ANALYSES OF THE RELATIVE ABUNDANCE AND REPRODUCTIVE ACTIVITY OF BATS IN SOUTHWESTERN COLOMBIA

by

ANDREW A. ARATA [1, 2, 3] and JOHN B. VAUGHN [2].

SUMARIO

Aproximadamente 1600 murciélagos fueron recolectados en el Departamento del Valle del Cauca durante julio y agosto de 1964, en el curso de un reconocimiento de agentes patógenos de estos animales.

Se presentan los datos sobre la reproducción y abundancia relativa de 1365 animales (que representan 6 familias, 18 géneros y 25 especies). Se consideran las ratas de embarazo y lactancia de las hembras.

Se presentan estimados relativos de abundancia y distribución como también sugerencias sobre la interpretación de datos ecológicos pertenecientes a los murciélagos tropicales.

INTRODUCTION

Despite many recent publications on the bats of Colombia (Tamsitt and Valdivieso, 1963[a]; 1963[b]; 1964; 1965; 1966: Tamsitt et al. 1964: Valdivieso, 1964: Barriga, 1966: Handley, 1966: and others) we have little detailed information on the life histories of most Colombia bats. The situation is no different for Neotropical bats in general. Most reports of tropical bats are based on relatively small collections and are primarily of taxonomic and zoogeographic import. As valid, of course, are these concerns, a common result is the inadvertant ignoring of the basic biology of the more common, abundant species in favor of the taxonomically interesting forms or the zoogeographic rarity.

Department of Biology[1] and Department of Tropical Medicine and Hygiene, Division of Epidemiology[2], Tulane University, New Orleans, La; Departamento de Biología, Universidad del Valle, Cali, Colombia [3].

During July and August, 1964, a survey of zoonotic infections in bats in the Departamento del Valle, Colombia, was conducted. During this survey, over 1600 bats were collected, of which 1000 were examined for pathogens. This report will deal only with two aspects of the biology of the bats collected in this survey: their relative abundance and reproductive status. Reports on the results of various aspects of the pathogen survey will be published subsequently in appropriate journals. Food habits of a number of the bats collected in this survey are reported elsewhere (Arata et al., 1967).

Materials and Methods. — The two principal areas of bat collections were in the vicinity of Cali, and to the east and south of Buenaventura. Cali is situated in the Cauca Valley between the western and central Andean cordilleras (altitude, 1000 meters; mean monthly temperatures, 24.5° C ± 0.5°; anual rainfall, 1500 mm). The area is heavily cultivated and retains little native vegetation on the Valley floor or the adjacent foothills. Buenaventura is situated on the Pacific Ocean (elevations of collecting sites were less than 100 meters; mean monthly temperatures, 25.5° C ± 2°; anual rainfall is in excess of 7000 mm). The vegetation is the "bosque pluvial tropical" of Espinal and Montenegro (1963).

Thirty - nine days and/or nights were spent in the field, and 29 localities (sites) were collected. Mist nets were generally tended for 5-6 hours/night, though occasionaly were left overnight. Six to nine nets were used nightly, but on several occasions, as many as 15 were set. Seldom was a single site netted in a night; usualy two or three sites within 3-4 kilometers were worked simultaneously.

Near Cali most mist net collections were made in mixed plantations of bananas, platanos, citrus, cocoa and other fruits. Near Buenaventura some collections were made in cultivated areas (bananas, etc.), but most were made along the forest edges, over streams, in clearing, etc. All *Molossus* were taken near Cali. Otherwise all animals taken in July were collected near Cali, while those taken in August were collected near Buenaventura. All *Histiotus*, most of the *Peropterix*, *Molossus* and *Desmodus*, and about one half of the *Carollia* were taken in roosts, or by netting the entrances of roosts. All other bats were taken by mist nets during periods of their normal activity (Table 1).

Data tabulated in this paper are from 1365 bats representing 6 families, 20 genera and 25 species. Representative specimens of all species are deposited in the mammal collections of Tulane University.

Bats designated as immature ranged from nursing young to full-sized individuals with juvenile pelage and/or incompletely closed phalangeal sutures. All pregnancies were observed by post-partum dissection.

The authors would like to thank Philip Hershkovitz for aid in specific identifications, and to Joseph C. Moore for permission to examine comparative material in the collections of the Field Museum of Natural History, Chicago. Dr. Roger Barth helped immensely in the field.

This work was supported by the National Institutes of Health, United States Public Health Service (TW00143) I.C.M.R.T. Award to Tulane University.

RESULTS AND DISCUSSION

Reproductive activity. Knowledge of the seasonal reproductive activity of the vast majority of bats of northern South America is still scant, despite recent publications (Tamsitt and Valdivieso, 1963[a]: 1964: 1965). Asdell (1964) and Tamsitt and Valdivieso (1965) summarize much of our current knowledge.

In this study the limitations of time prevented examination of the sexual condition of males. Our information is based therefore on post-partum examination of 492 females from which tissues were removed for microbial isolation. Pregnancy figures are thus more accurate than could be obtained by palpation of animals in the field.

Sex ratios, approximate age groupings and reproductive conditions of the females are presented in Table 1.

Sex ratios of most forms for which sufficient numbers of specimens are available approach a 1:1 ratio (Table 1). *Desmodus rotunds* (1:0.2; N = 115) and *Histiotus montanus* (1:5.0; N = 12) are exceptions. The combined sex ratio (N = 1000) of 15 species of bats (representing 6 families) = 1:1.03 (493 ♂ ♂ and 507 ♀ ♀). The combined sex ratio of 10 species of phyllostomatids examined (N = 675) was 1:1.16 (317 ♂ ♂ and 368 ♀ ♀).

The large number of pregnant or lactating females of certain species collected in July and August suggests that the sample was made during a peak in a seasonal breeding cycle (Table 1). Other species were represented by smaller percents of pregnant or lactating adult females, suggesting asymptotic breeding.

In July, 45% of the *Peropteryx macrotis,* 58% of the *Glossophaga soricina,* and 56% of the *Sturnira lilium* collected were pregnant, representing possible cycle behavior. *Artibeus lituratus* (11% pregnant), *Desmodus rotundus* (18% pregnant), and *Molossus molossus* (14% pregnant) suggest a more even distribution of breeding throughout the year.

The collection of 12 *Histiotus montanus* in a line kiln near Cali clearly represented a maternal colony not unlike those of other vespertilionids in north-temperate zone (Table 1).

In August, a large number (213) of *Carollia perspicillata* was collected near Buenaventura. Twenty percent were immature animals, and 56% of the adult females were either lactating (18%) or pregnant (38%). *Carollia* was collected in early September, 1965, from the same roost from which the bulk of the August, 1964, sample was taken. Over 200 individuals were handled in 1965, but fewer than 20 females were found-all were either in advanced pregnancy or carrying nursing young.

If *Carollia* and *Glossophaga* continue breeding at the July-August rate (approximately 50% of the adult females pregnant in a given month), it would be necessary for them to have at least 3 litters/year (assuming a two month gestation period), in order to maintain acyclic breeding in all months. The only alternative is a seasonal periodicity that has not generally been accorded these forms. Hamlett (1935) reported precisely this in *G. Soricina* from eastern Matto Grosso, Brazil, shortly before the rainy season. July and August are dry months in western Colombia, the rains increasing in September and reaching their annual highs in October. This observation, therefore, supports Hamlett's earlier statement. This does not disclude as valid the statements of Cockrum (1955) and Tamsitt and Valdivieso (1964) that *Glossophaga soricina* and many other phyllostomatids breed all year. Unpublished observations on a number of forms by the senior author suggest this as well, but from the observations reported in this paper, we can only conclude that more are pregnant at certain periods than at other times. Thus it is necessary that reports of pregnant bats indicate what percent of the total adult females population is represented. Recording of individual pregnancies can otherwise be misleading as a single pregnancy does not constitute a breeding season. Many north temperate zone mammals are known to breed all year, but the major part of breeding is often concentrated into one or two peak periods (Asdell, 1964).

Relative abundance:

One of the more elusive parameters of bat biology is the measure of their relative abundance and habitat specificity. Jones (1966) comments: "Some data regarding population dynamics of some cavern dwelling bats are available..., but information concerning populations of noncavernicolous bats, other than that gained through studies of bats at roosts, is far from complete". In this quotation Jones is referring to southwestern North American bats. The statement can be multiplied ten-fold for the Neotropical bat faunas.

The introduction of mist nets into bat collecting in the 1950's has vastly increased our knowledge of the general distribution of tropical bats, but they have yet to be used in the American tropics in a quantitative fashion to express relative abundance or population density of specific forms.

The following attempt at quantification of population data is crude. We think, however, that it represents a workable approach to the study of Neotropical bat populations. The authors are quite aware of the obvious bias in the collecting techniques that have been employed (i.e., lumping data from roost and net samples), and the innate errors in such percentage figures as are presented. There are no more accurate estimates, however.

We do not think that "commonness" of any species is directly related to the numbers actually, or potentialy, collected. A single collection of bats in an appropriate roost can often yield any desired number of individuals. Netting in a particulary good plantation also often yields large numbers of certain species. The number of nets used in a collection often only increases the number taken, not the species composition. On the other hand, the number of sites at which specific animals are collected in a given area may serve as an index of their commonness. Thus, though we collected for different numbers of nights, utilizing slightly different numbers of nets at each site, we ignore absolute numbers as an index of abundance. Our results are, therefore, more an indication of "ubiquitousness" than of relative abundance, *per se* (Table 2).

Perhaps a true index of relative abundance could be expressed as: *the percent of the sites at which a species was collected* X *the number of individuals collected (adjusted by the number of nets used night).*

Any consideration of a bat fauna sampled with mist nets must consider the differential susceptibility of different types of bats to netting. In this study, for example, *Myotis, Eptesicus, Rhynchonycteris,* and others are poorly represented. The few numbers collected and the few sites at which they were collected is probably not a true indication of their relative abundance. These animals are far more adept at avoiding nets than are the larger phyllostomatids, and often fly higher than conventionally sete nets. In this study we did not elevate nets above their normal height (2 - 3 meters). Further, certain forms (i.e. *Noctilio* and *Molussus* fly quite early, often up to one hour before dark, and will not be taken at later periods. Thus, any analysis of a bat fauna must subjectively consider those forms that are not taken by the methods of collecting employed.

Further, netting studies in arid areas (Jones, 1966) where a single habitat necessity (i.e, water) serves as a magnet to attract individuals cannot be favorably compared to collections made in humid sub-tropical and tropical zones.

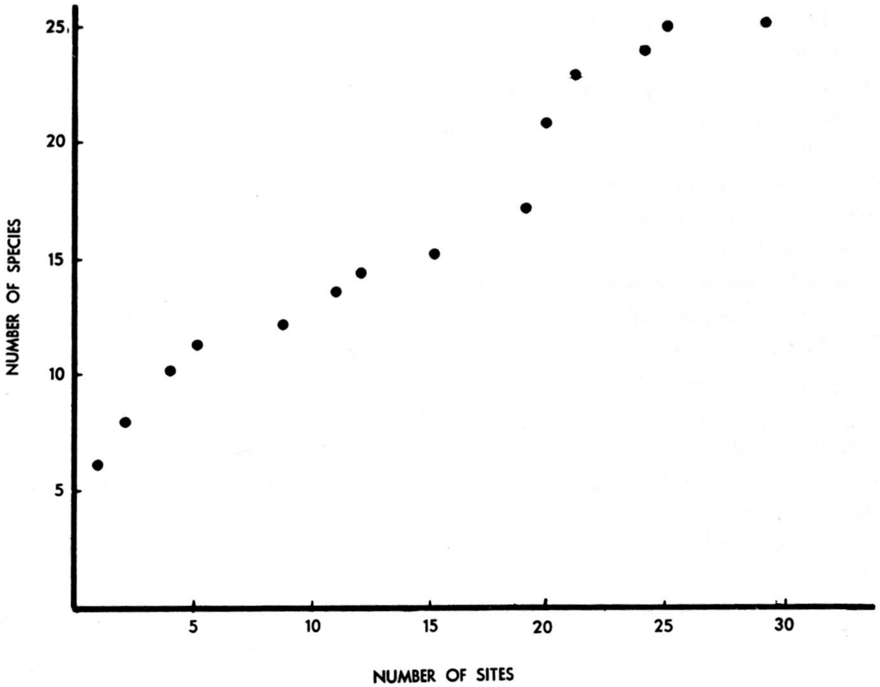

FIGURE 1. Relationship between the number of species of bats collected and the number of sites sampled. The slope of the curve suggests that the 30 sites sampled did not yield the number of species that probably inhabit the area.

The difference between absolute number collected and the commonness or ubiquitousness of a species can easily be seen in comparing the collections of *Sturnira lilium* (collected at 37% of all sites) and *Peropteryx macrotis* (6%) in which a larger number of *Peropteryx* were taken largely in roosts. Similarly, *Glossophaga soricina* (53% of all sites, both roosts and by netting) just slightly outnumbered *Molossus molossus* which was taken at only 19% of the sites, mostly in roost (Table 2).

The species composition of the samples taken by netting in different habitats is also revealing. *Artibeus cinereus* was collected at every locality netted near Buenaventura but at only one-third of the Cauca Valley localities, while *Artibeus lituratus* was taken at 88% of the sites in the valley and 66% of the sites near Buenaventura. *Vampyrops dorsalis,* on the other hand was taken at 66% of the Buenaventura sites, but not at all in the valley (Table 3). Further comparison of habitat differences between the rain forest area near Buenaventura and the sub-tropical Cauca Valley faunas are shown in Table 4. As only two months were involved in the collection of animals herein reported, no detailed comparison of the two faunas will be attempted.

Variations of the "species - area curve" have been used in ecological sampling for some time. Essentially, they are used to determine the approximate number of samples necessary to indicate the number of species of a given form inhabiting a specific area. The curve will rise with the first samples, and flatten when most species have been collected. To our knowledge, this analytical technique has not been previously applied to tropical bat populations. Its application to the two-month sample reported in this paper, suggests several points (Figure 1). We collected for 39 days (or nights) at 29 sites in the Departamento del Valle, and collected 25 species of bats. Subsequent collections (Arata, unpublished) at many more sites in numerous habitats within this Departamento has swelled the species list to approximately 50 forms. Thus, though the sample of almost 1600 bats upon which this report is based reveals much about relative abundance and basic biology of the forms collected, we can easily see that collections at more sites are necessary to adequately delimit the species composition of the bat fauna.

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LEGENDS

TABLE 1. Sex ratios and reproductive data on females of 15 species of bats (N = 1000) collected in the Departamento del Valle del Cauca, Colombia, during July and August, 1964. Species for which data on less than five (5) individuals were available are omitted from this table.

TABLE 2. Frequency of occurrence of 25 species of bats, representing 6 families, at 29 collecting sites in the Departamento del Valle del Cauca, Colombia, during July and August, 1964.

TABLE 3. Comparisons of collecting results, both in roosts and by mist nets, of 25 species of bats (N = 1365) in the Cauca Valley and near Buenaventura, in the Departamento del Valle del Cauca, Colombia, during July and August, 1964.

TABLE 4. Comparison of species abundance of 17 species of bats (N = 1351) in the Cauca Valley and near Buenaventura, in the Departamento del Valle del Cauca, Colombia, collected during July and August, 1964.

TABLE 1

SPECIES	JULY, 1964						AUGUST, 1964			
	Number	Sex-ratio	Adult males	Adult females (preg. + lact.)	imm. males	imm. females	adult males	Adult females (preg. + lact.)	imm. males	imm. females
Noctilio labialis	7	1: 2.5	2	5	—	—	—	—	—	—
Peropteryx macrotis	71	1: 1.0	35	33 (15 + 0)	—	3	—	—	—	—
Phyllostomus hastatus	9	1: 8.0	1	8 (1 + 0)	—	—	—	—	—	—
Glossophaga soricina	124	1: 1.2	45	55 (32 + 0)	5	—	6	13 (8 + 0)	—	—
Sturnira lilium	52	1: 1.5	16	16 (9 + 3)	1	—	4	15 (1 + 1)	—	—
Carollia perspicillata	217	1: 1.1	3	1 (1 + 0)	—	—	81	90 (34 + 16)	18	24
Vampyrops dorsalis	58	1: 0.9	—	—	—	—	15	21 (0 + 3)	15	7
Vampyrops helleri	24	1: 1.2	—	—	—	—	9	13 (2 + 2)	2	—
Vampyressa thyone	5	0: 5.0	—	—	—	—	—	4 (1 + 3)	—	1
Artibeus cinereus	40	1:07	—	—	—	—	15	15 (1 + 5)	9	1
Artibeus jamaicensis	58	1:10	5	8 (1 + 1)	1	—	14	17 (0 + 3)	9	4
Artibeus lituratus	98	1: 1.2	28	47 (5 + 10)	4	4	11	3	—	1
Desmodus rotundus	115	1: 0.2	85	17 (3 + 3)	8	5	—	—	—	—
Histiotus montanus	12	1: 5.0	—	8 (1 + 7)	2	2	—	—	—	—
Molossus molossus	110	1: 1.5	11	22 (3 + 0)	6	6	23	30 (14 + 0)	4	8

TABLE 2

Species	(N)	Percent
Glossophaga soricina	(175)	53
Carollia perspicillata	(270)	40
Artibeus lituratus	(130)	37
Sturnira lilium	(77)	34
Artibeus jamaicensis	(65)	31
Desmodus rotundus	(175)	31
Artibeus cinereus	(65)	28
Molossus molossus	(150)	19
Phyllostomus hastatus	(20)	16
Vampyrops helleri	(33)	12
Vampyrops dorsalis	(65)	12
Phyllostomus discolor	(7)	9
Peropteryx macrotis	(86)	6
Noctilio labialis	(7)	6
Vampyressa thyone	(9)	6
Rhögeessa parvula	(2)	6
Anoura geoffroyi	(4)	3
Lonchophylla robusta	(1)	3
Linchonycteris obscura	(1)	3
Rhinophylla alethina	(2)	3
Vampyrops vittatus	(5)	3
Rhynchinischus naso	(1)	3
Histiotus montanus	(12)	3
Eptesicus brasiliensis	(1)	3
Myotis nigricans	(1)	3

TABLE 3

	Number Collected			Percent of roosts examined at which found		Percent of subsites at which netted		
	in roots	by nets	total	Valle (9)	B/v (5)	Valle (9)	B/v (6)	total
Peropteryx macrotis	85	1	86	11%	—	11%	—	7%
Rhynchinischus naso	—	1	1	—	—	—	17%	7%
Noctilio labialis	3	4	7	11%	—	11%	—	7%
Phyllostomus hastatus	3	17	20	11%	—	33%	17%	26%
Pyllostomus discolor	7	6	7	—	20%	11%	17%	13%
Glossophaga soricina	40	135	175	22%	80%	77%	66%	73%
Anoura geoffroyi	—	4	4	—	—	11%	—	7%
Lonchophylla robusta	—	1	1	—	—	—	17%	7%
Linchonycteris obscura	—	1	1	—	—	—	17%	7%
Sturnira lilium	—	77	77	—	—	77%	66%	73%
Carollia perspicillata	181	89	270	11%	80%	44%	66%	53%
Rhinophylla alethina	—	2	2	—	—	—	17%	7%
Vampyrops helleri	—	33	33	—	—	11%	50%	26%
Vampyrops dorsalis	—	65	65	—	—	—	66%	26%
Vampyrops vittatus	—	5	5	—	—	11%	—	7%
Vampyressa thyone	—	9	9	—	—	—	33%	13%
Artibeus cinereus	—	65	65	—	—	33%	100%	60%
Artibeus lituratus	—	130	130	—	—	88%	66%	80%
Artibeus jamaicensis	—	65	65	—	—	66%	66%	66%
Desmodus rotundus	168	7	175	33%	20%	44%	33%	40%
Myotis nigricans	—	1	1	—	—	11%	—	7%
Rhögeessa parvula	—	3	3	—	—	11%	17%	13%
Histiotus montanus	12	—	12	11%	—	—	—	—
Eptesicus brasiliensis	—	1	1	—	—	11%	—	7%
Molossus molossus	146	4	150	33%	—	33%	—	20%
	639	726	1365					