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COLONY STRUCTURE AND ORGANIZATION OF *PIPISTRELLUS SUBFLAVUS* IN SOUTHERN LOUISIANA

Few observations have been made on populations of bats in caveless Louisiana. Limited information on populations of some species was included by Lowery (1943) in his work on distribution and taxonomy of the mammals of Louisiana. Pagels (1970) presented some data on populations of *Tadarida brasiliensis*, but these were incidental to a study of temperature responses. Some observations made during a one-year study of a population of *Pipistrellus subflavus* were summarized by Jones and Pagels (1968).

Data on population structure and habits of *P. subflavus* were summarized by Barbour and Davis (1969). *Pipistrellus subflavus* was reported to make extensive use of caves as winter hibernacula and summer night roosts. Data on summer day roosts were scarce, but a few observations suggested the possibility of trees or foliage (Findley, 1954). Davis (1966) studied population dynamics of *P. subflavus* in West Virginia caves. Barbour and Davis (1969) pointed out that pipistrelles were rarely found in buildings, but scattered individual records were available.

In this report we present data on structure and organization of a population of *P. subflavus* in southern Louisiana.

Procedures.—The data presented herein were obtained from observations of bats at the Hebert Center of Tulane University near Belle Chasse, Plaquemines Parish, Louisiana. Detailed descriptions of the roosting sites, as well as the surrounding area, were provided by Jones and Pagels (1968).

This study was conducted from December 1965 to December 1971. Examinations of 20 roosting sites were made periodically throughout the study. However, equal efforts in examining bat roosts were not expended at all times. Standard procedure was to examine several roosts regularly and to visit all sites periodically. Except for 1967 and 1968 when numbers of visits to roosts were reduced, a mean of 11 roosting sites was visited during each month of the study.

TABLE 1.—*Numbers of bats banded each year.*

Years	Males	Females	Totals
1965	23	38	61
1966	63	66	129
1967	0	0	0
1968	4	1	5
1969	20	12	32
1970	28	29	57
1971	12	7	19
Totals	150	153	303

Bats were taken mostly by hand during the day from roosts, but a few animals were captured at night in mist nets set over entrances to the roosts. Animals were marked with bands furnished by the Bird and Mammal Laboratories. Number, sex, date, and precise site of capture or recapture were recorded for each bat. Because of some differences in emphases of studies during various portions of this investigation, the data were not always completely comparable with regard to what was learned about each of the aspects studied. Discrepancies in the amounts of data presented reflected the numbers of animals from which information was obtained.

Results and discussion.—Pipistrellus subflavus roosted beneath old ammunition-storage bunkers in the spaces formed by excavations for construction of concrete footings. Openings near the ground level in the fronts of the buildings provided access to the roosting sites. Support beams near the fronts of the buildings prevented light from entering most of the roosting areas. Barbour and Davis (1969) reported that *P. subflavus* is not commonly found in dark roosts in buildings.

Most bats were found hanging singly either from the tops of the roosting sites or on the sides of concrete pilings and support beams. However, clusters of two and three bats were found on nine occasions. All clustering occurred between December and February. Of the clusters found, two females were adjacent on three occasions, two males were together one time, males and females were paired four times, and a male was with two females on one occasion. Clusters of *P. subflavus* consisting of up to 30 animals were reported by Barbour and Davis (1969).

Copulating bats were found on 25 January 1967 and 1 February 1970. Copulation of this species occurred in caves in Florida during November (Barbour and Davis, 1969). Apparently *P. subflavus* copulates intermittently throughout the winter, as has been suggested for other North American bats (Carter, 1970).

Numbers of *P. subflavus* banded in each year of this study are summarized in Table 1. Of the bats banded, 64.0 per cent were marked during the first 2 years of the study. The decrease in numbers of animals banded in the late phases of this investigation may have reflected fewer numbers of bats that moved into the area following the initial colonization in the winter of 1965.

Some differences were noted between the sex ratios for the bats banded in the first 2 years and the animals marked during the last 4 years of the study. In the initial part of the study, males were outnumbered by females (1:1.21); in the final period of study, females were outnumbered by males (1:1.28). For the total number of males and females banded, the ratio was 1:1.03. Because these differences were not significant at the 5 per cent level, no conclusions were made with regard to the role of either sex in the evolution of colony structure. Wilson (1971) suggested that new roosts of *Myotis nigricans* probably were formed by young males that in turn attracted females; in mature roosts, females outnumbered males by three to one.

TABLE 2.—*Numbers of bats recaptured each calendar year. Total number of bats banded is given in parentheses for each year.*

Year banded		Year recaptured							
		1965	1966	1967	1968	1969	1970	1971	Totals
1965	(61)	48	41	4	2	1	1	1	98
1966	(129)		69	8	5	7	9	4	102
1967	(0)								
1968	(5)				0	2	2	2	6
1969	(32)					9	13	8	30
1970	(57)						36	20	56
1971	(19)							3	3
Totals	(303)	48	110	12	7	19	61	37	295

Seasonal changes in sex ratios were apparent for the population we studied. In the winter months (November to March), males were outnumbered by females (1:1.21), but females were outnumbered by males (1:1.88) in the remainder of the year (April to October). These sex ratios were significantly different at the 5 per cent level as tested by Chi-square. These seasonal differences may have reflected movements of animals associated with reproduction activities. More females than males dispersed from the roosts in spring; more females than males reassembled at the roosts in autumn. Seasonal changes in sex ratios were discussed briefly by Jones and Pagels (1968). For some summaries of data on disproportionate sex ratios in winter populations of *P. subflavus*, see Davis (1959) and Jones and Pagels (1968).

More bats were recaptured within the first 24 months after banding than during the next 5 calendar years (Table 2). However, the rates of recaptures were relatively high for the first 4 years after marking. For example, rates of recaptures at annual intervals following banding were: year 1, 39.7 per cent; year 2, 37.8 per cent; year 3, 18.9 per cent; year 4, 16.2 per cent; year 5, 4.3 per cent; year 6, 2.4 per cent; year 7, 1.6 per cent. Following banding, a few bats were recaptured at least once annually throughout the entire study. Of those bats that were recaptured in the study area for 5 or more years, females outnumbered males. After banding, the population of marked bats remained fairly stable during years 1 and 2, declined by 50 per cent in years 3 and 4, and was reduced greatly in years 5 to 7. These reductions in numbers of banded bats probably were correlated with the numerous disturbances in the roosting sites made by the investigators, as well as death and emigration of bats.

Of the 303 *P. subflavus* banded in this study, 178 animals were recaptured at least one time (Table 3). About one third of the bats were recaptured one to three times, a considerable number of animals were retaken four to 11 times, and a few bats were recaptured from 12 to 19 occasions. For the bats recaptured up to 11 times, females outnumbered males. However, for animals recaptured more than 12 times, the converse was true generally. During this study, 112 bats were not recaptured after banding. Of the bats that were not recaptured, males outnumbered females.

Females seemingly were more closely associated with the area studied than were males. The difference between the sexes with regard to attachment to the area might be explained on the basis of differential dispersal. More males than females apparently left the area after being either banded or recaptured several times. For some males, however, attachment to the area was expressed more strongly than for others; a few males were recaptured on numerous occasions. On the basis of these data, we suspect that a few males were involved with all of the reproduction for the colony.

TABLE 3.—*Frequency of recapture.*

Recaptures	Males	Females	Totals
0	65	47	112
1	79	99	178
2	62	76	138
3	41	60	101
4	28	43	71
5	22	38	60
6	14	29	43
7	13	19	32
8	7	13	20
9	5	12	17
10	5	9	14
11	4	9	13
12	4	4	8
13	3	3	6
14	3	1	4
15	3	1	4
16	3	1	4
17	2	1	3
18	2	0	2
19	1	0	1

There was a tendency for some bats to utilize specific buildings as places to roost (Table 4). Most bats roosted in not more than three separate buildings. Bats that left a building where they were either banded or recaptured moved mostly to the nearest available roosting site. For example, when the entrances to some buildings were closed during this study, bats from these roosts moved into buildings adjacent to the original roosting sites.

Females exhibited greater specificities than did males for roosting constantly in a single building. Many females recaptured on numerous occasions over a long period of time (2 years or more) were taken in certain buildings repeatedly. For 102 females studies, 58.8 per cent were captured only in one building, 25.5 per cent were taken in two buildings, 10.8 per cent were found in three buildings, and only 4.9 per cent utilized four or more buildings. On the other hand, for 83 males studied, 31.3 per cent were taken in one building, 45.8 per cent were found in two buildings, 15.7 per cent were captured in three buildings, and 7.2 per cent roosted in more than three buildings. Males exhibited stronger inclination than did females for utilizing either two or three buildings for roosts. A total of 61.4 per

TABLE 4.—*Frequency of building usage.*

Buildings	Males	Females	Totals
1	26	60	86
2	38	26	64
3	13	11	24
4	4	4	8
5	1	1	2
6	0	0	0
7	1	0	1

TABLE 5.—*Frequency of compartment usage.*

Compartments	Males	Females	Totals
1	0	1	1
2	9	7	16
3	5	5	10
4	2	4	6
5	2	3	5
6	1	0	1
7	0	1	1

cent of the males studied roosted in two or three buildings; only 36.3 per cent of the females utilized two or three buildings. Females were more sedentary than were males perhaps because females roosted in the same places with young, and males utilized several roosting sites in relation to reproduction activities.

Some limited data were obtained with regard to utilization of specific areas for roosting within the buildings (Table 5). Most bats, a total of 65 per cent of this particular sample, roosted in either two or three compartments within a given building. Relatively no differences were detected between the sexes with regard to the numbers of compartments used for roosts. Thus, there was more attraction of bats to a building as a roost rather than to a separate area within a building.

Some aspects of social organization in *Myotis adversus*, as well as in several other bats, were discussed by Dwyer (1970, 1971). The availability of these data permits some general comparisons of data on organization of the population of *P. subflavus* studied with those of some other populations of bats.

Some differences were noted with regard to the frequency of recapture for *P. subflavus* and *M. adversus* (Table 6). For bats recaptured from one to nine times, frequency of recapture of *P. subflavus* was greater than that for *M. adversus*. However, the percentages of animals not recaptured were similar for both species.

Examination of the recapture data revealed that, although some *P. subflavus* of both sexes exhibited stronger attachment to the area than did others, more females than males

TABLE 6.—*Frequency of recapture (per cent) for* Myotis adversus *(Dwyer, 1970) and* Pipistrellus subflavus *(this study). Total numbers of bats studied are given in parentheses.*

	Myotis			*Pipistrellus*		
Recaptures	Males (27)	Females (36)	Total (63)	Males (150)	Females (153)	Total (303)
0	44.44	22.22	31.74	44.52	31.12	37.71
1	25.92	19.44	22.22	54.10	65.56	59.93
2	3.70	22.22	15.87	42.46	50.33	46.46
3	18.51	30.55	25.39	28.08	39.73	34.00
4	22.22	19.44	20.63	19.17	28.47	23.90
5	7.40	5.55	6.34	15.06	25.16	20.20
6	3.70	5.55	4.76	9.58	19.20	14.47
7	14.84	0	6.34	8.90	12.58	10.77
8	0	0	0	4.79	8.60	6.73
9	3.70	0	1.58	3.42	7.94	5.72

were associated closely with the area. For *M. adversus*, attachment to the general roosting area was expressed more strongly by males than by females.

Specificities for precise roosting sites were exhibited by *P. subflavus* and *M. adversus*. The former species utilized certain buildings in the area studied; the latter species roosted in certain holes in an abandoned railway tunnel. There were some differences between the species with regard to specificities of males and females for precise roosting sites. Tendencies of *P. subflavus* for roosting in a single building were expressed more strongly by females than by males. However, specificities for roosting in two or three sites were greater for males than for females. Associations of *M. adversus* with a specific hole in a tunnel were stronger for males than for females. When individuals of *P. subflavus* were found in more than one building, the bats generally utilized two to three buildings in close proximity to each other, and roosted mostly in one building more than in others. The behavior of *M. adversus* was similar in that the bats utilized several holes in close proximity, and generally used one hole more frequently than others.

The pattern of organization in the population of *P. subflavus* studied reflected group stability correlated with area association and site attachment. These relationships of the bats in the area studied perhaps were strengthened because of decreasing availability of suitable roosting sites in the region adjacent to the study area. In addition, the system of organization observed seemingly was related to reproduction activities. We suggest that the specific site attachment expressed by females perhaps was related to bonds between mothers and young. The attachment of males to a larger area than females provided mechanisms for considerable mixing of genetic materials either by harem formation or random mating. The pattern of social organization found in *M. adversus* was correlated with reproduction activities, especially harem formation concurrent with mating, as well as the bonds between females and their offspring. Male *M. adversus* attracted females to their territory and roosted in close proximity in small clusters. Male *P. subflavus* moved around a great deal probably because of the tendencies for females to roost in isolation.

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