TABLE 1. Changes in characteristics of shells of eggs of the Common Murre (*Uria aalge*) from the Farallon Islands, California.

	1913 ($n = 66$)	1968 and 1970 ($n = 29$)
Length (mm)	82.52 ± 0.78	83.60 ± 1.48
Breadth (mm)	50.51 ± 0.37	50.24 ± 0.64
Weight (g)	13.63 ± 0.33	12.10 ± 0.49
Thickness index[a]	3.27 ± 0.06	2.88 ± 0.10
Thickness (mm)	0.70 ± 0.01	0.61 ± 0.02

[a] $\frac{\text{weight (g)} \times 10}{\text{length (cm)} \times \text{breadth (cm)}}$

ppm on a wet weight basis, or approximately 38 ppm on a lipid basis.

The murres of the Farallons, with a 13 per cent decrease in shell thickness, might be expected to experience lowered reproductive success. A reduction in shell thickness of 13 per cent in eggs of Mallards (*Anas platyrhynchos*) induced by dietary DDE under controlled experimental conditions was associated with increased numbers of cracked eggs, reduced hatchability of eggs with uncracked shells, and increased embryonic mortality (Heath et al. 1969).

Studies of the effects of marine pollution upon the Common Murres and other marine avifauna are continuing at the Farallon Island Station of the Point Reyes Bird Observatory.

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FOOD HABITS OF THE STARLING IN EASTERN TEXAS

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The objectives of this study were to determine the seasonal variations in the foods of the Starling (*Sturnus vulgaris*) in eastern Texas, and to compare these findings with those of authors in more northern and eastern areas of the United States.

The most comprehensive report on the food habits of the Starling is contained in Kalmbach and Gabrielson's (1921) paper on the economic value of the Starling. The animal composition of these Starlings' diet is shown in figure 1. Over one-half of the insects found were Coleoptera, of which the clover-leaf beetle (*Hypera puncata*) was the most prominent. Kalmbach and Gabrielson (1921) stated that the Starling is the most effective bird enemy of this pest in America and, because of this, should be considered a neutral, if not benefical bird. Wood (1924) in his survey of the Starling included a warning that "it is too early yet to say what will be the result of the introduction of the Starling into this country. Its value as an insect destroyer is plain, but its unchecked increase may prove a calamity to several species of useful native birds, and from the experience of other countries we may assume that it is likely to become a pest to fruit growers." Kalmbach (1922) summarized his data from earlier papers and reaffirmed his faith that the Starling is a useful bird and would cause few problems.

Lindsey (1939) found that insects constituted 35 per cent of the annual food of the adult Starling in New York and 77 per cent of the food of nestlings. Garbage was utilized in large quantities by adult birds as a winter food. Killpack and Crittenden (1952) reported that Starlings in the Unita Basin of Utah fed mainly upon grain from feedlots, corn silage, and garbage during the winter. Besser et al. (1968) reported Starlings feeding heavily upon high protein pellets in feedlot operations in Colorado. Briefer articles mention specific foods of the Starling, such as the monarch butterfly (*Dianus archippus*) in California (Brooks 1952), and the fruits of yaupon (*Ilex vomitoria*), American holly (*Ilex opaca*), hackberry (*Celtis laevigata*), camphor tree (*Cinnamomum camphora*), and chinaberry tree (*Melia azedarach*) in Louisiana (McIlhenny 1936).

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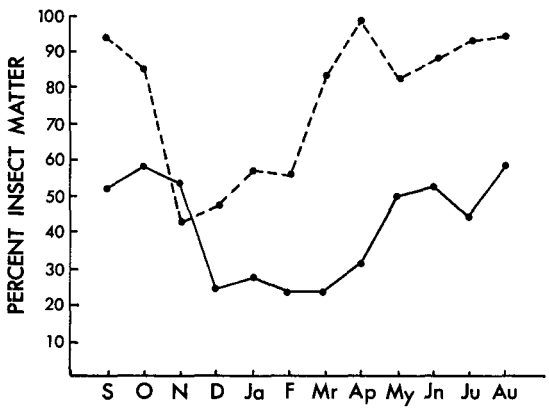

FIGURE 1. A comparison of the percentages of insect material in the total diet of Starlings from a New England sample (solid line; Kalmbach and Gabrielson 1921) and an eastern Texas sample (dashed line).

METHODS AND MATERIALS

Adult Starlings and independent juveniles were collected with a gun or mist net in the area surrounding Nacogdoches, Texas, September 1968–August 1969. An attempt was made to take a sample of about 20 birds each month.

The age and sex of each individual were determined using the criteria described by Kessel (1951) and Wydoski (1964). Each individual was weighed while intact. The esophagus, proventriculus, and gizzard were removed and their contents examined after placing them in a solution of 50 per cent ETOH. After the contents were separated, the total volume of each item was determined (to the nearest 0.25 cc) by water displacement in a graduated cylinder.

The contents were then divided into two categories: plant and animal. Grit content was not recorded, since it was small or nonexistent in the sampled population. Each animal was categorized as to family group and the plant material was identified to the generic level. Data on the foods of each bird were recorded as three expressions of quantitative measurements: number, volume, and occurrence. Swanson (1940) has shown that two or more of these measurements complement each other while any one expression by itself is imperfect or inadequate.

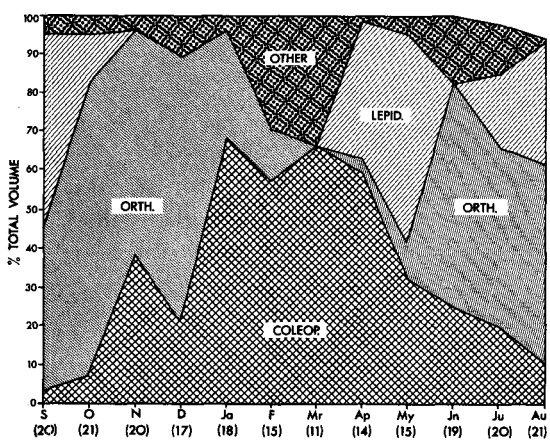

FIGURE 2. Per cent (by volume) composition of animal materials eaten by adult and independent juvenile Starlings, September–August (values of *n* appear in parentheses below letters designating months).

TABLE 1. Identified foods from the gizzards of 200 adult and independent juvenile Starlings from eastern Texas.

Item	No.	Freq.	Vol. (cc)
Mollusca			
Gastropoda	17	13	4.00
Arthropoda			
Arachnida			
Araneidae	1	1	.50
Lycosidae	4	4	.50
Thomisidae	9	6	2.00
Crustacea			
Armadilliidae	4	1	.50
Insecta			
Orthoptera			
Gryllidae	73	28	31.25
Locustidae	123	34	43.75
Tettigoniidae	61	40	69.25
Homoptera			
Cicadellidae	6	3	tr.
Coleoptera			
Carabidae	97	51	13.75
Cicindelidae	5	4	.50
Cleridae	1	1	tr.
Coccinellidae	4	1	tr.
Cucujidae	1	1	.25
Curculionidae	30	27	3.25
Elateridae	14	7	1.50
Histeridae	12	10	.75
Meloidae	2	2	1.50
Passalidae	1	1	1.00
Scarabaeidae	23	14	15.25
Tenebrionidae	5	1	1.00
Lepidoptera			
Geometridae	19	5	7.25
Lasiocampidae	3	2	.75
Noctuidae	42	18	34.75
Notodontidae	8	3	10.00
Satyridae	2	1	.50
Diptera			
Asilidae	4	3	tr.
Hymenoptera			
Formicidae	1	1	tr.
Plant Materials			
Celtis occidentalis	136	25	13.50
Galactia sp.	23	1	tr.
Ilex sp.	10	3	.75
Nyssa sylvatica	4	1	2.00
Prunus serotina	9	1	1.50
Rubus sp.	2	1	2.00
Sapium sebiferum	26	8	6.25
Vaccinium sp.	4	1	.25
Totals	786	324	270.00

RESULTS

Examination of gizzards of 211 adult and independent juvenile Starlings yielded 200 usable samples, distribution of which is shown in figure 2. Examination of these stomachs revealed that 73 per cent of the annual food of the Starling was animal material and that 27

TABLE 2. Percentage (by number) change, by months of several important insect families in the animal diet of Starlings.

Family	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
Orthoptera												
Tettigoniidae	22	44	4	–	–	–	–	–	2	2	10	21
Locustidae	21	21	29	7	29	14	–	4	7	36	29	20
Gryllidae	–	11	25	61	–	–	–	–	–	9	7	10
Coleoptera												
Carabidae	–	2	5	6	45	43	33	40	21	12	–	–
Scarabaeidae	–	2	11	15	22	14	30	19	12	8	8	3
Curculionidae	3	3	17	–	–	–	3	–	–	6	12	5
Lepidoptera												
Noctuidae	20	2	–	–	–	–	–	12	26	10	10	17
Geometridae	29	10	–	–	–	–	–	23	27	4	9	4

per cent was vegetable matter. During the months of March–October, inclusive, animal material made up more than 85 per cent of the diet, the maximum occurring in April (97 per cent). The lowest amount of animal material (44 per cent) was found in November.

Of the total yearly food of the adult and independent juvenile Starlings, 71 per cent, by number, was composed of insects. The monthly percentages of insect foods are shown in figure 1. Of the 71 per cent insect food consumed by the Starling, about one-half (48 per cent) was Orthoptera, represented by three families, Tettigoniidae, Locustidae, and Gryllidae, in order of their volumes (see table 2 for changes in the relative importance of these families by months). Coleoptera constituted 36 per cent of the total insect food of the Starling (table 1). Families appearing in the sample, by order of their number were: Carabidae, Curculionidae, Scarabaeidae, Elateridae, Histeridae, Tenebrionidae, Cicindelidae, Meloidae, Coccinellidae, Cucujidae, Passalidae, and Cleridae. The Carabidae, Curculionidae, and Scarabaeidae were the only families that appeared with a great enough frequency to be of any importance in the Starling's diet. Lepidoptera constituted 14 per cent of the total insect food for the year. Noctuidae and Geometridae (adults) were the only families represented in quantity, with larvae of these families appearing early in the summer.

The three orders, Orthoptera, Coleoptera, and Lepidoptera, were found to comprise 98 per cent of the total insects eaten and 68 per cent of the total food. Other insects that appeared in the sample in small quantities are: Formicidae, Reduviidae, Cicadellidae, and Asilidae (table 1).

Gastropods and arachnids are the only other animal foods that appeared significantly in the sample population. Both groups were found in the gizzards throughout the year. However, they appeared to be a significant part of the diet in February and March when each composed about one-sixth of the animal diet. One bird was found to have eaten four *Armadillium vulgare* (pillbugs) in June; these were the only crustaceans in the sample.

Plant materials constituted only 27 per cent of the total diet of the Starlings. Twenty-three seeds of milk pea (*Galactia* sp.), were eaten by one bird. The rest of the plant materials in the sample were fruits. Chinese tallow tree (*Sapium sebiferum*), hackberry, and yaupon were the only fruits eaten in significant quantities or by more than one bird in the sample. These were all eaten November–January.

DISCUSSION

Comparison of data from eastern Texas with that of Kalmbach and Gabrielson (1921) from New England (fig. 1) shows greater use of animal foods by Starlings in Texas. The New England studies show that the Starling used plant material for 43 per cent of its annual food supply, as compared with 27 per cent in this study. Insects made up 41 per cent of the annual diet of the Starling in New England whereas in eastern Texas they constituted 71 per cent of the total food. Figure 1 demonstrates that the Starling in eastern Texas utilized more insects in every month, except November, than did the Starling in more northern areas. The rapid drop in insect material utilized in November in Texas may have been caused by the first freeze of the season.

Kalmbach and Gabrielson (1921) found that Coleoptera constituted the greatest portion of the insect material in their sample. In Texas they composed only 15 per cent of the total number of insects consumed. But occurrence indicates that Coleoptera were important in the diet of Texas Starlings. Figure 2 shows that it is doubtful if the Starling could survive from January through April were it not for the large amounts of Coleoptera (over 50 per cent of the insect diet) that they are able to obtain, even in mid-winter. Kalmbach and Gabrielson (1921) found that the Curculionidae, Carabidae, and Scarabaeidae (in order of importance) were the most commonly consumed beetles. The same families were of primary importance but the frequency of occurrence changed, with the Carabidae being the most common family, followed by the Curculionidae and Scarbaeidae. These families are common on lawns and grassy areas where the Starling is likely to forage in both the north and south. Thus, the changes in the percentages taken each month probably indicate the availability of the various groups of insects rather than preference.

Kalmbach and Gabrielson (1921) and Lindsey (1939) found Orthoptera to be the second most common group of insects eaten by the Starling. They found that the Locustidae and Gryllidae predominated, constituting 12 per cent (Kalmbach and Gabrielson 1921) and 5 per cent (Lindsey 1939) of the annual diet of the Starling. In Texas the Orthoptera composed 48 per cent of the insects eaten. Tettigoniidae were present in only small quantities in northern studies, whereas, they were the most important item (volumetrically) in the diet of Texas Starlings. The Locustidae and Gryllidae were found in the same order of importance in both Texas and New England.

Lepidoptera composed 14 per cent of the insect diet of the Starling in Texas. This is much higher than was shown in the New England studies. The Noctuidae, however, was the largest group found in both Texas and New England.

The other orders of insects found in the Texas samples were also present in the samples from New England, the only deviation being in the Formicidae (ants) which the northeastern Starlings ate in much greater quantities than did the Texas birds.

Miscellaneous animal foods (gastropods, spiders, and pillbugs) were all recorded as important foods of the Starling in New England. They occurred throughout the year in the Texas sample, but only rose to importance in late winter (February–March) when it may be presumed that insects are not readily available.

The proportion of plant material in Texas samples is lower than that found in New England. The New England studies showed that the Starling consumed great quantities of cherries during the spring of the year. The uncommon wild black cherry (*Prunus serotina*) was the only member of this group to be found in the Texas sample, and then it was present in only one bird. Hackberry and tallow tree were the only plant materials eaten in large quantities and these were eaten only in the early winter. They are not recorded in the diets of New England Starlings, but McIlhenny (1936) has mentioned that these were consumed by the Starling in Louisiana. These are the two known fruits in the area that are the most nutritive in fats and proteins (Hastings 1966). They seem to play an important role in the diet of the Starling in eastern Texas and are probably the second most preferred food (after insects).

SUMMARY AND CONCLUSIONS

Animal food is eaten in greater quantities by Starlings in eastern Texas than in New England. Orthoptera are the most commonly taken insects in Starling diets in eastern Texas, and since these insects are generally considered harmful to grasslands, this makes the Starling a useful bird in the area. Coleoptera are eaten in large amounts during the late winter but are not taken in as large quantities as they are in the northeast. Gastropods and arachnids are important foods during the late winter but they may not be preferred foods since they are generally not found at other times of the year. Plant material is utilized in the fall when fruits that are highest in protein and fat, hackberry and Chinese tallow tree, are consumed in large quantities.

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WANDERING INTERSPECIFIC FLOCKS IN RELATION TO ANT-FOLLOWING BIRDS AT BELÉM, BRAZIL

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Many naturalists have noted that one can wander for hours in tropical forests without seeing any bird and then suddenly encounter a noisy flock of birds. Some species of birds flock together to exploit fruit trees, while other species follow army-ant raids day after day to feed on flushed arthropods. The species of wandering flocks, however, wander together through the forest without being attracted by concentrated sources of food.

At Belém, Brazil, while studying ant-following birds at swarms of *Eciton burchelli* (Oniki, MS), I saw wandering interspecific flocks join the ant-followers on six occasions for a few minutes to 2 hr. Usually the wandering flock moved away in a few minutes, since these birds move faster than do ant-following birds, which stay with the slow-moving ant raids. On 21 other occasions I observed wandering flocks far from ant-following groups. From these 27 flocks I obtained a list of 45 species (table 1). More birds may have been present, for I must have overlooked small and shy birds behind tangled lianas and thick foliage.

The largest interspecific flock contained 13 individuals. Most of the birds perch on thin branches from the ground up to 20 m. Most move rapidly and chatter noisily. Unlike the ant-following birds, which preen for long periods between foraging activities, they rarely preen for long periods.

Moynihan (1962:1), who studied the organization of some kinds of mixed flocks of neotropical birds in Panamá, points out that most birds of these complex flocks are passerines. At Belém, they are also passerines with the exception of one woodpecker that is regularly with the wandering interspecific flocks.