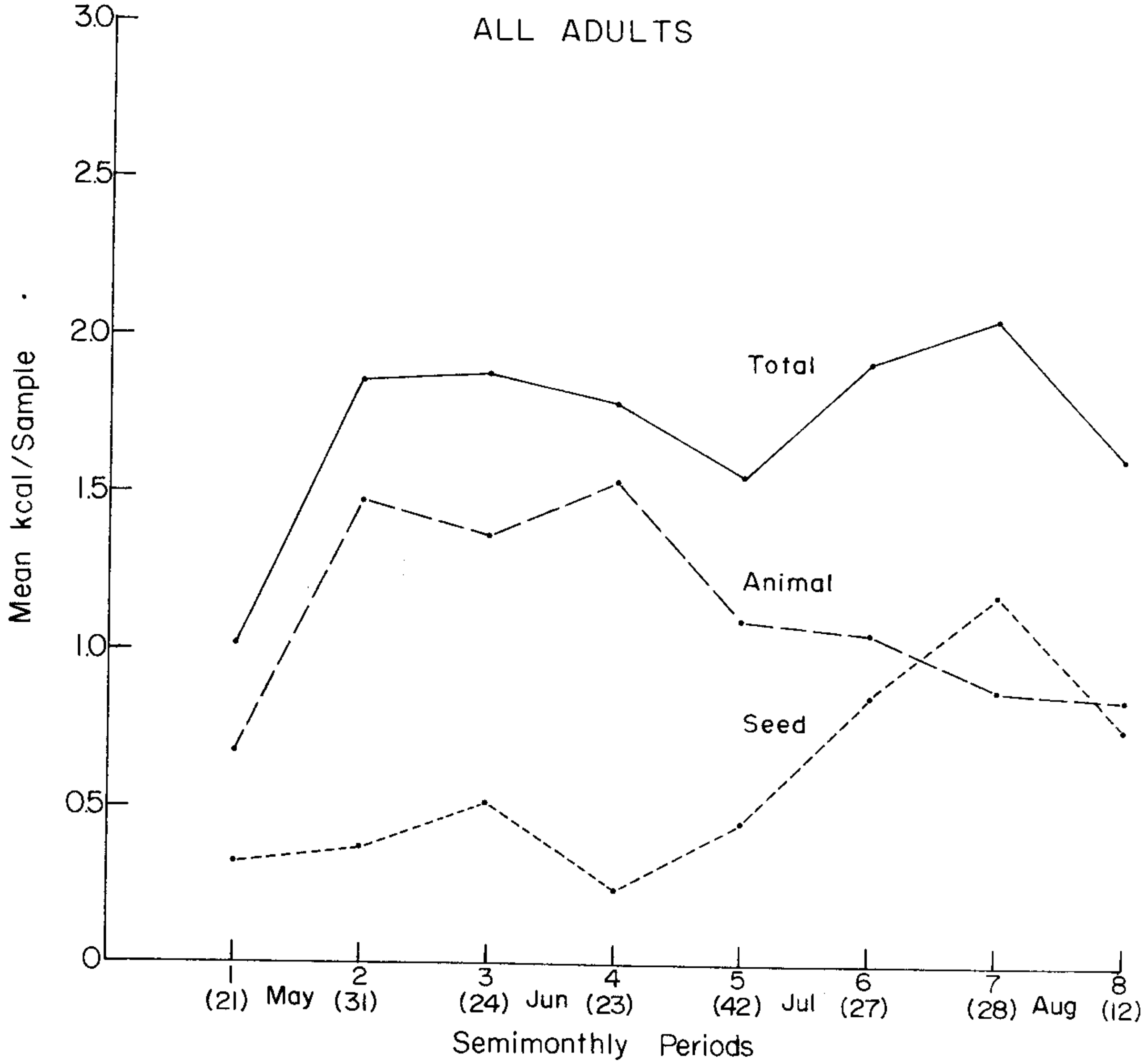

Figure 1. Food intake in kilocalories represented in seed, animal, and total food samples of male and female adult Lark Buntings. Data from table 1. Number of stomach samples given in parentheses.

2, 3, 4, and 6 appear to show feeding levels in balance with resources and activities. Period 5 shows an unexplained dip. Perhaps breeding duties were demanding and competing; possibly some foods they otherwise would eat were being carried to nestlings; perhaps some food resource was off. Period 7 is toward the end of breeding time, and the high level of food intake may assist recovery of adults from the breeding effort; also, some energy from food was probably being stored in preparation for migration; seed levels in the environment were rising. Period 8 presents another unexplained dip; conceivably it could be associated with increased mobility at time of migratory departure, i.e., attention may be diverted from eating by the migratory urge and activity; perhaps some environmental obstacle arose to hinder foraging.

For all adults the intake of animal foods was uneven over the season as shown by ANOVA ($p<.0026$). The line (fig. 1) suggests that heaviest consumption of animal foods occurred from mid-May through June, lighter consumption thereafter. Periods 2 and 4 differed from all others except period 3 by LSD, and period 3 differed from periods 1, 7 and 8. Period 2 was significantly different from period 1 ($p<.001$) by t-test, and period 4 just failed to differ from period 5 ($p<.100$); all other periods did not differ by t-test. Possible reasons for differences could be that relative levels of suitable animal versus plant foods may have differed with seeds relatively scarce in spring and early summer. This could result in Lark Buntings finding more insects; then reinforcement of the search image could have further increased the amount of animal material eaten. Later in the summer when levels of seeds increased the reverse happened.

For all adults the intake of seed foods differed decidedly over the season ($p<.0000$). Testing by LSD, period 7 differed from all other periods; period 6 differed from all others by 3 and 8; period 8 differed from all others but 3, 5 and 6. With t-tests, periods 3 and 4 were significantly different ($p<.025$), period 4 from 5 ($p<.005$), and period 5 from 6 ($p<.01$). Possible influences were that the low periods 1 and 2 were too early for the appearance of new seeds of the year. Medium levels were seen in periods 3, 5, 6 and 8, which actually cover most of the rest of the season; however, values in the sample were higher for periods 6 and 8 than for 2 and 4 and although not significantly different they may have risen as part of a trend for increasing consumption of seeds in mid and late summer. The increased value for seed intake in period 3 may relate to the occurrence of green seeds in early June. High seed consumption is seen for period 7, which is early August, and this may correspond to a time of ripening of many seeds. Period 8 shows an unexplained dip, although the sample shows relatively high consumption.

The line for total food intake for all adults seems reflective of the animal food pattern; however, the differing periods are not the same as those in the animal food intake line.

There appears to be a bimodal trend in total food intake, both peaks corresponding to the peak in animal foods and seed foods, respectively. The same general rule occurs with the sexes, as would be expected, although slight shifts in the time of these peaks occur.

For male adults, the means and related statistics are given in table 2; graphs of the means are shown in figure 2. The total food intake pattern is similar to that for all adults. It is bimodal, but the two

Table 2. Mean caloric content of foods from male adult Lark Buntings.

Food	Biweekly period	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	1	20	.6792	.4239	.0948
	2	23	1.4815	.7411	.1545
	3	14	1.1267	.8316	.2223
	4	12	1.2470	.6709	.1937
	5	24	.8943	.6285	.1283
	6	14	1.0101	.6120	.1636
	7	18	.9450	.7336	.1729
	8	7	.7629	.6839	.2585
Plant food	1	20	.3403	.2978	.0666
	2	23	.3316	.2325	.0485
	3	14	.4396	.3923	.1048
	4	12	.2682	.2008	.0580
	5	24	.3619	.2992	.0611
	6	14	1.1189	.7892	.2109
	7	18	1.0332	.7297	.1720
	8	7	.7733	.7948	.3004
Total food	1	20	1.0195	.5783	.1293
	2	23	1.8131	.7416	.1546
	3	14	1.5663	.8307	.2220
	4	12	1.5152	.6628	.1913
	5	24	1.2561	.6402	.1307
	6	14	2.1291	.8989	.2402
	7	18	1.9782	.9417	.2220
	8	7	1.5362	1.3383	.5058

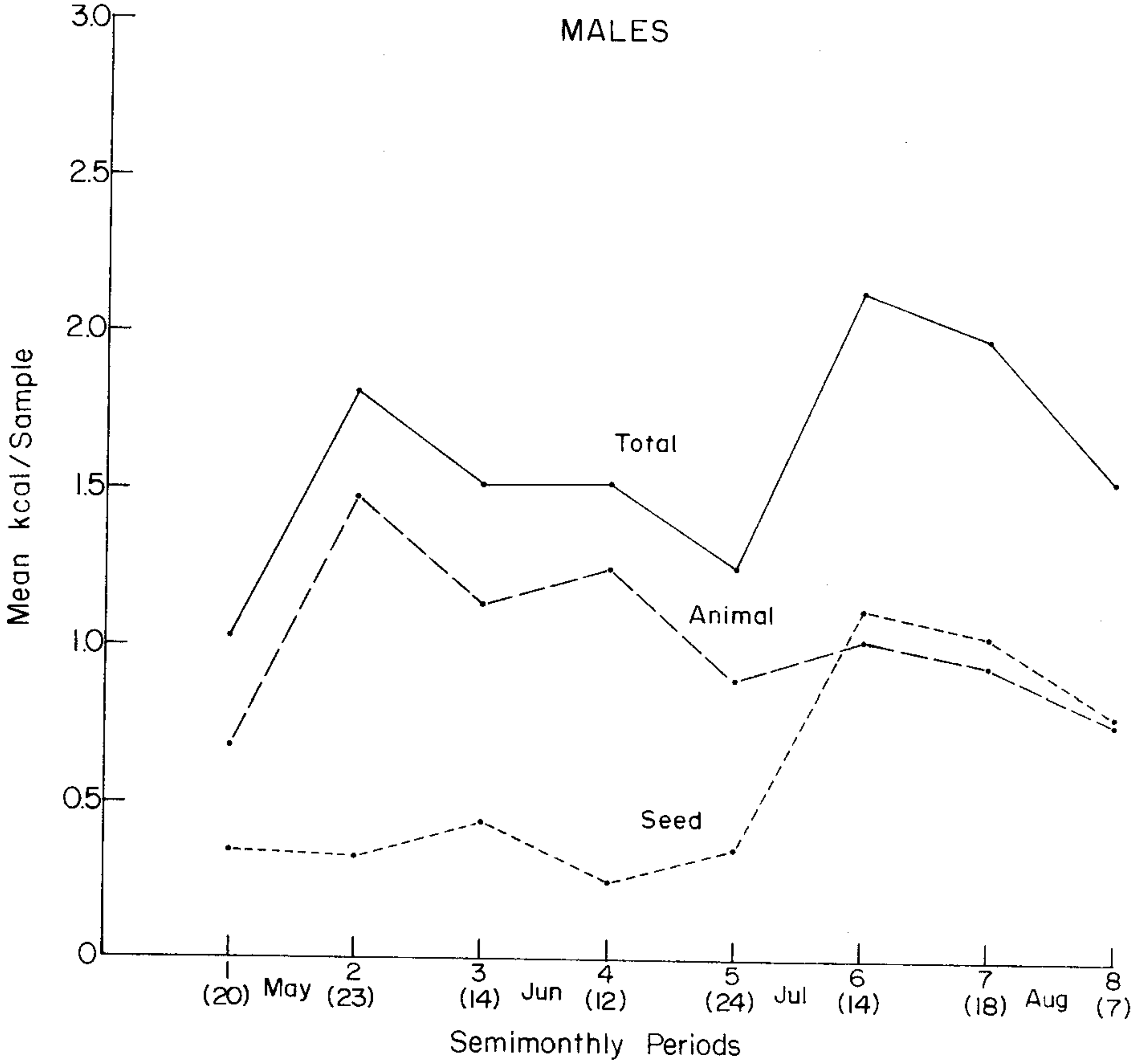

Figure 2. Mean caloric content of foods from male adult Lark Buntings for biweekly seasonal periods. Data from table 2. Number of stomach samples given in parentheses.

peaks present are in the early part of the peaks demonstrated for all adults. Further testing of the means of total food intake shows a significant difference ($p<.001$ by t-test) between periods 1 and 2 and periods 5 and 6 ($p<.005$). The latter indicates a significant change emphasized by an increase in the average amount of plant food intake. Periods 7 and 8 fail to differ, with a probability of $<.10$, which is considered indecisive. Animal food intake showed significant differences between periods 1 and 2 by t-test ($p<.001$). Also, period 2 was found different from all others. Periods 3 and 4 were not different from the other periods, as was the case for all adults. Males experienced a marked increase in seed food intake between periods 5 and 6 ($p<.005$, t-test). Periods 6, 7 and 8 did not differ significantly from each other. Increased variation was present in the samples of the last three periods. Possible influences were the following: By period 2, i.e., late May, males may have had more time and energy to devote to foraging after early territorial establishment was accomplished. Also, animal foods reached higher levels in the environment removing previous restrictions on intake from scarcity. A sharp increase in seed consumption observed in late July perhaps coincides with maturation of seeds from important plants. Alternately, seed consumption might have been augmented as a result of possible decline of important insect foods.

For female adults, the means and related statistics are listed in table 3; graphs of the means are shown in figure 3. The total food intake pattern is similar to that of adults in being bimodal. The two peaks in total food consumption are both one, two-week period later than with the males. Period 1 was represented by only one sample and thus did

Table 3. Mean caloric content of foods from female adult Lark Buntings.

Food	Biweekly period	n	Mean kcal	Std. dev. (s)	Std. error($\frac{s}{\sqrt{n}}$)
Animal food	1	1	.8340	-	-
	2	8	1.4925	1.1061	.3911
	3	10	1.6926	.8472	.2679
	4	11	1.8436	.7298	.2200
	5	18	1.3633	1.3239	.3120
	6	13	1.0980	1.0445	.2897
	7	10	.7302	.4294	.1358
	8	5	.9768	1.0509	.4700
Plant food	1	1	.1230	-	-
	2	8	.4794	.6162	.2179
	3	10	.6183	.5813	.1838
	4	11	.2101	.1624	.0490
	5	18	.5797	.4842	.1141
	6	13	.5716	.4223	.1171
	7	10	1.4398	1.0664	.3372
	8	5	.7408	.5990	.2679
Total food	1	1	.9570	-	-
	2	8	1.9719	.9322	.3296
	3	10	2.3109	.9749	.3083
	4	11	2.0537	.6429	.1938
	5	18	1.9431	1.4198	.3347
	6	13	1.6696	.8410	.2333
	7	10	2.1700	1.2715	.4021
	8	5	1.7176	1.2834	.5740

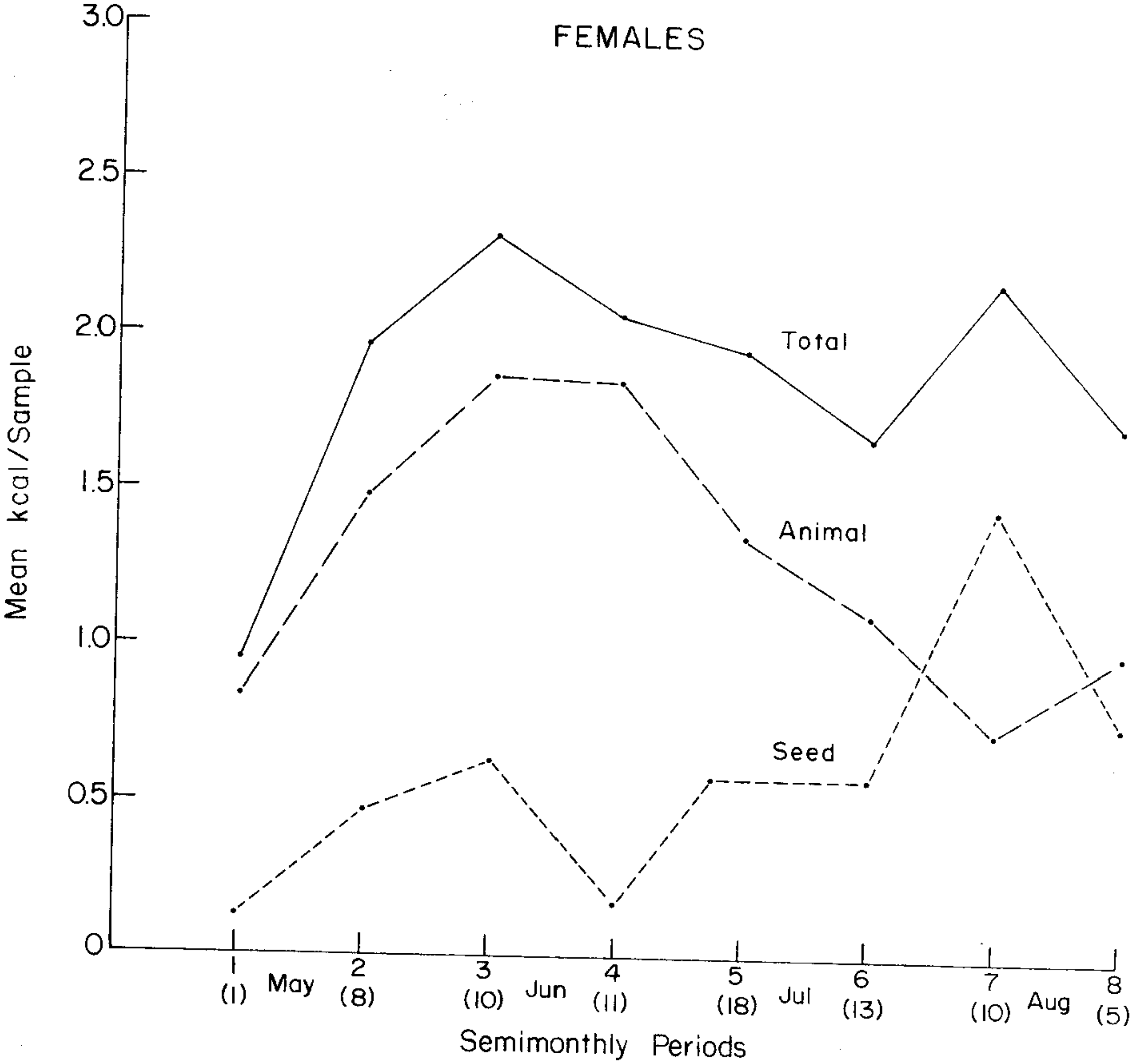

Figure 3. Mean caloric content of foods from female adult Lark Buntings. Data from table 3. Sample size in parentheses.

not enter into the testing phases; the small sample was due to the paucity of females in that period. All other periods did not differ in consecutive order by t-test. Because of a decrease in animal food intake between periods 6 and 7, the large increase of plant food intake at the same time did not cause a significant difference in the total food intake. Animal food did not achieve significant differences between consecutive periods, but periods 4 and 6 did differ ($p<.05$) as would the remaining two periods. Seed foods differed significantly several times; thus, periods 3 and 4 ($p<.10$, indecisive), periods 4 and 5 ($p<.01$) and periods 6 and 7 ($p<.05$). Possible influences may have been mobility, searching activity, social uncertainty and general unfamiliarity with the environment as accounting for the low food intake in early May (only one female collected in early May) coupled with the fact that the birds were using fat reserves (see below). From period 2 through period 5 (late May through early July), high levels of insects might account for high consumption of animal foods by females. Increased levels of seeds in late summer could account for the actual and relative rise in seed intake in that part of the season. The high variability present in the sample may have resulted from involvement of females in different aspects of breeding activity.

Differences between the caloric content of stomach samples in males versus females is shown in figure 4. This graph should be compared with figure 12, a graph of gross energy intake in units of kcal/bird-day.

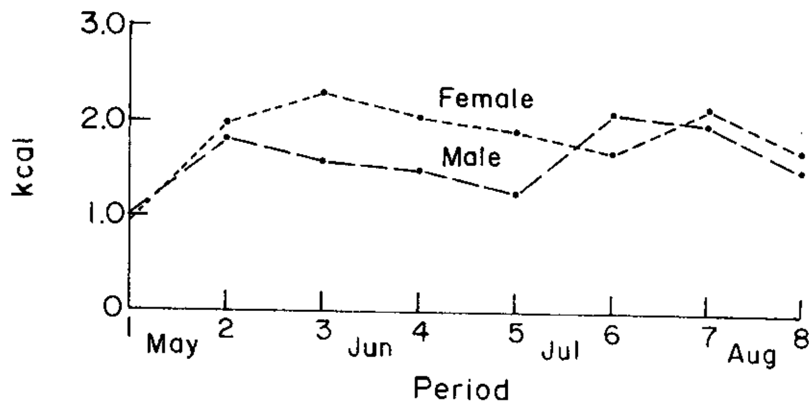

Figure 4. Mean biweekly caloric content of stomach samples of male versus female adult Lark Buntings.. Data from tables 2 and 3.

Cumulative consumption of food over the breeding season

Another way to examine the patterns of food intake is to use cumulative summaries of the data. We have summed the mean caloric content of foods represented in individual stomach samples in order to produce the cumulative data listed in table 4. The cumulative relationships are graphed in figures 5, 6 and 7. The graphs are suggestive of the following points:

The generally straight lines produced by graphing the cumulative total food, i.e., animal and plant foods together, in each case for all adults, male adults and female adults indicate a relatively sustained and even average total food intake per adult over the breeding season. Another feature is the higher end point of the total food line for females which shows that female adults consume more foods than male adults while at the breeding range. Thus, the cumulative mean kilocalories per stomach for females reached 14.8 by end of August, whereas for males it reached only 12.8, females consuming 15.2 per cent more than males. This obviously results mainly from the effect of activities in setting levels of energy demand. The steeper slope of total food intake for females means this sex, except at the start, invests more effort in the breeding cycle than the male.

The deviations seen as small bends in the lines for total food consumption were related to differences between male and female adults in feeding patterns. These differences were: (1) higher intake of animal food by females during late May and the month of June, (2) a dip in total food intake occurring in early July for males and a comparable dip in late July for females; in both cases this dip was concurrent with

Table 4. Cumulative mean kilocalories per stomach sample for adult Lark Buntings.

Birds	Biweekly period	Cum. n	Cumulative mean kilocalories: Animal Food	Plant Food	Total Food
All adults	1	21	.6866	.3300	1.0166
	2	52	2.1709	.6997	2.8706
	3	76	3.5334	1.2137	4.7471
	4	99	5.0657	1.4541	6.5198
	5	141	6.1610	1.9093	8.0703
	6	168	7.2134	2.7647	9.9781
	7	196	8.0817	3.9431	12.0248
	8	208	8.9337	4.7004	13.6341
Male adults	1	20	.6792	.3403	1.0195
	2	43	2.1607	.6719	2.8326
	3	57	3.2874	1.1115	4.3989
	4	69	4.5344	1.3797	5.9141
	5	93	5.4287	1.7416	7.1702
	6	107	6.4388	2.8605	9.2993
	7	125	7.3838	3.8937	11.2775
	8	132	8.1467	4.6670	12.8137
Female adults	1	1	.8340	.1230	.9570
	2	9	2.3265	.6024	2.9289
	3	19	4.0191	1.2207	5.2398
	4	30	5.8627	1.4308	7.2935
	5	48	7.2260	2.0105	9.2366
	6	61	8.3240	2.5821	10.9063
	7	71	9.0542	4.0219	13.0763
	8	76	10.0310	4.7627	14.7939

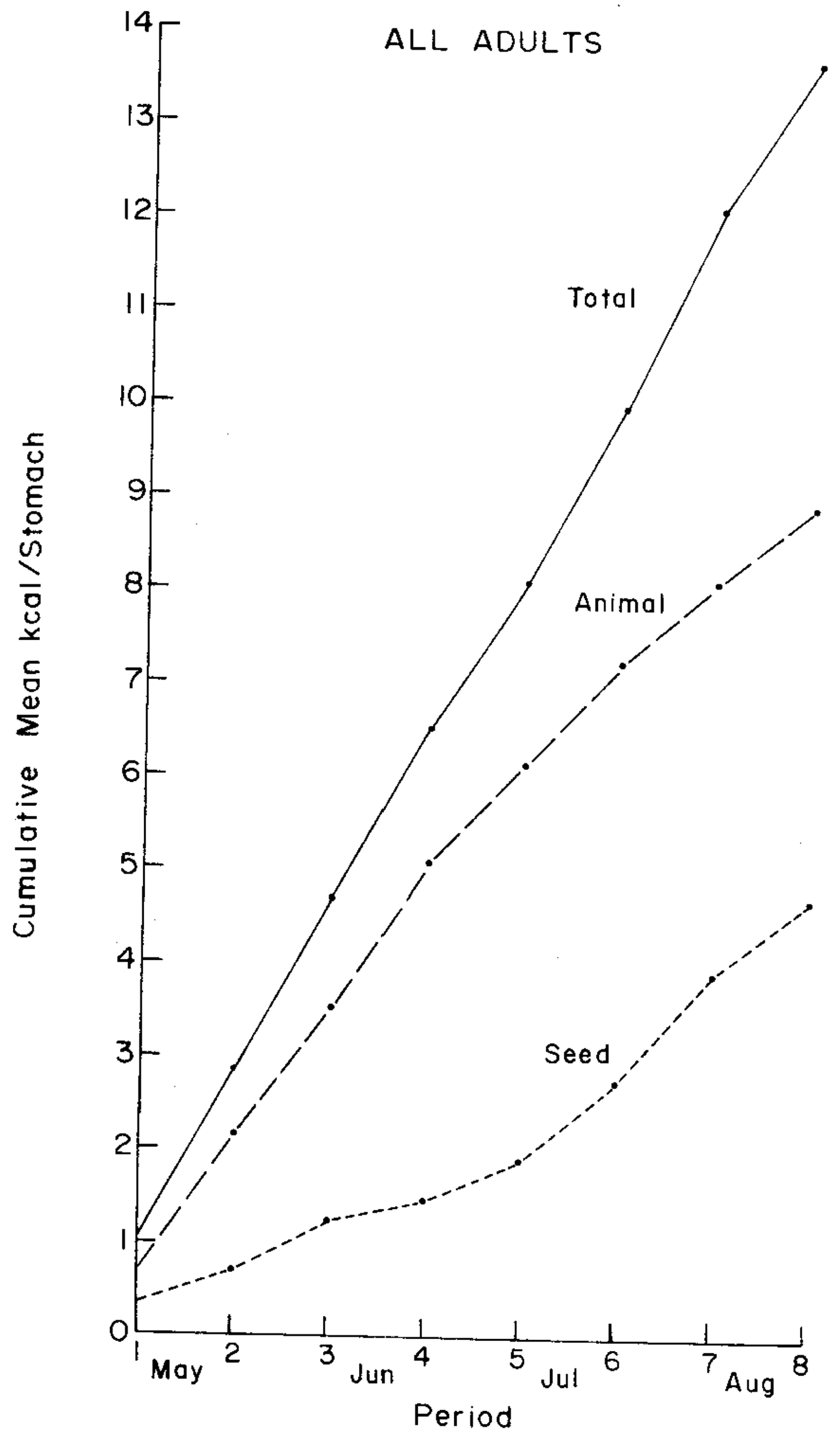

Figure 5. Cumulative consumption of kilocalories of total food over the breeding season by adult Lark Buntings. Data from table 4.

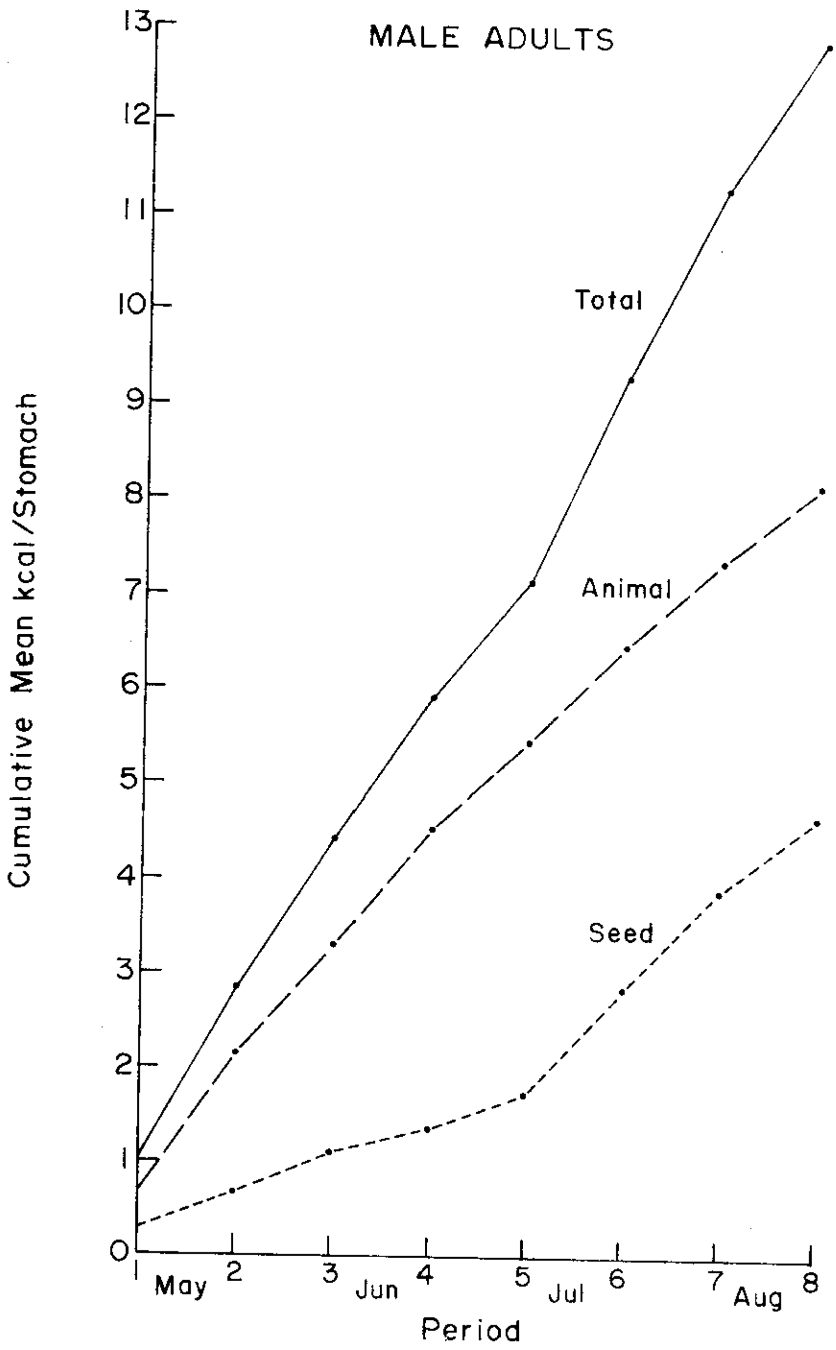

Figure 6. Cumulative consumption of kilocalories of total food over the breeding season by male adult Lark Buntings. Data from table 4.

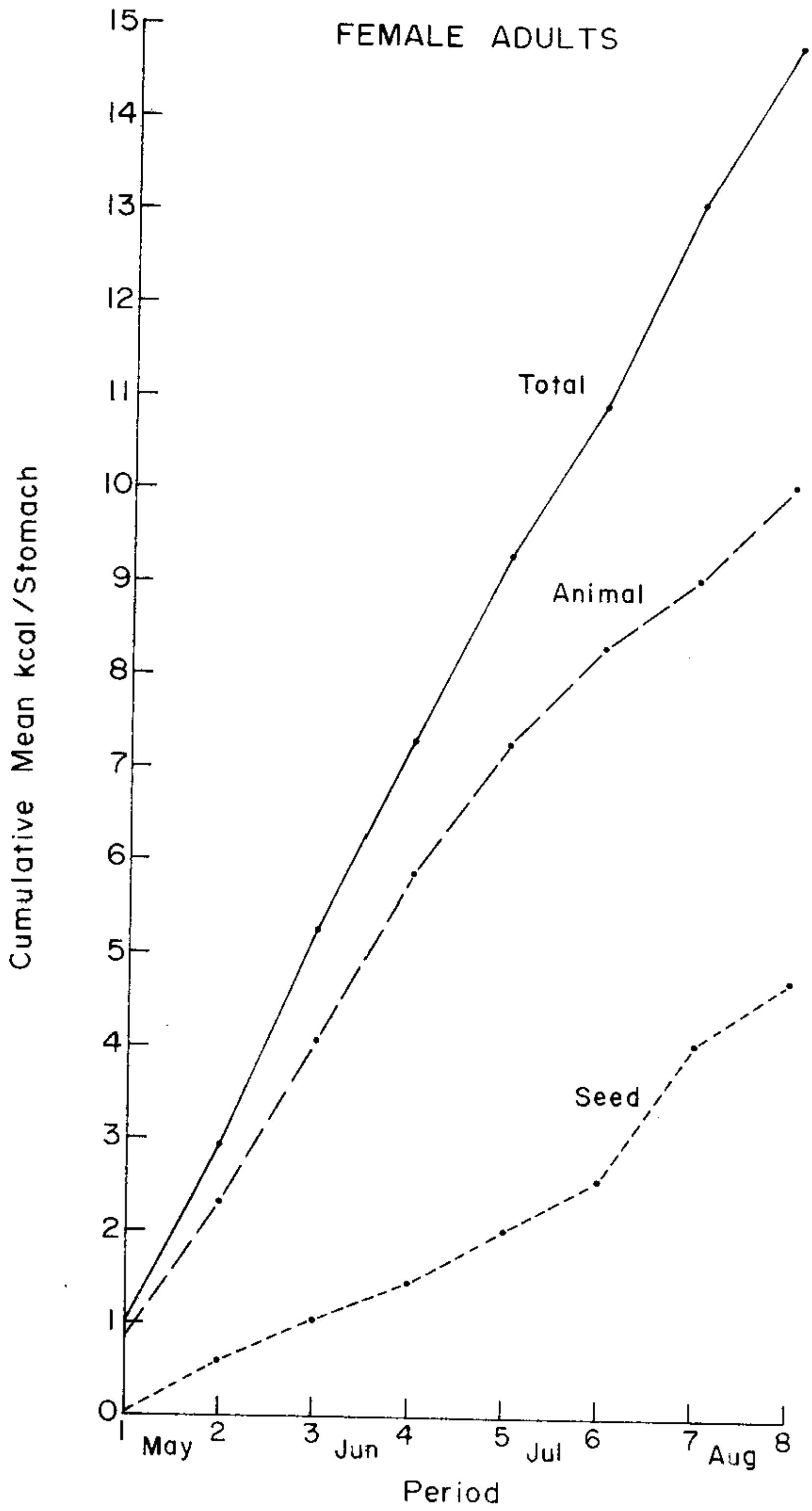

Figure 7. Cumulative consumption of total foods over the breeding season by female adult Lark Buntings. Data from table 4.

slacking off on animal food intake without increase in plant food intake; the slacking off occurred earlier for males than for females, and (3) restoration of a slightly higher total food intake in late July for males and in early August for females; this rise was concurrent with a distinct and abrupt increase in seed consumption in late July for male adults and in early August for female adults. Visual comparison of the slopes in the graphs for animal and plant food intake shows that the ratio for utilization of animal versus plant food was roughly 3 to 1 from early May through early July and then roughly 1 to 1 from late July through late August for male adults. The ratios were similar for female adults, except that the switch occurred between late July and early August. Calculations properly weighted for sample sizes confirm this (table 5).

Table 5. Proportions of animal versus plant matter in cumulative stomach sample data for early versus late parts of breeding season.

Birds	Food intake in early part of season[1/]		Food intake in late part of season[2/]	
	% animal food	% plant food	% animal food	% plant food
Male adult	75.4	24.6	47.9	52.1
Female adult	74.6	25.4	40.2	59.8

1/ Males, biweekly periods 1-5; females, biweekly periods 1-6.

2/ Males, biweekly periods 6-8; females, biweekly periods 7-8.

Body weights of adult Lark Buntings

Body weights are given in table 6 and graphed in figure 8. The weights of both sexes were relatively high at the time of arrival on the nesting range at the start of May (period 1). The weights of both sexes steadily declined through May, June and the first two weeks of July. Then male weights rose but female weights declined further. In August, male weights appeared to plateau, whereas female weights rose. Late August showed a decline in female weights, but this is interpreted as resulting from the sampling of stressed or unusual females that have failed to migrate for reasons such as late breeding, late molting, poor health, etc., preventing normal migratory readiness with increase in weight.

Compared with food intake curves (see figures 2 and 3), the rises in body weight in periods 5 and 6 are seen to correspond with increased food intake by males and females, respectively. At the start of summer, the body weight is dropping rapidly all the while food intake is increasing rapidly. It would seem that the birds must feed sufficiently during the migration to remain heavy with fat upon arrival. Thus, at arrival time there is no deficiency, and they are not compelled to feed heavily. When they become involved in territorial activity and mating, they become extremely active with breeding concerns and use up the fat reserves. Since they have less time to devote to foraging and eating, body weight declines. Later, in July an increase in feeding and a rise in body weight in males indicates release of males from breeding activity and growing involvement in molt. The continued low body weights of females indicate longer preoccupation with breeding, presumably feeding and protecting young. Then the release is so late the females appear to have insufficient time to both molt and regain high weights.

Table 6. Body weights of adult Lark Buntings in grams.

Biweekly period	Males n	Males Mean wt., g	Males s	Males $\frac{s}{\sqrt{n}}$	Females n	Females Mean wt., g	Females s	Females $\frac{s}{\sqrt{n}}$	All adults n	All adults Mean[1/] wt., g
1	20	41.3	3.2	0.7	1	39.2	-	-	21	40.25
2	23	38.5	2.8	0.6	8	39.4	1.9	0.7	31	38.95
3	15	38.2	2.2	0.6	10	37.0	2.3	0.7	25	37.60
4	11	36.1	1.8	0.5	11	36.8	3.4	1.0	22	36.45
5	22	36.1	2.3	0.5	19	35.9	3.3	0.8	41	36.00
6	14	39.4	2.7	0.7	13	35.4	2.8	0.8	27	37.40
7	16	39.4	3.0	0.8	12	36.2	2.6	0.7	28	37.80
8	6	39.6	1.1	0.5	6	35.3	3.4	1.4	12	37.45

[1/] Arithmetic mean of males and females

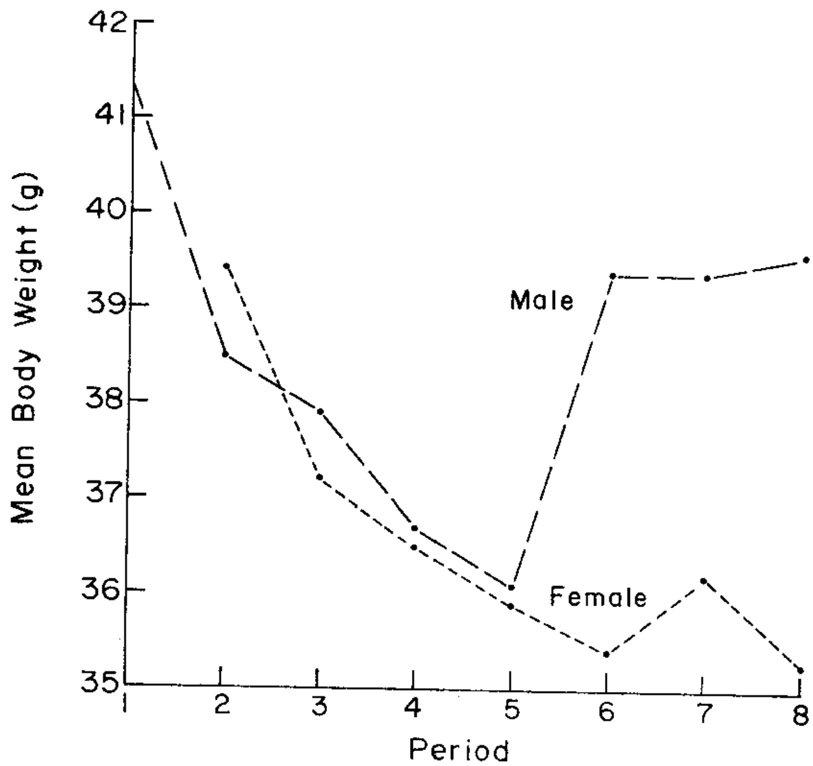

Figure 8. Mean body weight of male and female Lark Buntings for periods 1 to 8. Data from table 6.

The correspondence of pattern and apparent interdependence of pattern for body weight and for food intake fortify the conclusion that trends shown in the data are real, even though consectuive data points, such as biweekly means, cannot in all cases be shown to differ statistically.

Rates of food intake

If information on food consumed is to be fully useful for studies of energy flow in the ecosystem it must be expressed as the rate of feeding. A suitable form would be kilocalories consumed by one bird in one day, thus in units of kcal/b-d (kcal/bird-day).

Since data derived from inspection of stomach contents is based on an essentially instantaneous sample lacking in time dimension, feeding rates cannot be deduced directly from them. The mean caloric content of stomach samples for a biweekly period does not give a direct reading on amount of food eaten in that period (a rate). It is possible, however, to relate the caloric content of stomach samples to the caloric requirement and caloric consumption for periods of time. We assume the mean caloric content of the stomach over a period of time is a function of the rate of feeding. Thus the mean sample content and the total amount eaten in a period have a predictable relationship to each other. It is necessary only to utilize this relationship for a given period, then the total food intake can be calculated from the mean stomach content. Determining this relationship requires the use of general information described in the literature together with data on the local birds and their environment.

Calculation of estimates for the existence energy requirements (Kendeigh, 1963) of Lark Buntings involved the use of mean air temperatures for the Pawnee Site (table 7) and mean body weights of the Lark Buntings (table 6). These calculated estimates of existence energy as they vary over the season from May through August are listed in table 8. These existence energies are graphed in figures 9 and 10.

Table 7. Mean air temperatures at the Pawnee Site (Central Plains Experimental Range) for 1969-1972 in °C.

Year	Biweekly period and calendar dates							
	1	2	3	4	5	6	7	8
	5/1-5/15	5/16-5/31	6/1-6/15	6/16-6/30	7/1-7/15	7/16-7/31	8/1-8/15	8/16-8/31
1969	12.2	13.3	12.2	13.9	19.2	21.3	21.5	20.9
1970	9.5	13.9	12.3	19.5	20.3	20.9	22.0	20.1
1971	9.7	10.8	15.4	21.8	21.4	19.3	20.4	21.2
1972	10.0	14.9	19.2	18.4	18.6	21.5	21.7	18.8
Av., '69-72	10.4	13.2	14.8	18.4	19.9	20.8	21.4	20.3

Table 8. Existence energy requirement for adult Lark Buntings over the spring and summer. Body weights used in calculations are given in table 6, air temperatures in table 7. Calculation of existence energy employed Kendeigh's equations.[1/]

Biweekly period	Mean daily existence energy, kcal/bird-day		
	All adults	Male adults	Female adults
1	26.8	26.8	26.0
2	24.4	24.4	24.7
3	23.2	23.3	23.1
4	21.1	21.1	21.1
5	20.2	20.2	20.1
6	20.2	20.9	19.5
7	20.1	20.6	19.5
8	20.4	21.2	19.7

[1/] At 30°C, $M = 1.368W^{0.674}$; at 0°C, $M = 3.974W^{0.562}$ (Kendeigh, 1963 and personal communication)

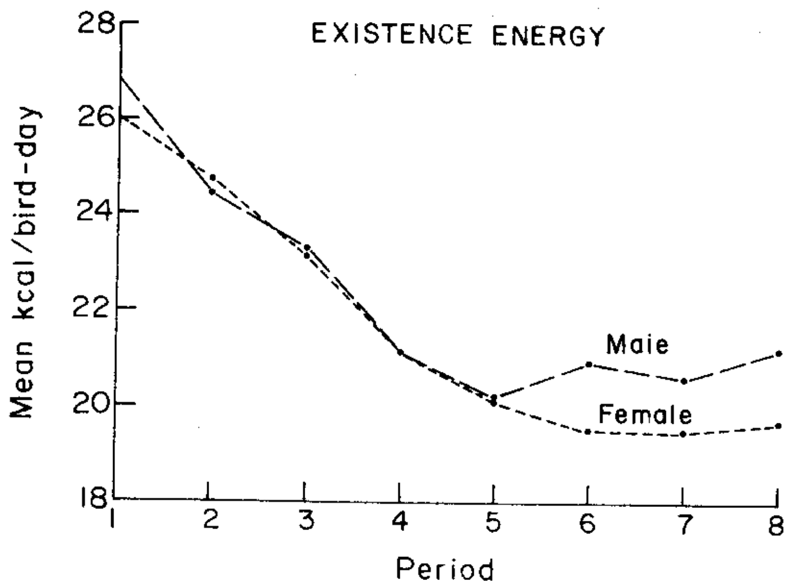

Figure 9. Existence energy requirement (available calories) for males and females compared. Data from table 8.

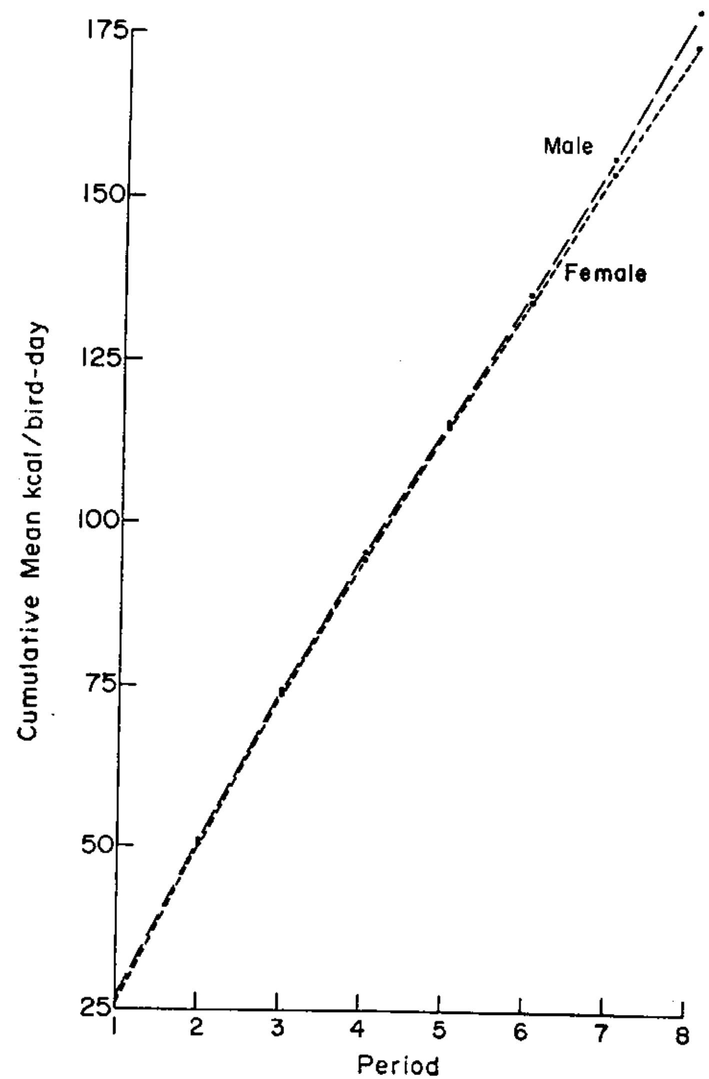

Figure 10. Cumulative mean existence energy requirement for males and females compared. Data from table 8.

In addition to the energy required each day for maintaining the body and performing activities of immediate basic need, a seasonally variable amount of energy is devoted to other processes, such as breeding, molt or fat deposition, and this will be referred to hereafter as activity energy. The sum of existence and activity energies (EE and AE) constitute the total energy (TE) in the daily budget. Thus, some proportion of the calories available from an average stomach content are destined to support EE, the rest AE.

The latter proportion may be estimated for a given period where the chances for an accurate estimate are relatively high. A period of low activity and low body weight was chosen (period 5 for males, period 6 for females). Relying on time budget studies of a similar bird (Schartz and Zimmerman, 1971), we estimated that an amount in the order of .7TE goes for EE and .3TE goes for AE in both the male and female Lark Buntings at these times. Already having an estimate of EE (table 8), we can estimate AE as 8.6 kcal/b-d for males in period 5 and 8.4 kcal/b-d for females in period 6 ($AE=\frac{.3}{.7}EE$). The total energy (TE) is 28.9 and 27.8 kcal/b-d for males in period 5 and females in period 6, respectively.

Not all calories in the food are available to the birds, and a digestive efficiency factor of .8 was arbitrarily assumed; thus, the total calories in food represents gross energy (GE), but the available calories are .8GE, or GE is 1.25 x available calories. To continue with reference to females alone of period 6, we return to the mean caloric content of stomach samples (GE, 1.6696 kcal). We infer that .7 of the calories represented were required for EE and .3 for AE. In terms of GE, this is 1.2 kcal (rounded) for EE and 0.4 kcal for AE. Total available kcal for EE and AE would be 1.3 kcal.

However, we have calculated the EE requirement for females in period 6 to be 19.5 kcal/b-d. To satisfy this demand, the bird would have to provide 20.9 (i.e., 19.5 ÷ 0.9349 kcal) times as many available calories for EE as were found in one average stomach sample. To provide this many available kilocalories for EE, the GE intake per day would have to be 24.4 kcal [20.9 (.7 x 1.6696)]. By the same ratio (.7:.3), the daily demand for AE would be 8.4 kcal in available energy or 10.4 kcal in GE. The total daily demand for available energy (TE) would be 27.9 kcal, and the total daily food intake (GE) would be 34.8 kcal.

To compare food intake of females in other periods we proceed as follows: The ratio of the calculated EE requirement for female adults of period 3 (23.1 kcal, table 8) to the EE requirement of females in period 6 is 23.1:19.5 = 1.185. Also note that the mean caloric content of stomach sample for females of period 3 is 2.31 kcal (table 3) and that the ratio for mean caloric content of samples in period 3 to that of period 6 is 2.3109:1.6696 kcal = 1.3841.

If maintaining 1.7 kcal in the stomach through the day results in a food intake of 34.8 kcal, then maintaining 2.3 kcal in the stomach results in a daily food intake of 48.2 kcal [(2.3109 x 34.8241) ÷ 1.6696], which represents the GE intake by females for period 3. Accordingly, the female in period 3 takes in 38.6 kcal/b-d as available calories (.8 x 48.2001) and 15.8 kcal for AE (TE - EE, or 38.6 - 23.1 kcal).

One arithmetic modification was required. When the GE was calculated as above for both males and females, it was necessary to use the mean of the caloric content values for male period 5 and female period 6 rather than the actual sample values themselves. This was done in order to avoid distorting the relation between male and female values existing in the stomach sample data. The use of the mean was justified, as body weights for period 5 males and for period 6 females were alike, their activities were at a fairly similar level, and the caloric content of the stomach samples did not differ statistically.

The resulting estimates for AE are listed in table 9, and these data are graphed in figure 11. On the graph suggestions have been indicated as to activities that correspond with changes in rates of food intake.

Some interpretations are as follows:

The negative values for period 1 resulted from the birds utilizing their fat reserves and diminishing their food intake.

The males resumed greater consumption of food in period 2 and appeared to invest a considerable but slowly declining amount of energy in reproductive activities through period 5. The females likewise increased food consumption in period 2, but they increased demand for activity energy to a higher level than males. Compared to females, the males appeared to coast through the later phases of nesting. The females carried more of the reproductive burden than the males.

In males, food consumption rose sharply at a time when many males were in annual post-breeding molt; subsequently, excess calories resulted in fat deposition. In females the same sharp rise in expenditure of activity energy occurred at the end of reproductive duties, and onset of molt was delayed.

The total food intake per day (GE) is shown in table 10, and these data are graphed in figures 12 and 13. The female adults consumed food

Table 9. Activity energy requirement for adult Lark Buntings over the spring and summer. See text for energy requirements included as activity energy.

Biweekly period	Mean daily activity energy, kcal/bird-day		
	All adults[1/]	Male adults	Female adults
1	-7.2	-6.7	-7.7
2	12.2	11.4	12.9
3	14.3	7.6	21.0
4	13.4	8.8	18.0
5	10.8	4.6	17.0
6	16.8	21.1	12.4
7	20.2	18.4	21.9
8	11.1	9.1	13.1

[1/] Arithmetic mean of columns 2 and 3.

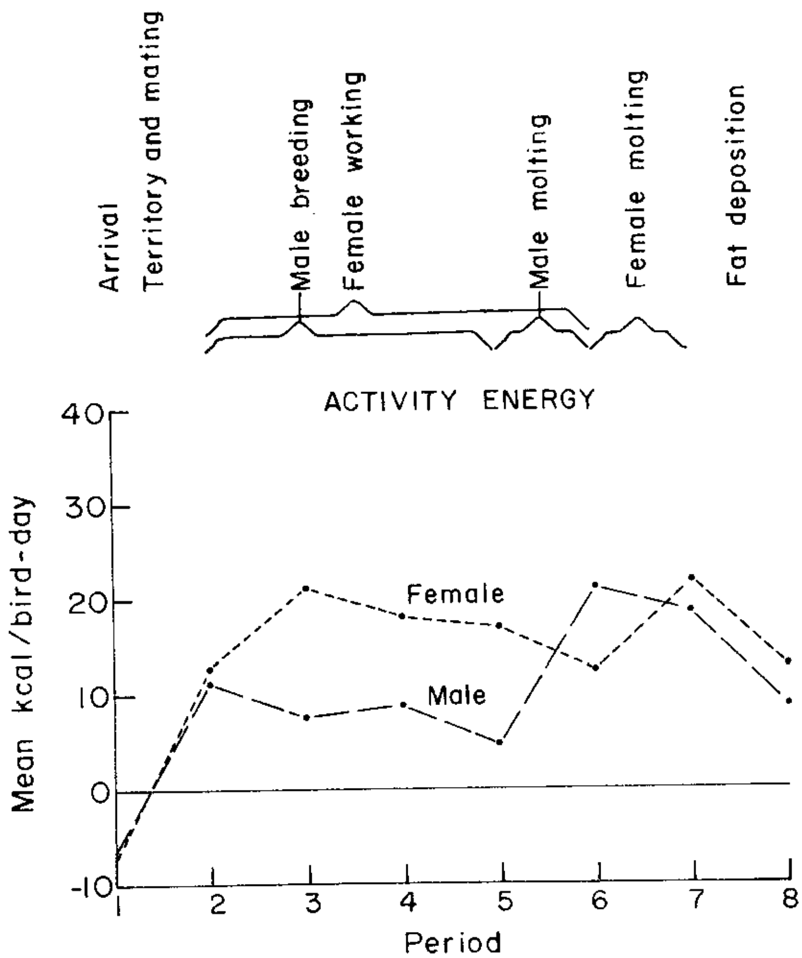

Figure 11. Energy in available calories going to support extra activities, molt and fat deposition for males and females compared. Data from table 9.

Table 10. Total daily food intake requirement (GE) for adult Lark Buntings over the spring and summer.

Biweekly period	Mean total daily energy, kcal/bird-day		
	All adults[1/]	Male adults	Female adults
1	24.0	25.1	22.8
2	45.9	44.7	47.0
3	46.9	38.6	55.1
4	42.7	37.4	49.0
5	38.7	31.0	46.4
6	46.2	52.5	39.8
7	50.3	48.8	51.8
8	39.4	37.9	41.0

[1/] Arithmetic mean of columns 2 and 3.

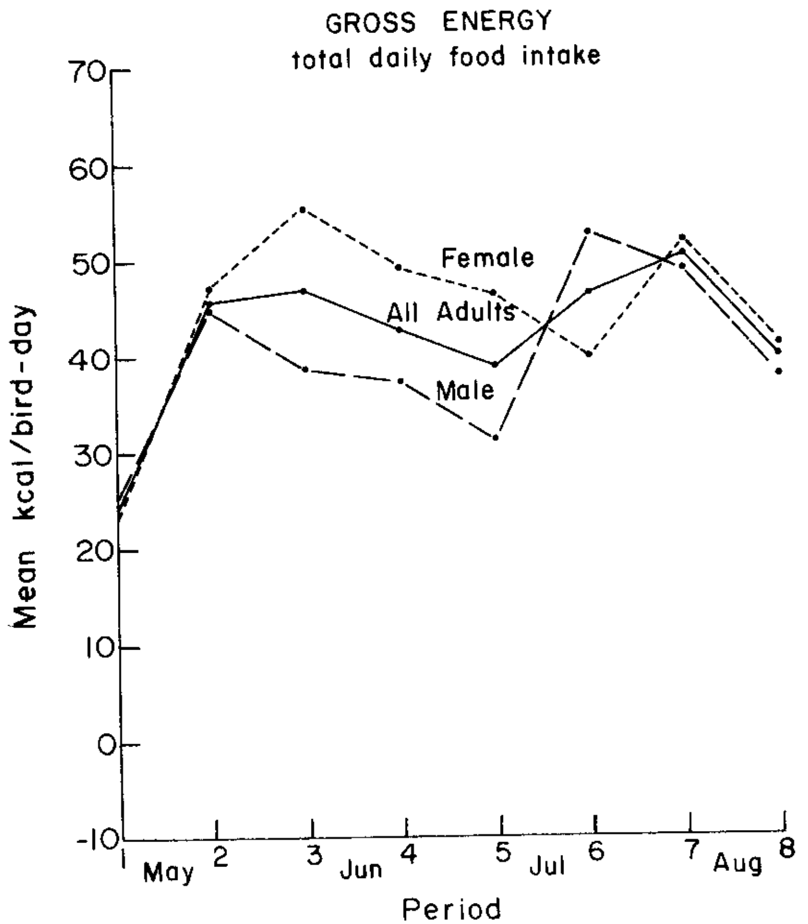

Figure 12. Daily intake of gross energy as food for adult Lark Buntings. Data from table 10.

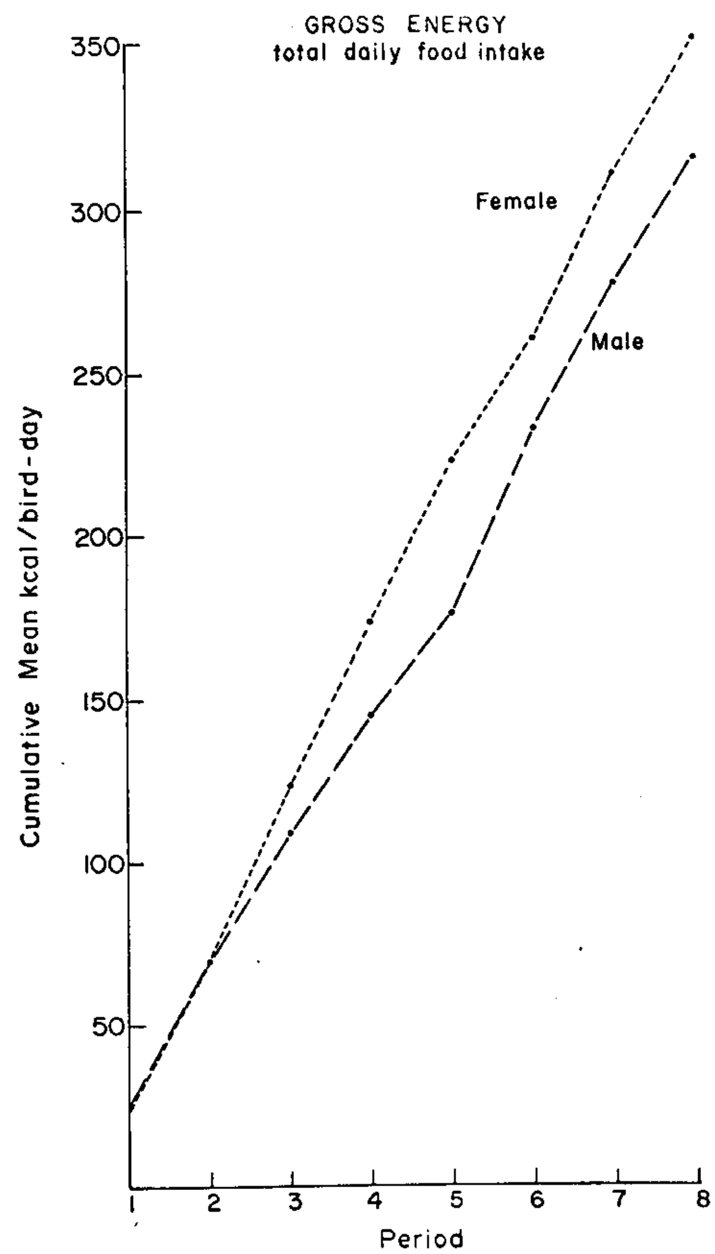

Figure 13. Cumulative mean gross energy intake for adult Lark Buntings Data from table 10.

at a higher average rate in summer than did males, resulting in a greater total consumption of food by females. The cumulative mean food intake in units of kcal/b-d from May through August is calculated as 352.9 for females and 316.0 for males. This represents a 11.7 per cent greater rate of food intake by females. The mean feeding rate for adults is 42.06 kcal/b-d, for male adults 39.50, and for female adults 44.11.

One bias in the above estimates should be mentioned. Since the total daily intake was derived by multiplying mean stomach content by a quantity in part dependent on length of day, the magnitude of calculated intake would vary as the length of day. This source of variation was ignored in the calculations. The shorter daily periods available for feeding early in the season would result in somewhat lower total daily intake than calculated here.

<u>Seasonal pattern of food consumption by juveniles</u>

First the pattern of food consumption by adults and juveniles combined will be examined, then the pattern for juveniles alone and finally points of comparison between juveniles and adults. The ANOVA in all cases compares adults from seasonal periods 4 through 8 with juveniles from the same periods. Data on food intake for adults and juveniles combined are given in table 11 and graphed in figure 14; those for juveniles alone in table 12 and figures 15 and 16; and those for adults alone in table 1 and figure 17.

For total foods eaten, the ANOVA indicated a highly significant difference between ages ($p<.0001$), and t-tests showed significant differences between ages at periods 4 ($p<.001$), 6 ($p<.05$), and 8 ($p<.025$). The fact that the ANOVA did not show a significant difference between seasonal periods ($p<.0901$) is explained by occurrence of compensating changes in proportions of animal versus plant foods taken as the periods progressed. Juveniles differed between periods 5 and 6 ($p<.05$), but at all other periods did not differ. These effects are shown in figures 15 and 16.

For animal foods the ANOVA revealed strong differences between adults and juveniles ($p<.0000$) and also between seasonal periods ($p<.0011$). LSD tests showed period 4 to differ from period 7 but others not differing. A considerably higher intake of animal foods by juveniles than by adults accounted for the difference between ages. By t-test, the adults differed significantly from juveniles at period 4 ($p<0.25$) and period 6 ($p<.05$), but periods 7 and 8 were indecisive ($p<.10$). Adults showed an indecisive difference in food intake between periods 4 and 5, as indicated by t-test

Table 11. Food intake by adults and juveniles (out of the nest) combined from late June through August. Data are mean kilocalories of food in stomach contents.

Food	Biweekly period	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	4	25	1.6459	.8221	.1644
	5	51	1.1806	.9981	.1398
	6	38	1.5098	1.4562	.2364
	7	44	1.1392	1.1235	.1694
	8	40	1.1979	.8087	.1279
Plant food	4	25	.2218	.1749	.0350
	5	51	.3957	.4041	.0566
	6	38	.7757	.8469	.1374
	7	44	.9877	1.0234	.1543
	8	40	1.0259	1.3429	.2123
Total food	4	25	1.8677	.7479	.1496
	5	51	1.5763	1.3137	.1840
	6	38	2.2854	1.2942	.2099
	7	44	2.1269	1.3063	.1969
	8	40	2.2231	2.4442	.3865

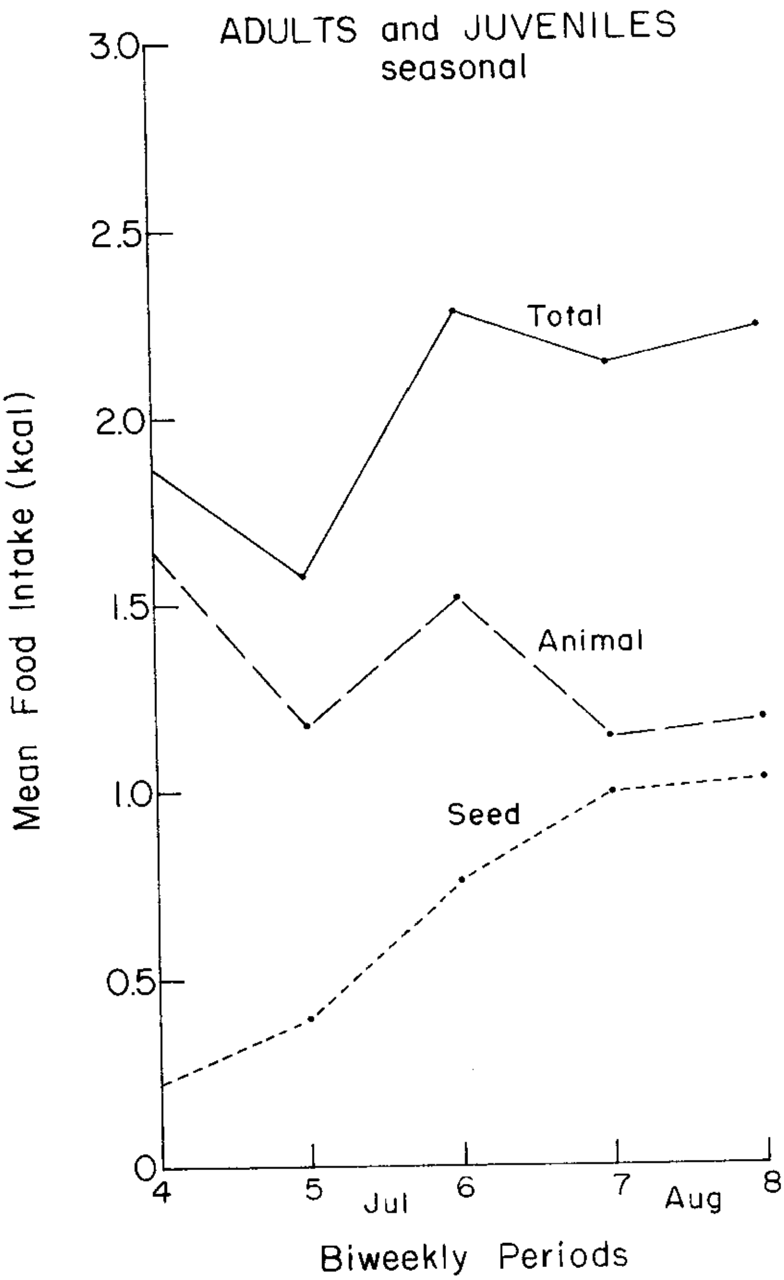

Figure 14. Food intake by adults and juveniles (out of the nest) combined from late June through August. Data from table 11.

Table 12. Mean caloric content of stomach foods in juveniles (out of the nest) from late June through August. Refer to table 1 for adult values.

Food	Biweekly period	Date	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	4	16-30 June	2	2.952	.4412	.3120
	5	1-15 July	9	1.5787	.9317	.3106
	6	16-31 July	11	2.6324	2.0899	.6301
	7	1-15 Aug	16	1.6133	1.5796	.3949
	8	16-30 Aug	28	1.3461	.7722	.1459
Plant food	4		2	.0075	.0106	.0075
	5		9	.1179	.1837	.0612
	6		11	.5799	.7632	.2301
	7		16	.654	.5894	.1474
	8		28	1.14	.9497	.1795
Total food	4		2	2.9595	.4518	.3195
	5		9	1.6966	1.1176	.3725
	6		11	3.2123	1.6813	.5069
	7		16	2.2673	1.6935	.4234
	8		28	2.4861	.9233	.1745

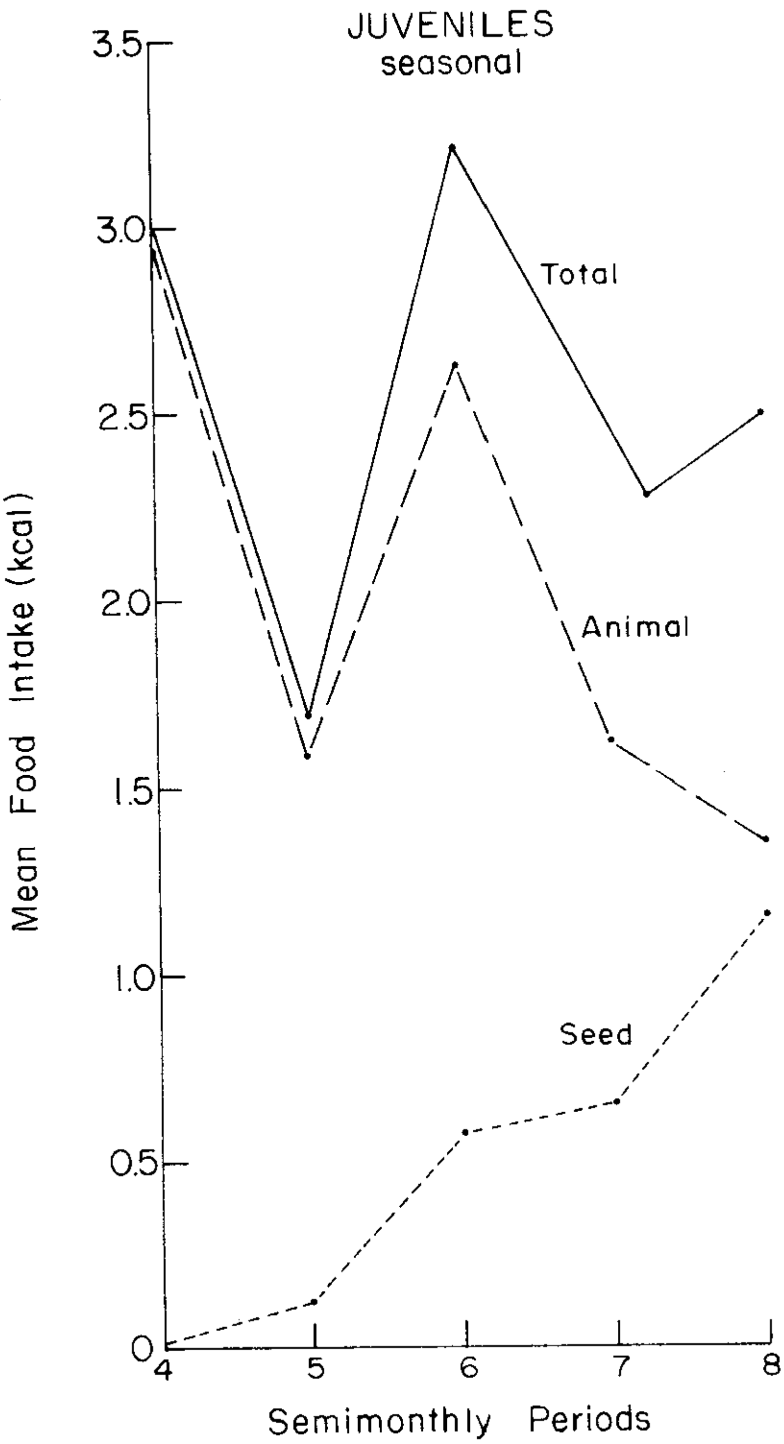

Figure 15. Mean caloric content of foods in stomach samples from juvenile Lark Buntings by seasonal periods. Data from table 12.

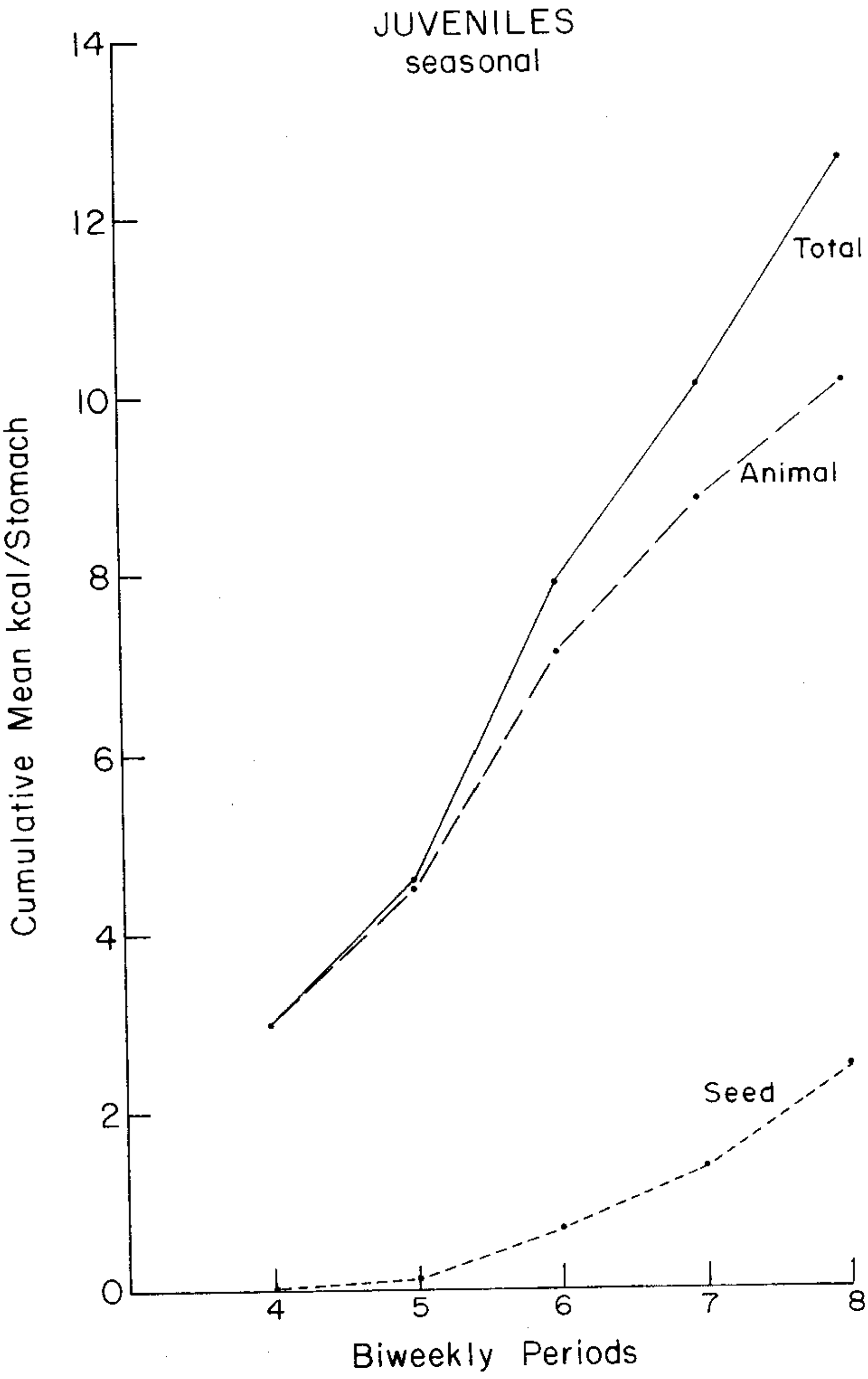

Figure 16. Cumulative mean caloric content of stomach samples of juveniles over seasonal periods 4 through 8.

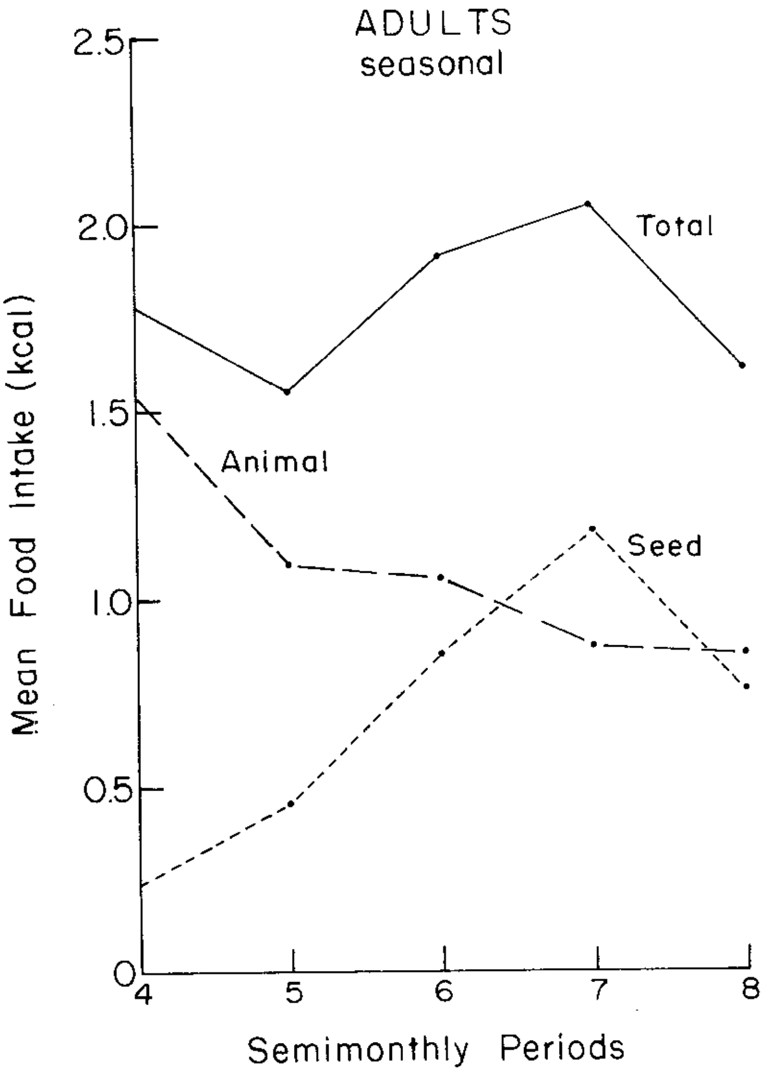

Figure 17. Mean caloric content of stomach samples from adult Lark Buntings for seasonal periods 4 through 8. Data from table 1.

(p<.10), and juveniles showed a more distinct difference (p<.05) for the same periods; all other periods did not differ when tested in consecutive order.

For plant foods, the ANOVA failed to reveal significant difference between ages (p<0.663); however, by t-test the ages did differ significantly at two periods, as juveniles were significantly lower at period 5 (p<.001) and period 7 (p<.05). The ANOVA indicated a highly significant difference between seasonal periods (p<.0000). LSD tests showed periods 4 and 5 to differ from periods 6, 7 and 8. It is evident from graphs (figures 14, 15, 16) that plant food items increased through the season. The adults differed significantly between themselves for periods 4 and 5 by t-test (p<.005) and periods 5 and 6 (p<.01). Juveniles had indecisive differences between periods 5 and 6 and 7 and 8 (p<.10).

The proportions of animal versus plant foods in the diet of adults and juveniles are presented in table 13. As before, the juveniles are those which have left the nest. Data for nestlings are considered by Creighton (1973).

Some relationships among adults are:

Between periods 5 and 6, the male adults decrease animal food from 71.2 to 47.4 per cent, near which latter level it remains through August. Female adults decrease animal food slightly (not significant) but still maintain the proportion of animal food to at least 2/3 through period 6. The females shift to predominatly plant foods between periods 6 and 7. For period 6, plant food intake by females was significantly different from that by males (p<.0500) but animal food intake was not.

Table 13. Proportions of animal versus plant foods within seasonal periods in diet of adult and juvenile Lark Buntings.

Biweekly period	Male adults			Female adults			All adults			Juveniles		
	n	% Animal food	% Plant food	n	% Animal food	% Plant food	n	% Animal food	% Plant food	n	% Animal food	% Plant food
1	20	66.62	33.38	1	87.15	12.85	21	67.54	32.46	0	-	-
2	23	81.71	18.29	8	75.69	24.31	31	80.06	19.94	0	-	-
3	14	71.93	28.07	10	73.24	26.76	24	72.61	27.39	0	-	-
4	12	82.30	17.70	11	89.77	10.23	23	86.44	13.56	2	99.75	0.25
5	24	71.19	28.81	18	70.16	29.84	42	70.64	29.36	9	93.05	6.95
6	14	47.45	52.55	13	65.76	34.24	27	55.16	44.84	11	81.95	18.05
7	18	47.77	52.23	10	33.65	66.35	28	42.42	57.58	16	71.16	28.84
8	7	49.80	50.20	5	56.87	43.13	12	52.94	47.06	28	54.15	45.85

The trends in juveniles are otherwise. The diet appears to be practically entirely animal for juveniles just out of the nest when presumably they obtain food almost exclusively from the parents. This would be the situation at period 4. It also appears that as the juveniles feed more on their own they take more seeds; however, the steady increase in seed food eaten in July and August corresponds in time to the mid and late summer increases previously noted for seeds eaten by male and female adults. The mean per cent of animal foods taken by juveniles drops lower by about 10 per cent for each successive biweekly period, and the proportion of plant food increases correspondingly. By the end of August, the juveniles are eating animal and plant foods in the same proportions as are adults.

Effect of time of day on amounts of food eaten

The mean caloric content of stomach samples randomly collected through the day is assumed to represent by some proportion the actual amounts of food eaten during periods of the day. Undoubtedly sampling in this case was not ideally random, yet an effort was made to sample at all periods of the day. Data obtained have been considered in the light of ANOVA, t-tests and least significant differences.

A summary of the mean caloric content of foods eaten by all adult Lark Buntings during two-hour periods beginning 0401 hours to 2000 hours is given in table 14; these data are graphed in figure 18. For total food intake by all adults an indecisive difference appears among the several bihourly periods (ANOVA, $p<.0962$). By LSD, period 5 is different from all other periods; also, by t-test periods 4 and 5 are close to differing ($p<.10$) and periods 5 and 6 differ ($p<.025$). On comparing intake of total foods by male and female (tables 15 and 16, figures 19 and 20), a significant difference is found between the sexes ($p<.0087$). This is a lower p value than that for the differences in animal foods alone between sexes ($p<.0234$). Even though no significant difference appeared in plant foods ($p<.3324$), the intake of plant foods together with animal foods resulted in greater significance of total food differences. Areas of significant differences between the means of the two sexes were indistinct. Between males and females, an indecisive difference was shown at period 1 ($p<.10$). Within males an indecisive difference showed between periods 4 and 5 ($p<.10$) and significant differences between periods 5 and 6 ($p<.05$); whereas, within females no differences appeared upon comparing these same means in consecutive order.

Table 14. Mean caloric content of animal, plant, and total foods from stomachs of adult Lark Buntings during bihourly periods beginning 0401 hours to 2000 hours.

Food	Bihourly period	Hour	n	Mean kcal	Std. dev.(s)	Std. error($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	11	.9218	.9991	.3012
	2	0601-0800	37	.9994	1.0785	.1773
	3	0801-1000	91	1.1690	.7247	.0760
	4	1001-1200	25	1.1794	.8052	.1610
	5	1201-1400	20	1.7529	.8841	.1977
	6	1401-1600	9	.7313	.5544	.1848
	7	1601-1800	5	.5916	.4154	.1858
	8	1801-2000	10	.9750	.5350	.1692
Plant food	1		11	.4237	.6705	.2022
	2		37	.5604	.5442	.0895
	3		91	.6680	.6653	.0697
	4		25	.5329	.5757	.1151
	5		20	.4271	.3975	.0889
	6		9	.612	.7229	.2410
	7		5	.4278	.2395	.1071
	8		10	.4863	.5268	.1666
Total food	1		11	1.3455	.8995	.2712
	2		37	1.5598	1.2448	.2046
	3		91	1.8370	.8637	.0905
	4		25	1.7123	.9521	.1904
	5		20	2.1800	.8756	.1958
	6		9	1.3433	.7860	.2620
	7		5	1.0194	.3703	.1656
	8		10	1.4613	.6705	.2120

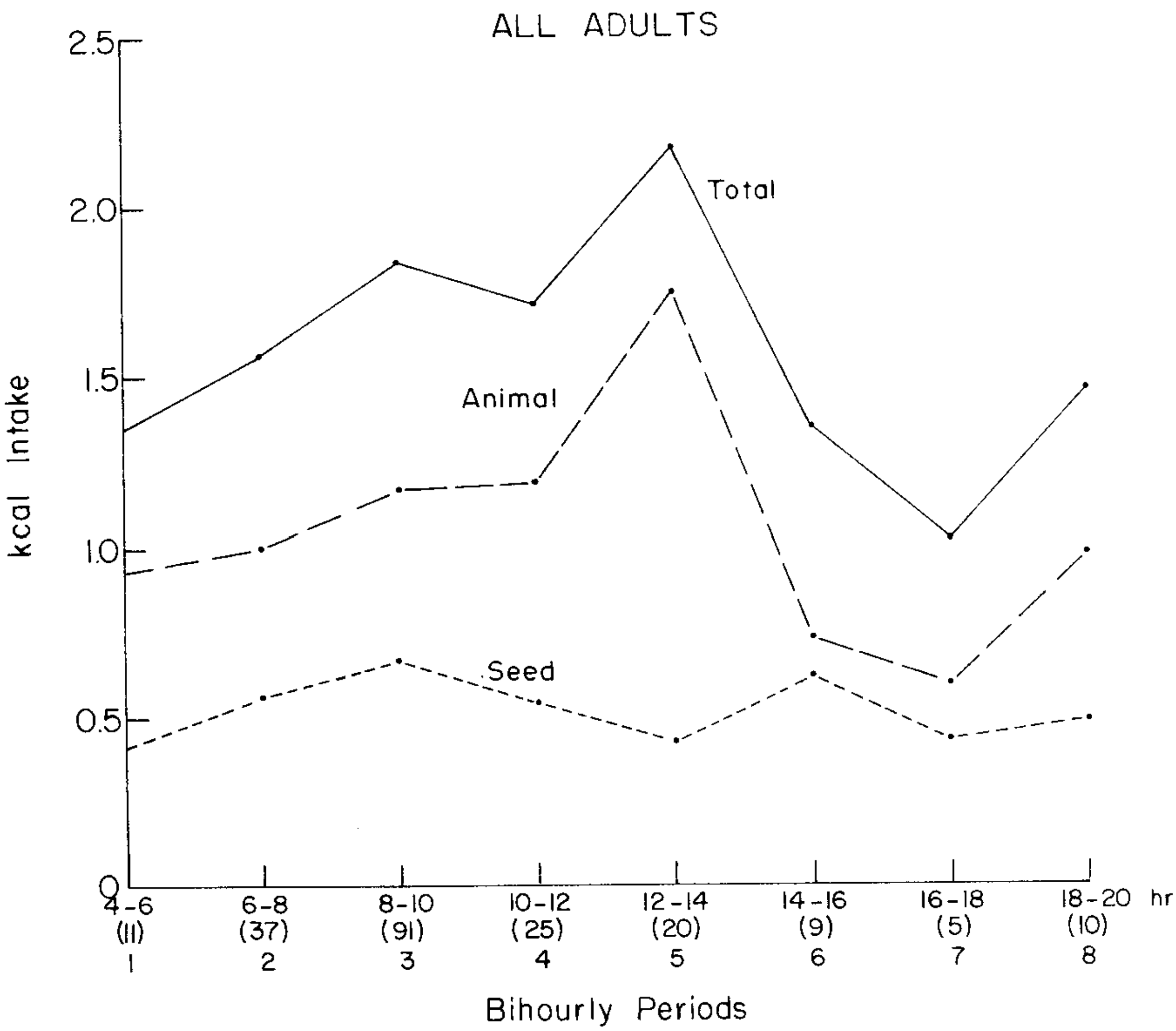

Figure 18. Mean caloric content of stomach samples of adult Lark Buntings by two-hour periods. Data from table 14. Sample size in parentheses.

Table 15. Mean caloric content of stomach samples of male adults during bihourly periods.

Food	Bihourly period	Hour	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	8	.7943	.5065	.1791
	2	0601-0800	22	.8173	.4934	.1053
	3	0801-1000	56	1.1085	.7624	.1019
	4	1001-1200	14	.9750	.6735	.1666
	5	1201-1400	13	1.6426	.7772	.2156
	6	1401-1600	8	.6832	.5773	.2023
	7	1601-1800	4	.7245	.3351	.1676
	8	1801-2000	7	.9385	.6274	.2371
Plant food	1		8	.1581	.2124	.0751
	2		22	.5479	.5384	.1148
	3		56	.6146	.6051	.0809
	4		14	.4971	.6440	.1721
	5		13	.5093	.3861	.1071
	6		8	.6845	.7370	.2606
	7		4	.4272	.2766	.1383
	8		7	.5185	.5542	.2095
Total food	1		8	.9524	.4288	.1516
	2		22	1.3652	.7732	.1648
	3		56	1.7231	.8533	.1140
	4		14	1.4721	.9878	.2640
	5		13	2.1519	.8567	.2376
	6		8	1.3677	.8367	.2958
	7		4	1.1517	.2569	.1285
	8		7	1.4570	.7956	.3007

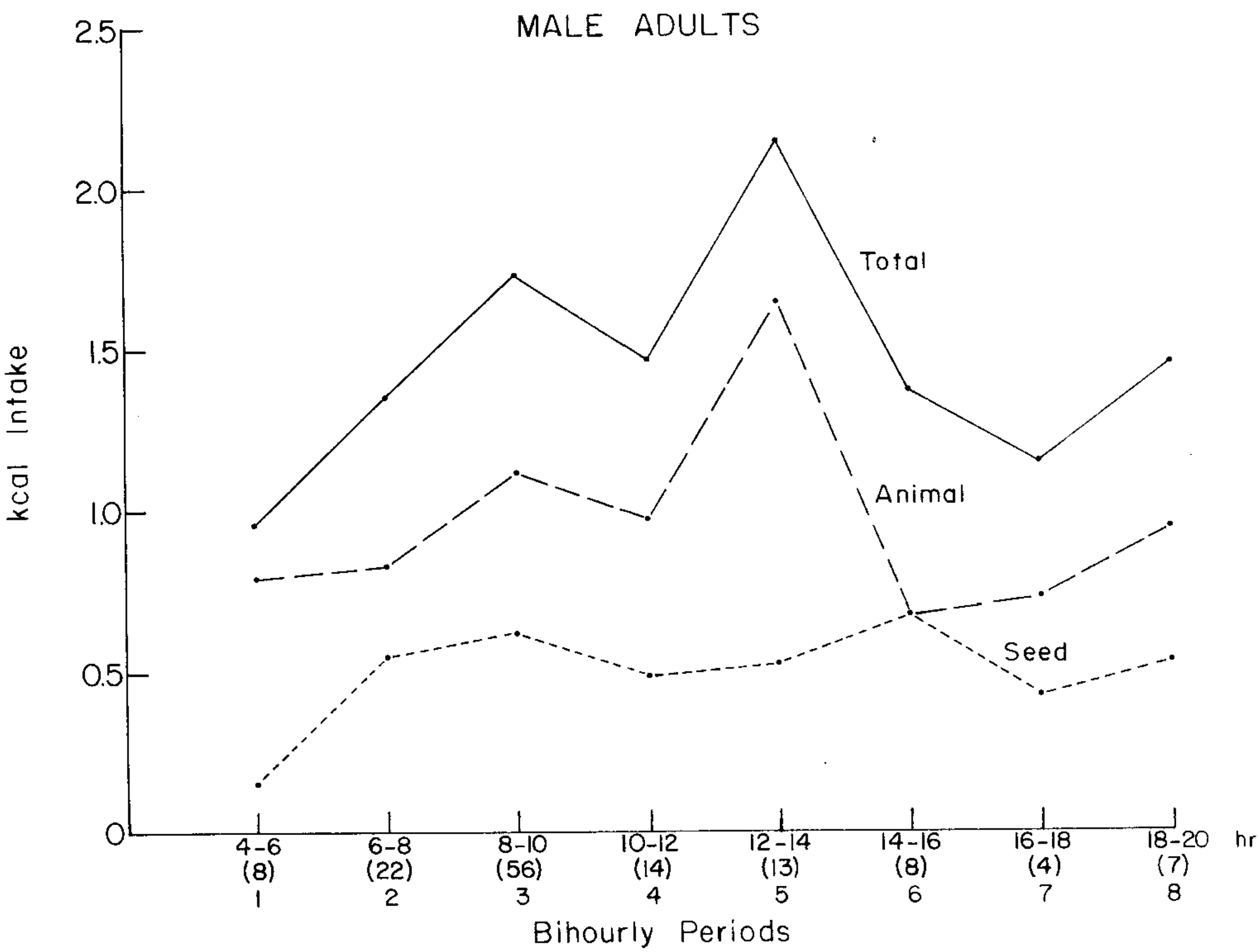

Figure 19. Mean caloric content of stomach samples of male adult Lark Buntings by two-hour periods. Data from table 15. Sample size in parentheses.

Table 16. Mean caloric content of stomach samples of female adults during bihourly periods.

Food	Bihourly period	Hour	n	Mean kcal	Std. dev.(s)	Std. error($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	3	1.2620	1.9634	1.1336
	2	0601-0800	15	1.2664	1.5801	.4080
	3	0801-1000	35	1.2658	.6592	.1114
	4	1001-1200	11	1.4394	.9580	.2889
	5	1201-1400	7	1.9577	1.0917	.4126
	6	1401-1600	1	1.1160	-	-
	7	1601-1800	1	.0600	-	-
	8	1801-2000	3	1.0600	.3033	.1751
Plant food	1		3	1.1320	1.0272	.5931
	2		15	.5786	.5710	.1474
	3		35	.7533	.7530	.1273
	4		11	.5785	.5022	.1514
	5		7	.2743	.4003	.1513
	6		1	.0320	-	-
	7		1	.4300	-	-
	8		3	.4110	.5616	.3242
Total food	1		3	2.3940	1.0652	.6150
	2		15	1.8450	1.7151	.4428
	3		35	2.0191	.8609	.1455
	4		11	2.0179	.8508	.2565
	5		7	2.2320	.9772	.3694
	6		1	1.1480	-	-
	7		1	.4900	-	-
	8		3	1.4710	.3521	.2033

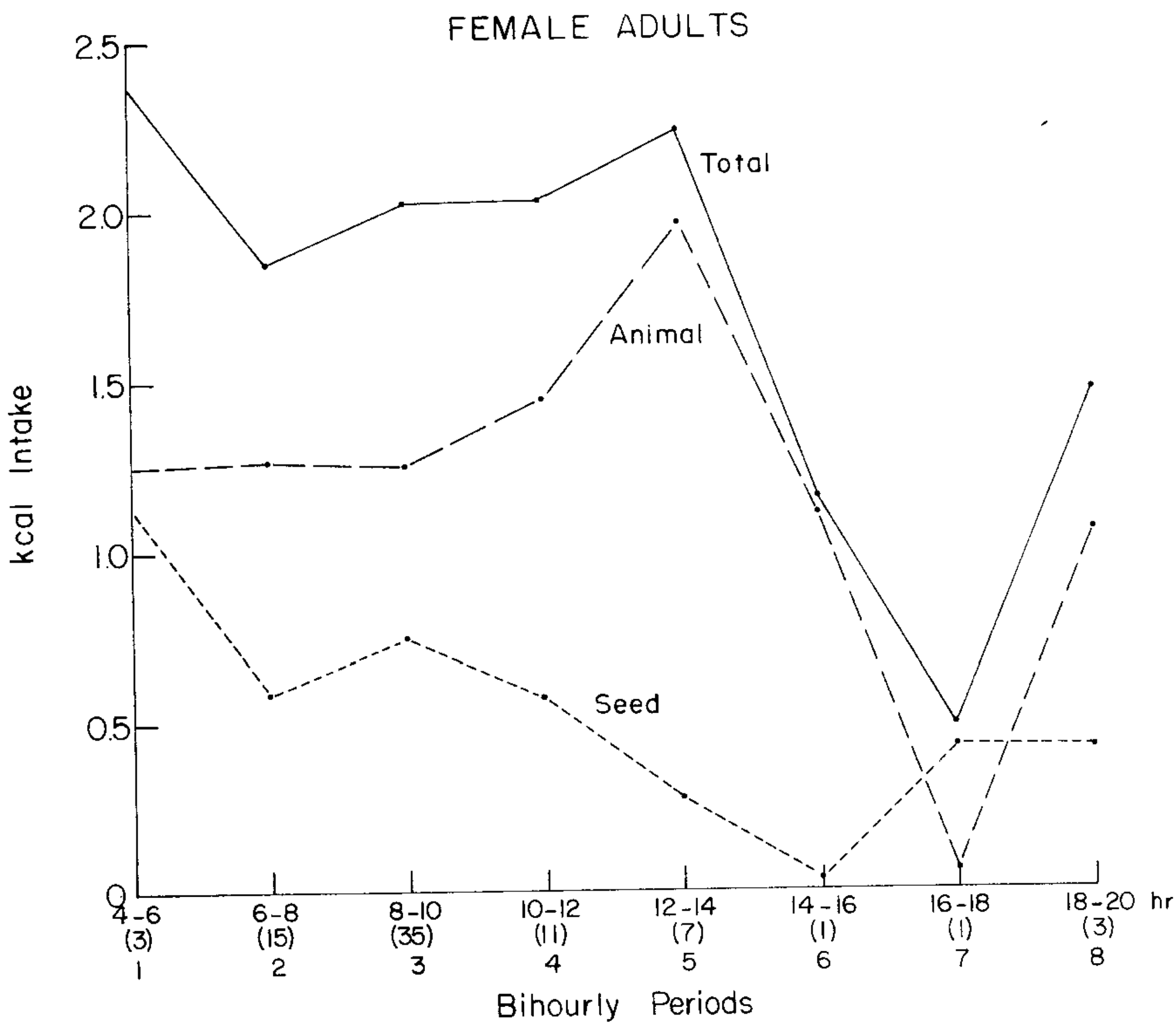

Figure 20. Mean caloric content of stomach samples of female adult Lark Buntings during bihourly periods. Data from table 16. Sample size in parentheses.

At best, it could be postulated that males fed less early in the day but steadily increased their food intake, but females fed earlier and more constantly; however, after 1400 hours food intake of both sexes decreased until late afternoon.

For animal foods eaten by all adults, ANOVA failed to show a significant difference through time of day ($p<.1823$). Nevertheless, LSD showed period 5 to be significantly different from all other periods; and by t-test a significant difference arose between periods 4 and 5 ($p<.05$) and periods 5 and 6 ($p<.005$). The nature of this difference in period 5 may be seen by reference to table 17, where percentage composition of the animal food component of the diet is given. Coleoptera (beetles) and Hymenoptera (ants) both decreased in representation, whereas Orthoptera (grasshoppers) increased in terms of grams dry weight. Analysis of variance showed significant differences to exist among bihourly periods for the three major orders ($p<.05$). Not only did a definite increase in animal food intake occur at period 5 (1201-1400 hours), but large changes were made in the proportions of the types of insects eaten. The increase in Orthoptera and decrease in Coleoptera appeared due to change in availability. Some beetles become less active during that part of day; thus, Orthoptera become relatively more conspicuous. Feeding on these larger sized insects would quickly build up the total intake. Data for comparing males and females are given in tables 15 and 16 and graphed in figures 19 and 20. The ANOVA indicated a significant difference between sexes for animal foods ($p<.0234$), but t-tests did not support this. From the graphs, the females appeared to eat a slightly greater amount, except in periods 6 and 7, where the single samples may reflect the trend poorly. The males, however, with a larger sample size for this

Table 17. Per cent composition per bihourly period for three major orders of animal food.

Bihourly period	Hour	Amount of order in food, per cent		
		Coleoptera	Orthoptera	Hymenoptera
1	0401-0600	44.4	17.0	9.1
2	0601-0800	55.1	19.5	18.7
3	0801-1000	47.9	29.2	17.5
4	1001-1200	42.2	34.7	17.1
5	1201-1400	36.1	49.0	7.3
6	1401-1600	45.0	38.8	10.6
7	1601-1800	55.6	26.3	14.6
8	1801-2000	47.1	35.1	11.7

period, did show the same general trend of decreased intake for those periods.

For plant foods eaten by all adults, the ANOVA did not show significant differences between bihourly periods ($p<.1811$), nor did t-tests. The dip at period 5 could relate to increased effort in obtaining animal foods. Further, ANOVA showed no differences between sexes; t-tests did not reveal differences either between or within sexes. Not even the two means which are farthest apart (female, periods 1 and 5) were shown to be different, due to large variance.

The proportions of animal versus plant foods eaten by adult Lark Buntings through the several bihourly periods are listed in table 18. The increase in animal foods just mentioned at period 5 is also substantiated with these data, which indicate a large increase in the proportion of animal foods eaten at this time. The smaller proportion of plant food, however, is not indicative of absolute decrease in plant food intake.

Table 18. Proportions of animal versus plant foods eaten by Lark Buntings at different times of day.

Bihourly period	Male adults			Female adults			All adults		
	n	% Animal food	% Plant food	n	% Animal food	% Plant food	n	% Animal food	% Plant food
1	8	83.40	16.60	3	52.72	47.28	11	68.51	31.49
2	22	59.87	40.13	15	68.64	31.36	37	64.07	35.93
3	56	64.33	35.12	35	62.69	37.31	91	63.64	36.36
4	14	66.23	33.77	11	71.33	28.67	25	68.88	31.12
5	13	76.33	23.67	7	87.71	12.29	20	80.41	19.59
6	8	49.95	50.05	1	97.21	2.79	9	54.41	45.56
7	4	62.91	37.09	1	12.24	87.76	5	58.03	41.97
8	7	64.41	35.59	3	72.06	27.94	10	66.72	33.28

Effect of time of day on proportion of animal and plant foods of juveniles

All comparisons were made between adults and juveniles collected in biweekly periods 4 through 8. The bihourly values obtained for adults from periods 4 through 8 did not differ significantly from the values obtained from adults over the entire season, except for bihourly period 6 for animal foods (t-test, $p<.05$). Results are given in tables 19, 20 and 21 and graphed in figures 21, 22 and 23.

Analysis of variance showed a significant difference in total foods eaten at different periods of the day ($p<.0043$); LSD showed periods 3, 4 and 5 differed from 1, 7 and 8 but not 2 and 6. ANOVA also revealed a highly significant difference between ages ($p<.0000$). By t-test, juveniles were significantly higher than adults at period 2 ($p<.05$), period 3 ($p<.025$), and period 4 ($p<.005$). Likewise, adults differed between periods 3 and 7 ($p<.025$) and indecisively between periods 5 and 7 ($p<.10$); all other periods did not differ. Juveniles differed by t-test between periods 1 and 4 ($p<.025$), 1 and 3 ($p<.05$) and 4 and 7 ($p<.05$); all other periods did not differ.

In animal foods, ANOVA revealed a significant difference through the day ($p<.0231$). By LSD, period 5 was different from all periods except 3. By t-test, juveniles were significantly higher than adults at period 3 ($p<.025$) and indecisively so at period 4 ($p<.10$). This increase at period 3 due to juveniles could have caused the non-difference with period 5 in the LSD test.

In plant foods, ANOVA failed to bring out significant differences between the times of day ($p<.4204$). An increase in intake at period 6 was found, but the small sample size and large variation precluded

Table 19. Mean caloric content of stomach samples for adults and juveniles combined through bihourly periods of the day. Birds were collected from biweekly period 4 through 8 (late June through August).

Food	Bihourly period	Hour	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	17	.8471	.8471	.2055
	2	0601-0800	37	1.0974	1.1290	.1856
	3	0801-1000	84	1.4893	1.1350	.1238
	4	1001-1200	28	1.3746	1.0535	.1991
	5	1201-1400	7	1.9414	1.2979	.4906
	6	1401-1600	2	.2790	.0126	.0089
	7	1601-1800	9	.9493	1.0336	.3445
	8	1801-2000	14	1.0213	.5518	.1475
Plant food	1		17	.4606	.7319	.1775
	2		37	.7859	.8287	.1362
	3		84	.7692	.7069	.0771
	4		28	.8167	.7830	.1480
	5		7	.5181	.6024	.2277
	6		2	1.4450	1.3138	.9290
	7		9	.3942	.3116	.1039
	8		14	.3747	.4779	.1277
Total food	1		17	1.3775	1.0408	.2524
	2		37	1.8825	1.4257	.2344
	3		84	2.2585	1.0969	.1197
	4		28	2.1913	1.1060	.2090
	5		7	2.4596	1.0563	.3993
	6		2	1.7240	1.3010	.9200
	7		9	1.3436	.9072	.3024
	8		14	1.3960	.6401	.1711

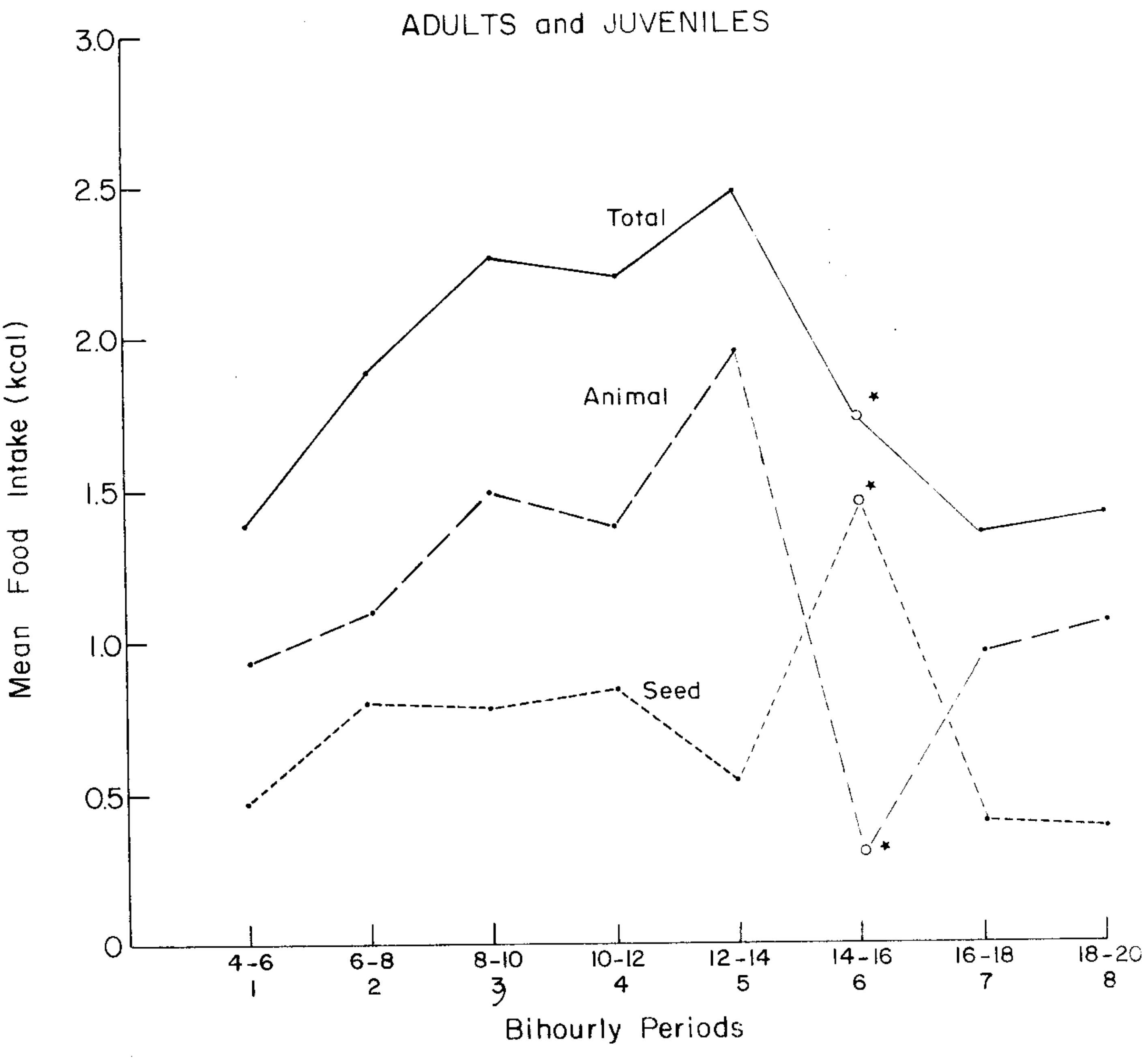

Figure 21. Mean caloric content of stomach samples from adults and juveniles combined. Data from table 19. Star indicates average of observed adult value and theoretical juvenile value for period 6.

Table 20. Mean caloric content of stomach samples for bihourly periods in adult Lark Buntings collected during seasonal periods 4 through 8.

Food	Bihourly period	Hour	n	Mean kcal	Std. dev. (s)	Std. error ($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	11	.9218	.9991	.3012
	2	0601-0800	26	1.0449	1.2473	.2446
	3	0801-1000	58	1.2204	.7399	.0972
	4	1001-1200	16	1.0260	.6006	.1502
	5	1201-1400	4	1.6065	.9311	.4656
	6	1401-1600	2	.2790	.0126	.0089
	7	1601-1800	4	.5130	.4346	.2173
	8	1801-2000	11	.9687	.5080	.1532
Plant food	1		11	.4237	.6705	.2022
	2		26	.6284	.6098	.1194
	3		58	.8082	.7459	.0979
	4		16	.6544	.5639	.1410
	5		4	.4050	.5389	.2695
	6		2	1.4450	1.3138	.9290
	7		4	.4752	.2479	.1239
	8		11	.4637	.5053	.1524
Total food	1		11	1.3455	.8994	.2712
	2		26	1.6733	1.4211	.2787
	3		58	2.0286	.8615	.1131
	4		16	1.6804	.8861	.2215
	5		4	2.0115	.9479	.4739
	6		2	1.7240	1.3010	.9200
	7		4	.9883	.4200	.2100
	8		11	1.4325	.6431	.1939

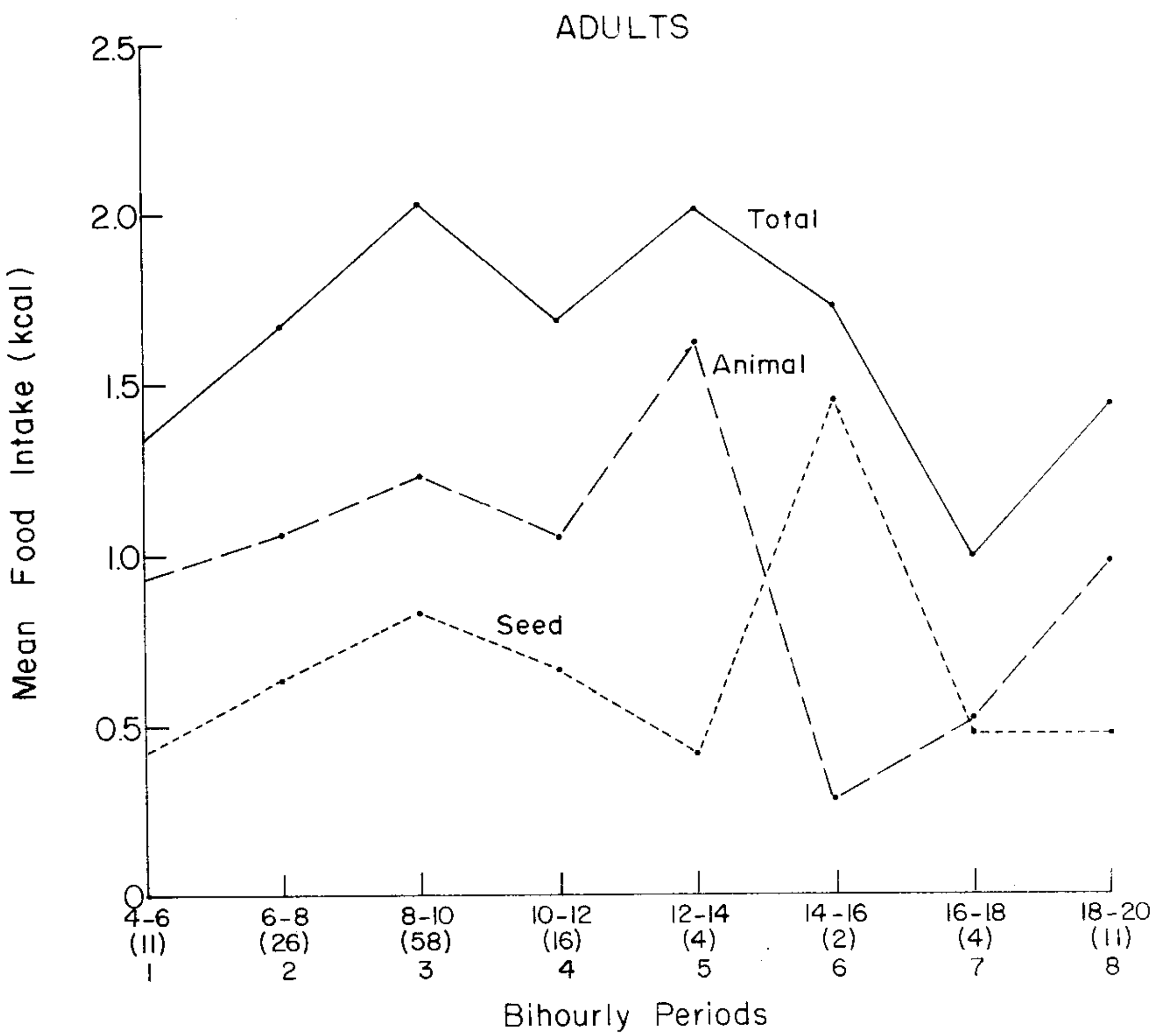

Figure 22. Mean caloric content of stomach samples for bihourly periods in adult Lark Buntings collected during seasonal periods 4 to 8. Data from table 20. Sample size in parentheses.

Table 21. Mean caloric content of stomach samples for juveniles during bihourly periods of day. Birds were collected from late June through August.

Food	Bihourly period	Hour	n	Mean kcal	Std. dev.(s)	Std. error($\frac{s}{\sqrt{n}}$)
Animal food	1	0401-0600	6	.9080	.5475	.2235
	2	0601-0800	11	1.2213	.8215	.2477
	3	0801-1000	26	2.0892	1.5773	.3093
	4	1001-1200	12	1.8395	1.3489	.3894
	5	1201-1400	3	2.3880	1.7971	1.0376
	6	1401-1600	0	0.0000	-	-
	7	1601-1800	5	1.2984	1.2855	.5749
	8	1801-2000	3	1.2140	.7861	.4539
Plant food	1		6	.5282	.8981	.3667
	2		11	1.1583	1.1584	.3493
	3		26	.6820	.6162	.1208
	4		12	1.0331	.9909	.2860
	5		3	.6690	.7701	.4446
	6		0	-	-	-
	7		5	.3294	.3691	.1651
	8		3	.0483	.0685	.0395
Total food	1		6	1.4362	1.3571	.5541
	2		11	2.3795	1.3717	.4136
	3		26	2.7712	1.3808	.2708
	4		12	2.8726	1.0243	.2957
	5		3	3.0570	1.0309	.6136
	6		0	-	-	-
	7		5	1.6278	1.1343	.5073
	8		3	1.2623	.7487	.4323

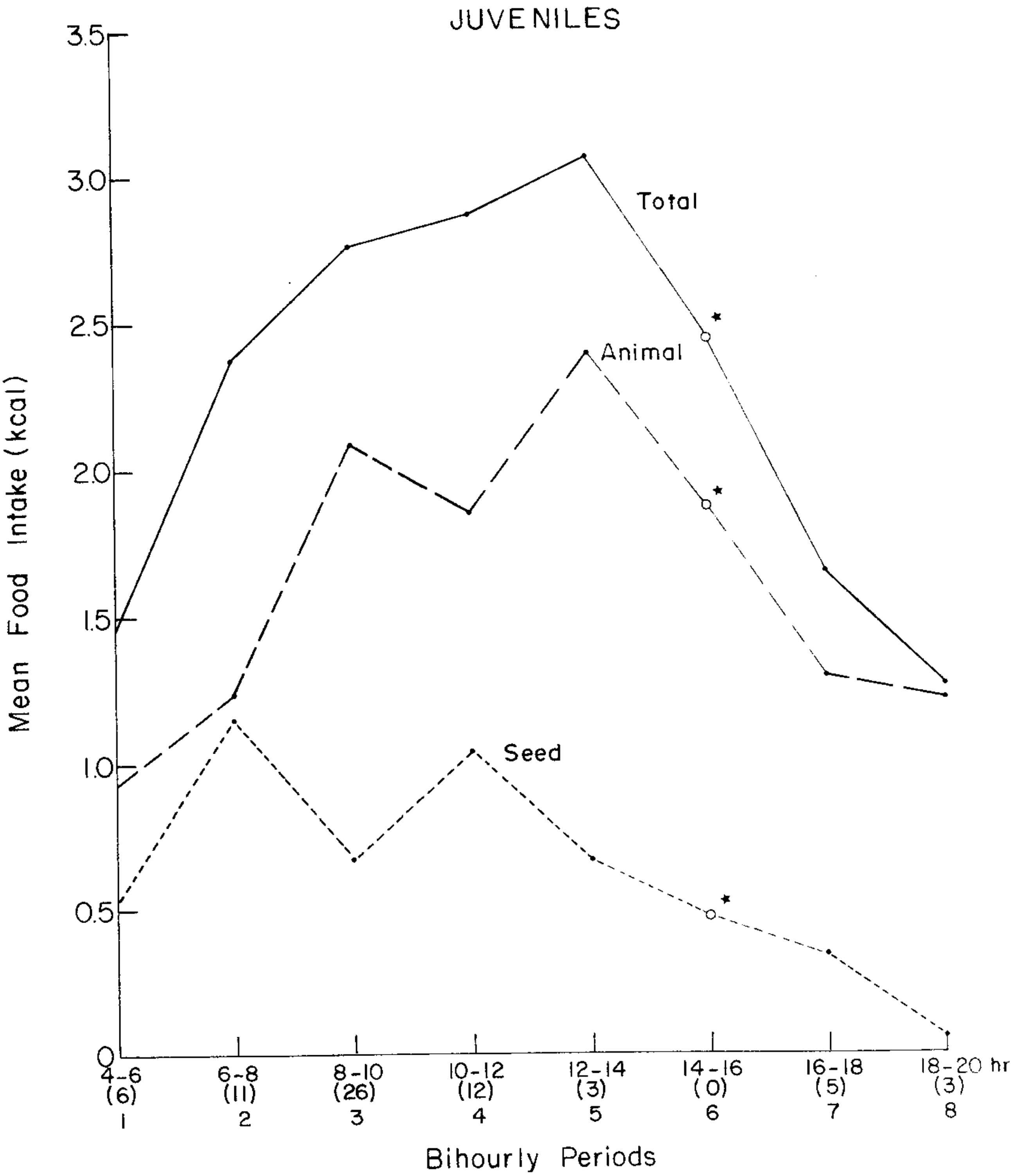

Figure 23. Mean caloric content of stomach samples for juveniles through time of day. Data from table 21. Sample size in parentheses. Star indicates a theoretical value.

significance. Also, no difference between ages occurred ($p<.3001$), but by t-test the ages differed indecisively at period 8 ($p<.10$).

The proportions of animal versus seed foods eaten by adults and juveniles at different times of day are listed in table 22. Differences between adult and juvenile appeared to be minor. Juveniles possibly fed more avidly upon animal items toward the end of the day.

Table 22. Proportions of animal versus seed foods eaten by adults and juveniles at different times of day. All birds were collected from late June through August.

Bihourly period	Adults n	Adults % Animal food	Adults % Plant food	Juveniles n	Juveniles % Animal food	Juveniles % Plant food
1	11	68.51	31.49	6	63.22	36.78
2	26	62.45	37.55	11	51.33	48.67
3	58	60.16	39.84	26	75.39	24.61
4	16	61.06	33.54	12	64.04	35.96
5	4	79.87	20.13	3	78.12	21.88
6	2	16.18	83.82	0	-	-
7	4	51.92	48.08	5	79.76	20.24
8	11	67.62	32.37	3	96.17	3.83

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Kendeigh, S. C. 1963. Relation of existence energy requirements to size of bird. Abstract 77, Amer. Zool. 3 (4) (No page number published).

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APPENDIX I

FIELD DATA

Lark Bunting specimens were taken at the Pawnee Site from 1969 to 1972. Samples were taken at 2-week intervals during the nesting and summer seasons. Bird identification data was reported on Form NREL-28. Stomach contents were analyzed and reported on one of two forms: Invertebrates on Form NREL-29 and seeds and plants on Form NREL-2A. Examples of the data forms and data follow.

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL IOLOGICAL PROGRAM

LAB DATA SHEET--AVIAN DIET, SAMPLE IDENTIFICATION

Card Code	Sample Type and Number	Genus and Species of Bird	Collector's Number	Activity	Type of Sample	State of Sample	Amount Grit	Estimate Percent Animal Food	Estimate Percent Plant Food	Number Animal Items	Number Seeds	Percent Seeds	Percent Plant Fibers, Leaf, and Stem Tissue	Age of Bird	Sex of Bird	Time	Date			Period	Season	Site	Data Type
																	Day	Month	Year				
1-5	7-12	14-17	19-25	27-28	30-31	33-34	36-37	39-41	43-45	47-49	51-53	55-57	59-61	62	63	64-67	68-69	70-71	72-73	74-75	76	77-78	79-80
																							28

IBP

GRASSLAND BIOME

U.S. INTERNATIO: - BIOLOGICAL PROGRAM

LAB DATA SHEET--AVIAN DIET, ANIMAL FOODS

Card Code	Sample Type and Number	Genus and Species of Bird	Collector's Number	Class	Order	Suborder	Family	Subfamily	Genus	Species	Ecological Function	Development Stage	Length (mm)	Number Individuals	Individual Dry Weight (g)	kcal/g Dry Weight	Date			Period	Season	Site	Data Type
																	Day	Month	Year				
1-5	7-12	14-17	19-25	26-27	28-29	30-32	33-35	36-38	39-41	42-43	44-45	46-47	48-52	53-55	56-61	62-66	68-69	70-71	72-73	74-75	76	77-78	79-80
																							29

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

LAB DATA SHEET--AVIAN DIET, PLANT FOODS

Card Code	Sample Type and Number	Genus and Species of Bird	Collector's Number	Family	Subfamily	Genus	Species	Type of Fruit	Length (mm)	Estimate Percent	Number Fruits	Individual Dry Weight	kcal/g Dry Weight	Date Day	Date Month	Date Year	Period	Season	Site	Data Type
1-5	7-12	14-17	19-25	26-28	29-31	32-34	35-36	37-38	39-43	44-46	47-49	50-55	56-60	68-69	70-71	72-73	74-75	76	77-78	79-8
																				2A

EXAMPLE OF THE DATA

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INVER LB   1 CAME PHB2097INCO    CUR        PCAD 08.0  1 .014 6.000 03056901 112
INVER LB   1 CAME PHB2097INCO    CUR        PCAD 03.5  2 .003 6.000 03056901 112
INVER LB   1 CAME PHB2097INCO    000        00AD 06.0  1 .005 6.000 03056901 112
INVER LB   1 CAME PHB2097INHY    000        PIAD 03.0  1 .001 6.000 03056901 112
INVER LB   1 CAME PHB2097INHY    FORMYRPOGOCPCAD 06.0  1 .003 6.000 03056901 112
INVER LB   1 CAME PHB2097ARAR    000        SC00 04.0  1 .002 6.000 03056901 112
INVER LB   1 CAME PHB2097INLF    000        PCLA 10.0  1 .003 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    CUR        PCAD 12.0  1 .020 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    CUR        PCAD 06.5  7 .006 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    CUR        PCAD 04.0  3 .003 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    SCA        PCAD 07.0  3 .006 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    SCA        PCAD 05.0  4 .004 6.000 03056901 112
INVER LB   2 CAME PHB2098INCO    SCA        PCAD 04.0  3 .001 6.000 03056901 112
INVER LB   2 CAME PHB2098INOR    ACR        PCAD 16.0  1 .024 6.000 03056901 112
INVER LB   2 CAME PHB2098INHY    FORMYRPOGOCPCAD 06.0  1 .003 6.000 03056901 112
INVER LB   3 CAME PHB2099INCO    SCA        PCAD 05.0 12 .003 6.000 03056901 112
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EXAMPLE OF THE DATA

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FRUTS LB    1 CAME PHB2097COM   HELAN02 5.3 90  3 .00855.400       03056901 112A
FRUTS LB    2 CAME PHB2098GRA   AVESA10 8.4 95  9 .02374.600       03056901 112A
FRUTS LB    2 CAME PHB2098COM   HELAN02 5.3  5  1 .00855.400       03056901 112A
FRUTS LB    3 CAME PHB2099GRA   AVESA10 8.4 60  3 .02374.600       03056901 112A
FRUTS LB    3 CAME PHB2099COM   HELAN02 5.3 30  3 .00855.400       03056901 112A
FRUTS LB    3 CAME PHB2099POL   POL0102 3.1 10  3 .00344.700       03056901 112A
FRUTS LB    4 CAME PHB2100GRA   BUCDA10 2.5 20  3 .00154.600       03056901 112A
FRUTS LB    5 CAME PHB2101POL   POL0102 3.1 85  4 .00344.700       03056901 112A
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FRUTS LB    6 CAME PHB2102GRA   BUCDA10 2.5 65  6 .00154.600       03056901 112A
FRUTS LB    6 CAME PHB2102POL   POL0102 3.1 20  2 .00344.700       03056901 112A
FRUTS LB    6 CAME PHB2102MAL   SPHC004 2.0  5  1 .00175.000       03056901 112A
FRUTS LB    6 CAME PHB2102CYP   SCI0402 2.0  5  1 .00085.000       03056901 112A
FRUTS LB    6 CAME PHB2102VER   VERBR05 2.5  5  2 .00055.500       03056901 112A
FRUTS LB    7 CAME PHB2103MAL   SPHC004 2.0 15  3 .00175.000       03056901 112A
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EXAMPLE OF THE DATA

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IDENT LB   4 CAME PHB2100 FF   1  2 04  85  15  14  11        41093003056901 112
IDENT LB   5 CAME PHB2101 FR   1  1 24  90  10  08  05        41102003056901 112
IDENT LB   6 CAME PHB2102 FR   1  2 22  75  25  06  12        41103003056901 112
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IDENT LB   8 CAME PHB2104 FG   1  2 18  85  15  26  19        42071504056901 112
IDENT LB   9 CAME PHB2105 FF   1  1 01  95  05  44  02        41083504056901 112
IDENT LB  10 CAME PHB2106 FF   1  1 09  65  35  11  27        41082504056901 112
IDENT LB  11 CAME RSS1    PF   1  3 43  60  40  27  34        41090509056901 112
IDENT LB  12 CAME PHB2112 FG   1  2 04  05  95  05  63        41085509056901 112
IDENT LB  13 CAME RSS2    FG   1  2 07  95  05  14  06        41092009056901 112
IDENT LB  14 CAME RSS3    FA   1  3 06  60  40  32  41        41094509056901 112
IDENT LB  15 CAME RSS4    FF   1  3 39  30  70  08  47        41134510056901 112
IDENT LB  16 CAME RSS5    FG   1  1 08  90  10  17  14        41140510056901 112
IDENT LB  17 CAME RSS6    Fw   1  1 13  80  20  06  28        41145010056901 112
IDENT LB  18 CAME RSS7    FR   1  3 22  40  60  14 123        41145210056901 112
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