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Vocal communication, nesting, and territoriality in the California scrub jay (*Aphelocoma coerulescens*)

Nancy Donehue Dodson
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VOCAL COMMUNICATION, NESTING, AND TERRITORIALITY

IN THE CALIFORNIA SCRUB JAY

(APHELOCOMA COERULESCENS)

A Thesis

Presented to

the Faculty of the

Department of Biological Sciences

University of the Pacific

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Nancy Donehue Dodson

May 1977

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INTRODUCTION

Social organization among jays ranges from the colonial nesting in the Pinyon Jay (Gymnorhinus cyanocephalus) (Balda, 1971), and communal breeding in the Mexican Jay (Aphelocoma ultramarina) (Brown, 1963b), to the strict pair-in-territory system utilized by the California Scrub Jay (Aphelocoma coerulescens) (Brown, 1974). The Steller's Jay (Cyanocitta stelleri), employs a somewhat intermediate social system which may be presently evolving from a pair-in-territory to a more colonial system (Wilson, 1975).

Social organization within the genus Aphelocoma is also quite varied. The Mexican Jay maintains year-round flocks of eight to fourteen jays in which members are usually closely related (Brown, 1974). Reproductive maturity is attained in these jays at three years; immature flock members often help breeding pairs with the care of young. The Florida Scrub Jay (A. c. coerulescens) also employs such helpers at the nest. Immature and nonbreeding birds efficiently aid closely related breeding pairs with nest-defense and the feeding of young (Woolfenden, 1974). The California Scrub Jay (A. c. californica) exhibits the least social of systems used by the jays. Pairs maintain year-round territories, and

the young disperse from the parents' territories soon after fledging. Breeding generally occurs within the first year in these jays (Brown, 1974).

While such aspects of social organization as mating systems and care of young have been studied in some detail in many of the jays, detailed communication studies exist only for the Steller's Jay (Brown, 1964; Pustmueller, 1969), Blue Jay (Conant, 1972), and two species of Old World jays (Goodwin, 1952). Lanyon (1960) defines communication as the mechanism by which all essential interactions between organisms are accomplished, and points out its necessity to the stability of social groups. The use of sound in communication has distinct advantages. It can pass through objects and darkness, and can be highly specific and complex. Generally, sounds are employed to convey to hearers the motivational state of the caller, and any responses given to sounds depend upon the motivational state of the hearer (Wilson, 1975). Sound communication among non-human animals becomes difficult to decipher, for it cannot be dissected into words and phrases. Brown (1975) presents an appropriate analogy in trying to define a laugh, snicker, snarl, scream or gasp, and points out that the influences of these sounds upon hearers are even more complex.

It has been implied that the California Scrub Jay utilizes a limited repertoire of discrete vocalizations (Brown, 1975; Hardy, 1961). Discrete calls may be given in a variety of behavioral situations, but occur without appreciable sonographic variation in a specific bird. Graded systems of communication, in contrast to discrete systems, employ calls which again may be given in more than a single behavioral situation, but these signals may vary considerably depending upon context. Calls of this type tend to be more complex than discrete signals, and intensity may often be an indication of the caller's motivational state (Wilson, 1975).

Brown (1964) concludes that in the Steller's Jay the relatively large number of different vocalizations is related to the complexity of the dominance hierarchy, which includes considerable intraspecific territory overlap. He likewise postulates that the limited repertoire of the Scrub Jay is related to the simpler dominance organization that exists in these birds. Brown (1964) has classified the vocalizations of the Steller's Jay into eleven groups, and has noted gradations within some of these categories. He also reports graded visual communication in these jays, whereby varying crest angles are employed in different behavioral situations.

Pustmueller's (1974) studies on communication in Steller's Jays in Colorado agree with Brown's work on those in California, indicating eleven main vocalizations with gradations in some of the calls. Goodwin (1952) has classified the vocalizations of two species of Old World jays into seven groups, and has suggested variability within some of these call-types.

This report evaluates vocal communication, nesting, territoriality, and other social behaviors of the California Scrub Jay.

METHODS AND MATERIALS

California Scrub Jays were observed from early December, 1975 through May, 1976, and from September, 1976 through March, 1977. All observations were made on campus at the University of the Pacific, Stockton, California (Figure 1).

Mist nets were set during all hours of daylight in late 1975 and early 1976. However, the jays were successful in avoiding the nets and only a single jay was captured for banding by this method. During the spring of 1976, traps (both National small-mammal and homemade jay traps) baited with bread, sunflower seeds, walnuts, peanuts, and suet were placed in the observational area, but only one jay was captured. Most of the jays that were banded for identification were done so as nestlings during the late spring and early summer in 1976 (Table 7).

Vocalization

Vocalization data were organized on data sheets (Figure 2). Tape recordings were made on a Uher Model 4000 at 7.5 inches per second. Most recordings were made at close to maximal recording level, using an 18 inch Dan Gibson parabolic microphone. Sonagrams were made from selected recordings with a Kay Elemetrics Sound

Spectrograph at the University of California, Davis, California. Each vocalization noted was first placed into a general behavioral category defined as follows:

1. Noninteraction: Single jay vocalizes, receives no vocal response, and does not appear to be in the immediate company of other jays.
2. Nonaggressive interaction: Two or more jays appear to respond vocally to one another without apparent threatening postures or pursuit.
3. Aggressive interaction: Two or more jays interact vocally with each other while engaged in active pursuit and/or fleeing.
4. Interspecific interaction: Any jay vocalization or behavior directed towards or in apparent response to another species.

All vocalization observations were subject to personal judgments regarding commencement and termination of events. Vocal "events" were therefore of variable duration, ranging from ten minute "conversational" periods to second-long single syllable calls. All events, regardless of duration have been scored equally on the data sheets.

Table 1 relates each vocalization to the contexts in which it was heard. Table 2 summarizes all interspecific interactions observed, including both vocal and silent interactions. Table 3 summarizes all vocal interactions observed between the jays, and includes any

behaviors that appeared to be motivated by another jay's vocalization.

Nesting

Four pairs of jays were observed during the breeding season in 1976. They will be referred to as "Cork Oak," "Chapel," "Loquat," and "Conservatory" pairs. The data collected on both the Chapel and Conservatory pairs were insufficient in yielding detailed nesting activities, but will be referred to in support of similar activities observed in the Loquat and Cork Oak pairs for which there is more thorough data. Figure 1 defines the nesting territories observed for each of these pairs.

Nesting observations were made from the onset of nest-building (first observation March 9) through the successful fledging (May 9) at the Cork Oak nest. A Bausch and Lomb spotting telescope approximately thirty feet from the base of the nest tree, was focused on the nest.

Nesting behavior for the Loquat pair conspicuously differed from the other pairs on campus in that two broods were raised. Observations made at the Loquat nest began on April 15 and continued until the nestlings were banded on June 14.

Territory

Territory maps were constructed for each pair of jays during the breeding season and indicate those areas in which the pairs were observed during breeding and nesting (Figure 1). The boundaries of each territory are the outermost edges at which either of the pair was known to visit.

Albino Scrub Jay

On May 18, 1976, I acquired a young albino Scrub Jay. At this time it had just left its nest and was still unable to fly. It appeared healthy and was almost fully feathered. The young albino was cared for by me until its death on June 1, 1976. Tape recordings of various adult vocalizations were played to the jay and observations regarding its behavioral responses were made.

RESULTS-DISCUSSION

Social Organization

Studies on coastal populations of the California Scrub Jay have reported strict pair-in-territory social organization (Brown, 1974). These jays are known to occupy and defend rigid year-round territories, and after fledging there is complete dispersal of the young in the fall. The young purportedly flock together during the first fall after fledging, forming pair-bonds in late winter, and breeding during the first spring. The jays studied on campus at the University of the Pacific (central California valley) have not strictly adhered to this standard, appearing less territorial and more social than those residing on the coast.

Late summer and fall observations in 1975 revealed groups of jays which were at that time guessed to be flocks of young birds as reported by Brown (1963a). However, observations taken during the same time period in 1976, after color-banding some of the jays for identification, indicated family groups consisting of parents and newly fledged young. These groups remained together until late winter at which time the young were driven from the parents' territory through a series of parental chases.

Brown (1963a) also reports that Scrub Jays rarely come within twelve inches of each other without aggression, and that territories are both well defined and well defended throughout the year. During the late summer and fall of 1976 and during the winters of both 1976 and 1977 groups of from three to five jays, from one or more family groups, were observed foraging, sunning, bathing, and interacting vocally without aggression. Occasional aggression was noted between family groups, often at the nesting territory boundaries, but sometimes two of the adult jays, L-R and L-Y (Table 7), known to belong to different groups were observed together in one or the other's territory without aggressive encounters.

During January in both years there appeared to be an increase in aggression within family groups and soon after, fledgling-dispersal became apparent as each territory contained only a single pair. In December of 1975, the Cork Oak group consisted of the pair and a single jay identifiable because of a more turquoise sheen to his feathers. I assumed that this turquoise jay was the 1975 fledgling of the Cork Oak pair. From the beginning of the observation period in November 1975 until February 28, 1976, all three were observed in the same territory without aggression. At this time parental chasing of the turquoise jay began and increased

in frequency until his disappearance some time after April 15, 1976. After the disappearance of the turquoise jay, the pair's activities appeared to be directed solely towards nesting. Unfortunately due to the early disappearance of this pair's 1976 fledgling in October 1976, this behavior was not observed again for this pair.

Courtship was observed on several occasions for the Cork Oak pair. The male was observed circling the tree-perched female and following her closely whenever she moved. He appeared to intently watch her while performing these displays, often bobbed with his whole body, and sometimes assumed a chin up posture. The female usually opened her beak and called "caw" softly, after which she was often fed. She did not always appear submissive (crouching, head up, begging) but usually remained quite erect, often looking away from the male. On one occasion the female's caw call was accompanied by threatening gestures.

A display much like that observed in the Pinyon Jay prior to breeding (Balda, 1971) was observed once in the Cork Oak pair. The pair was observed flying extremely fast throughout their nesting territory. One jay was following the other and the pair flew through several of the trees in the area. The turquoise jay flew

into the area during this display, and was immediately chased away. The display immediately resumed and ended when both jays flew into the redwood area, twenty five feet from their nest tree.

Copulation was not observed in the Cork Oak pair, but the supposed breeding area, beneath a redwood tree was well concealed and both jays spent much time there together. Vocalizations referred to as "song" and "caw" were heard from this area when both jays were known to be there. The caw, when observed was given by the female and appeared to be a courtship feeding begging call. The song was heard only a few times during the entire study, and was never observed directly. During this time a large cache of partially eaten acorns was found beneath these redwoods.

With the onset of the breeding season came the well-defined territory establishment characteristic of these jays. Hinde (1956) defines three components of behavior in the establishment and maintenance of territories:

1. Restriction of some or all types of behavior to a somewhat defined area.
2. Defense of that area.
3. Self-advertisement in that area.

All of these behaviors were noted during this time in the

jays. Prior to nesting, the jays had been observed outside of these territories, but from then on they were never observed beyond these limits. Throughout nesting they were repeatedly observed defending and vocally patrolling the boundaries, whereas before nesting, movements into these areas by other jays were often tolerated. Considerable aggression was noticed at the boundaries, and before incubation began both male and female were observed defending the territory. After the female began incubating, the male alone patrolled and defended the territory, with only a single case observed where the female left the nest in apparent aid of the male at a territory boundary. As incubation ensued the intraspecific aggression appeared to decrease, which may be correlated with the increased use of the patrol scree used by the male at the territory limits.

Throughout the nesting period, from egg-laying through fledging, there were no vocalizations given in the immediate nest tree area in any of three territories for which working nests had been located. All vocalizations noted during this time were heard at least thirty feet from the nests, and most often at greater distances. It was not until after the young had fledged that vocalizations were again heard near or in the nest trees (other than begging calls given by nestlings).

On most occasions when either of the jays entered the nest tree, a pause at another tree preceded movement into the nest tree. The male, when making the bulk of the feeding trips to the female and nestlings, approached and departed from the nest by a variety of different routes. He then rarely remained at the nest longer than it took him to feed the female and nestlings. This secretive nest approach in addition to the absence of vocalization near the nest rendered the nest site extremely inconspicuous. The advantages of a well concealed, inconspicuous nest seem obvious. In drawing little attention to themselves at this time the jays could conceivably raise their young with little fear of predation. Their silent acceptance of all other species in the area was surprising, especially the Starling nest only fifteen feet from their own. The advantages of silence possibly outweigh the disadvantages of vocally announcing themselves by loudly chasing other species.

False nest building, a characteristic of the Blue Jay, is a ritualistic behavior preceding the construction of the nest that will be used (Hardy, 1961). Behavior of this type has not been observed in the genus Aphelocoma, but most of the jays under observation at the University of the Pacific did appear to partially complete first nests before the construction of the nests that were used for

raising young. The Cork Oak pair were observed building two nests in their nest tree, only one of which was later used. This type of activity was also observed in the Chapel and Conservatory pairs.

Nest material consisted mostly of twigs broken from trees in the pairs' territories. The feet were employed to steady the twigs while the jay's beak was used to break them off. Once a jay was observed rubbing a twig on a branch before carrying it to the nest, similar to the rubbing of a bee observed before courtship feeding.

At fledging time, all of the young observed away from their nests were unable to fly. The Cork Oak young could not fly for even short periods and remained for the most part concealed in low bushes. The Loquat pair's first brood were also unable to fly, and R-YB (Table 7) was observed residing in the upper portion of a tree fifteen feet from the nest tree for two days. In both cases the parents, primarily the male, made regular feeding trips to the young until they were able to fly. After this time young fledglings and male parents were often observed traveling and foraging together. One other group observed in Stockton exhibited similar behavior. Neither the albino jay nor his nest-mate were able to fly when first discovered, and were observed spending much of

their time in low bushes.

After fledging at the two most closely watched nests, Cork Oak and Loquat, the male parents appeared to take the greater responsibility for caring for the young. The Loquat pair unexpectedly renested, and although I suspect the Cork Oak pair was similarly engaged, I was unable to locate a second nest. The Conservatory pair was also observed engaged in what appeared to be nest construction activities at this time, but their second nest may have resulted due to failure at the first. They were not observed with fledglings at this time in contrast to both Cork Oak and Loquat pairs.

Other Behaviors

Feeding and food storage activities closely agreed with previous findings for other jay species (Amadon, 1944; Goodwin, 1952; Hardy, 1961). Acorns appeared to be the major food source during the winter months. Jays were often observed holding acorns with their feet and pounding the hard shell with their beaks. They usually pounded them on wide branches, but were also observed using the pavement and the tops of concrete posts. Once a hole was made in the acorn's shell, vigorous twisting motions of the head were employed to enlarge its size. Jays often pounded acorns as described above and then dropped them

without retrieving them, and it could not be determined whether the acorn had been dropped by accident or rejected. Acorn storage occurred regularly throughout the winter. Typically the acorn was pounded into the ground with the beak and then covered with leaves or surrounding debris.

The jays appeared extremely adept at catching insects during the spring months, often catching them in mid-air. During nesting the male often foraged in open areas, catching insects and storing them in his crop until regurgitating them to the female and nestlings. Once a courting male was observed catching a bee, rubbing it thoroughly on the ground, and then offering it to the female.

Observations on the Albino Jay

While the behavior of captive birds cannot be directly applied to those in the wild, it often provides insights into similar behaviors observed in the wild. The albino Scrub Jay, obtained on May 18, 1976, was at first wary of my presence. He backed away when I placed my hand into his box and crouched low. When I lifted him from the box he vocalized loudly and struggled to be free. It was necessary to force-feed him throughout this first day, but 24 hours later he was begging food from me, no

longer struggling from my grasp, and even perching on my finger while I fed him. Whenever I walked into the room where he was kept he begged (i.e. stood erect, neck extended, wings flapping) until fed or until I left the room. As time ensued he often leaped from his cage onto my finger when I opened the door, begging louder each day. He was never observed grooming and when placed in a tub of warm water, exhibited no bathing behavior.

Several times I played tape recordings of adult jay calls to the albino. Most of these elicited begging vocalizations and postures, but the adult alarm scree served to silence him. Once he assumed a motionless, crouching posture, a typical response for nestlings who hear the alarm calls of their parents (Brown, 1975).

Vocalization

Eight separate vocalizations were identified. Six of these were recorded and later sonagrammed (Figures 4-7). The two calls which were not sonagrammed were two of the least frequently used calls. These are referred to as "song" and "caw," and the six calls which have been sonagrammed have been labelled "scree," "squawk," "chut," "tsch," "hiss-rattle," and "pew."

The scree and squawk calls were the most frequently heard vocalizations, comprising 58.3 per cent

and 31.1 per cent respectively (Figure 3). These two also exhibited the greatest amount of variability. Differences were based upon intensity, number of syllables per phrase, behavioral context, and/or those differences evident from sonagram analysis. The scree appeared to be the most variable call, exhibiting seven distinct varieties. Its use appeared to depend upon seasonal activities in some instances (Figure 8), with specific periods of the year coinciding with the extensive use of a particular variety of scree. The chut call was the third most often employed call, comprising 7.7 per cent of all calls noted (Figure 3), with the remaining 2.8 per cent of all calls observed comprising the other five call-types.

Screes

Three distinct screes can be differentiated through sonagram analysis: mobbing, alarm, and other screes (Figure 4). Mobbing screes ranged in duration from 0.38-0.53 seconds (n=6) and ranged in frequency from 1500-7000 Hz, exhibiting most of the intensity within the 3500-5500 Hz frequency range (Table 4). These calls were first observed on January 10, 1976 in an experimental situation. A stuffed Barn Owl (Tyto alba) was placed in plain view beneath a tree in the Cork Oak territory, at that time occupied by at least three jays. Less than

five minutes after its placement, the owl attracted a single jay who examined it silently at a distance before a second jay arrived. The second arrival soon began calling shrill mobbing screees which were followed by the appearance of three other jays into the immediate area. Four of the five jays emitted loud mobbing screees for ten minutes while approaching closer to the owl. I feared an attack would ensue and moved it before the jays got nearer than twelve inches. On another occasion this same call elicited the gathering of three jays to a newly placed feeder. All three jays circled the feeder, approaching closer by degrees, and calling the mobbing screees.

Mobbing-type calls, which serve to gather members of a species about a potentially harmful object, appear intuitively useful in the survival of the species. The speedy gathering of five jays around the Barn Owl imply easy-to-locate qualities in this call. Although none of the five jays were banded for identification at that time, I suspected three were the Cork Oak family group and the other two were the Conservatory pair. This gathering of jays in the Cork Oak territory during January again exemplifies the lack of aggression observed between the jays at close range.

The alarm scree (Figure 4) is of shorter duration

than the mobbing scree, lasting between 0.34-0.38 seconds (n=7). Its frequency ranges from 0-12500 Hz, with the greatest intensity occurring between 3000 and 7000 Hz (Table 4). This call sounds much like the mobbing scree except that it is of shorter duration and begins more abruptly. Alarm screees were observed most during the period immediately following fledging. Both parents called alarm screees loudly whenever I approached a bush or tree concealing their newly fledged young. The parents usually remained high in trees while giving this call, unlike the circular approach towards the object of concern observed with the mobbing screees. These calls never elicited a grouping of jays other than the caller's mate as was seen in the mobbing screees, but did elicit silence in loudly begging chicks. Recordings of these calls to the captive albino chick served to silence his begging as well. The silencing of young birds seems clearly advantageous to their survival.

Alarm-type calls have been associated with altruism in that they may benefit hearers by alerting them to danger, and endanger the caller by attracting predators to his location (Brown, 1975). Arguments against this hypothesis state that alarm calls may benefit the caller as well as the hearers by confusing

the predator. In the case of Scrub Jays most often those alerted are closely related birds, providing an auditory alert between family members.

Marler (1955, 1959) believes that calls best suited for alarm purposes are those which make location of the caller uncertain. He points out that hawk alarm calls adhere to these principles while their mobbing calls do not. The Scrub Jays' alarm screams were always given from conspicuous locations, but never were they called in the presence of true predators. Objects eliciting these calls were stuffed specimens or humans near the nest or nestlings. It may be that the nature of the threat determines the degree of concealment exhibited by the jays.

The remaining screams are referred to as "other," but may be further differentiated based upon intensity, duration, number of syllables per calling event, and behavioral context. While seasonal activities appeared important in distinguishing the calls behaviorally and on the basis of call-duration and number of syllables, those varying in intensity alone did not appear to be season-related (Figure 8). Loud multi-syllabled screams (Figure 5) called in flight were most often observed in aggressive encounters with other jays and were observed

primarily in chasing and/or threatening instances (Table 3). Softer multi-syllabled screees were also observed, but were not associated with aggressive behaviors. These, in contrast, appeared related to announcement of a jay's presence in an area, and were observed in both flying and stationary situations. Screees were also heard as individual syllables, and again high intensity calls appeared to be related to aggressive jay encounters, while low intensity calls were associated with non-aggressive or noninteraction instances. Single screees of high intensity were observed more often in fleeing than were multi-syllabled screees. These screees ranged in length from 0.24-0.34 seconds (n=26), and if given in series consisted of from as few as three to as many as twenty syllables per calling event. The syllables usually ran together without distinct pauses between them. The frequency range for these calls was from 1500-7000 Hz, and the majority of the call was within the 3000-6000 Hz frequency range (Table 4).

Screees used in both announcement and aggressive contexts were often observed in conjunction with squawks. These phrases did not appear to follow specific patterns and all combinations of single and multiple squawks and screees appeared to be used. A typical phrase taken from

my field notes is, "scree scree squawk squawk scree squawk squawk squawk squawk squawk pause scree scree scree."

This was observed in an announcement context with those syllables preceding the pause given in flight and those following, after landing. (Figure 8).

The remainder of other screees can be divided into three classes based upon behavioral and durational qualities. These will be referred to as "mate-contact," "patrol," and "family-contact" screees. The mate contact scree was first observed in late winter and appeared important in re-establishing (and perhaps initial establishment of) the pair-bond between mates. Beginning in late winter and continuing throughout courtship, this scree's mode of deliverance was characteristic (Figure 5). A period of calling had a mean value of 4.5 ± 0.8 minutes (mean \pm 95 per cent confidence limit, $n=28$, S.D.=4.24), with pauses between syllables of 2.8 ± 0.22 seconds (mean \pm 95 per cent confidence limit, $n=20$, S.D.=1.00). The behaviors associated with this call were extremely predictable. Usually the jay was moving about, often as if foraging, although rarely did the foraging appear to terminate in feeding. The jay typically hopped on the lawn, and called while standing upright with an open beak. These calls often elicited answer screees and rved

joining by the mate (Table 3). This mate-contact scree appeared to keep the pair in contact, and was noticed first with regularity in January, 1976. Its usage increased in February and then steadily declined as the nesting period approached (Figure 8).

Contact calls serve to keep a social group together (Brown, 1975). The mate-contact scree appeared to keep both members of the pair together, and soon after the regular use of this call both Cork Oak parents were observed almost invariably together.

A second type of scree call based upon context will be referred to as the patrol scree (Figure 5). This call was observed only during the nesting period, first seen in early April, 1976 (Figure 8), and continuing with regularity throughout the month of May. It was not observed prior to nesting in the spring and disappeared during the fall months. This call was almost invariably given in flight and was only observed in the male. It was first described as half-way between the squawk and scree in my field notes, but after examination of the sonagram, appeared much like those screes classified "other." Typically this call occurs in series of from six to eight syllables and is less shrill and somewhat lower pitched than other screes. It was always observed

at what appeared to be the nesting territory limits (Figure 1), and was never heard in the immediate area of the nest.

The third scree classified "other" will be called the family-contact scree. This was primarily given in single or double syllables and was most often given before a short flight, during the flight, or just after landing. It usually elicited following of the parent by the young fledgling, and often elicited an answer scree of the same type from the young bird. Screes of this type were associated with responses more often than any other call (Table 3). Both parents appeared involved in this interaction with the young, and during this period (late summer) the parents and young were frequently seen close together. This call appeared to keep the family group together, and a teaching function may be inferred, for imitation of the parents by the young seemed apparent. The scree used in this behavioral context was observed only during the late summer and early fall (Figure 8). This call was the most difficult to quantify for commencement and termination of vocal events were rarely well defined.

Squawks

Although squawks were not as conspicuously

variable as were scree calls, they too were given in a wide variety of situations. Intensity appeared important in revealing the motivational state of the caller whenever these calls were heard. The syllables ranged from 0.29-0.36 seconds (n=10) and ranged in frequency from 1750-6000 Hz. The major portion of the call was distributed between 3000-5000 Hz, and as in the scree call there were no distinct pauses between syllables when given in series (Figure 6). Low intensity series of squawks were characteristically used in long flights, appearing to serve as announcement calls. Otherwise similar, yet higher intensity squawk series most often appeared in aggressive encounters, frequently while chasing other jays. Single squawk syllables were infrequent, but during the late summer, 1976, while considerable family screees were being used, single, double, and triple low intensity squawks of lower pitch were also observed in contexts similar to the family-contact scree (Figure 9).

During the breeding season the squawk was employed on two occasions in conjunction with the song. It was softer, lower pitched, and less harsh sounding in these instances. Similar squawks were heard occasionally during this period without the transition to song.

Chut

The chut call (Figure 6) was the shortest call observed lasting from 0.12-0.15 seconds (n=3). Its frequency ranged from 500-5500 Hz with major intensities occurring between 1000-2000 Hz and 3000-5000 Hz (Table 4). This call first appeared in late winter, 1976, and became increasingly conspicuous as the breeding season progressed (Figure 9). Chuts are generally low pitched, of low intensity, and often appear in series of from four to eight syllables. Chuts were observed in most behavioral situations, but appeared most directly related to nest building activities, and appeared to establish an inconspicuous contact between members of a breeding pair.

Chuts often appeared conversational and were observed given by both sexes. When foliage appeared to inhibit visual contact between the birds, chuts were employed to establish auditory contact. These calls were given repeatedly and often answered from different trees. Frequently these calls were observed while a jay ran along the branches of the nest tree, an unusual behavior as jays usually hop rather than run or walk, and only in this context was running ever observed. Sometimes after an aggressive encounter with other jays

a pair was observed returning to the nesting area loudly calling chuts in flight and after landing. The frequency of this call's use and its intensity both rose abruptly just prior to nest-construction, and promptly decreased after the onset of incubation (Figure 9). It was not observed again until the following breeding season.

Caw

This call was observed infrequently and was never recorded. Caws were observed only by females and during courtship feeding alone. They appeared to be begging calls and often preceded feeding by the male. The posture observed while cawing was often atypical for begging (chin up, posture erect, beak open) and on one occasion the female appeared to exhibit mild aggression towards the male and flew away from him after giving the call.

Phew

Sonagram analysis of this call shows it to be the longest call recorded for the jay, ranging from 1.01-1.34 seconds (n=3). There are three separate syllables, each one of which flows smoothly into the next (Figure 7). The call ranges in frequency from 1500-6000 Hz (Table 4), with each syllable occurring in successively higher

frequency ranges. This call was observed only on a single occasion; it was given by the brooding female during late nesting while a cat prowled beneath the nest tree. The female flew from the nest and perched in a nearby tree before calling. The mate was already present in the nesting area and was observed calling the hiss-rattle call.

Hiss-Rattles

Hiss-rattles were observed in similar contexts as were alarm screeches, but appeared only during the breeding season. These calls did not elicit gathering of jays, and in one case (above) was observed with the phew call. These calls were observed both in flight and while jays were perched in trees, and were longer than most of the calls. Hiss-rattles ranged from 1.01-1.06 seconds ($n=2$) and consisted of two portions (Figure 7). The hiss is of shorter duration and ranges in frequency from 0-2000 Hz (Table 4). The rattle syllables follow a short pause and range in frequency from 300-11000 Hz. The rattles increase in intensity to mid-phrase and decrease in intensity through the final call.

Hiss-rattles seem to comply better to alarm call standards than do alarm screeches. These may be less conspicuous alarm evoking calls employed when the jays

are under threat by natural predators. The first observation of this call came when a cat was observed beneath the nest tree in the Cork Oak territory. It was given by the male and soon after the brooding female left the nest and perched in another close-by tree. A second observation of hiss-rattles came when I attempted to band the Loquat nestlings. Another observation of this call occurred during early breeding in 1977. A Cork Oak tree (Quercus suber) suspected to contain the Cork Oak pair's 1977 nest was invaded by one of the Conservatory pair (L-R) (Table 7), after which the hiss-rattle call was heard in flight from the nest tree to another nearby tree. A squawk/scree aggressive encounter ensued and L-R was chased from the area by the Cork Oak pair. In all of the above instances the birds or their nests were faced with potential danger, as opposed to instances in which they were presented with stuffed specimens. All of the above situations also elicited hiss-rattles rather than alarm screees, which were more inconspicuous even when the calling bird was in sight. There is a hard-to-locate quality apparent in this call.

Tsch

Tsch calls, ranging in frequency from 1500-6250 (Table 4) lasted from 0.19-0.24 seconds (n=3). These

calls were heard during the breeding season, usually while a pair engaged in foraging and once while the Cork Oak male pursued his mate. Tsch calls were also called repeatedly in January, 1976 by one jay for ten minutes while four others gathered around the stuffed Barn Owl.

Song

Although there is controversy surrounding the distinction between calls and song, it is generally agreed that songs are longer and more complex than calls (Brown, 1975). The song given by jays proved to be the most inconspicuous of all vocalizations reported and was never observed directly. On four occasions this soft, four-syllabled song was heard early in the breeding season. It was longer than any of the calls noted above, and on two occasions was heard immediately following a series of soft squawks. It was only through its association with the squawks that I guessed it to belong to the jay repertoire. It was more melodic than any of the jay calls, although by no means as melodic as any of the songs of the "singing" birds. Because of its unusual length and melodic qualities, and its observation during the early breeding season alone, I have designated it song, completing the eight call repertoire.

All five of these last calls described (song,

caw, tsch, hiss-rattle, and phew) were inconspicuous and may therefore have been used more frequently than was recorded. Because of the wide variety of avian species residing in the observational area (Table 8), and due to the excessive foliage, all five of these calls may have been overlooked until it became visually apparent that they belonged to the jay repertoire. For these reasons little attempt has been made to relate these vocalizations to behavioral contexts, and instances of occurrence alone have been discussed.

Table 9 summarizes the monthly vocalizations per hour data for each type of call which appeared to exhibit seasonal qualities. The differences between the months were not statistically significant for any specific call, probably due to the small sample size for each call-type. There appeared to be an increase in the usage of all types of vocalizations just prior to nest building (February) and a gradual decline thereafter (Table 9). Vocalization results during the month of May, while incubation and brooding were both in progress, indicated the least amount of calling, differing significantly (99 per cent probability) from all other months except April (Table 6). September's results indicated significant differences in vocalizations per hour from all other months (Table 6).

The dramatic increase was due primarily to the family interaction occurring during that period (Table 9).

Nesting

Nesting in the genus Aphelocoma generally occurs once each year, beginning in early spring and ending with the fledging of chicks in late spring/early summer. Table 5 presents significant data in chronological form suggesting simultaneous involvement at two nests for the same breeding pair (Loquat pair). Nest No. 1 was located in a Loquat tree (Eriobotrya japonica), approximately fifteen feet above the ground. Upon inspection the nest proved to be typical for the Scrub Jay (Bent, 1946), being quite large and constructed loosely with twigs. The dense foliage of the Loquat tree rendered the nest extremely inconspicuous, so much so that it was not verified as belonging to jays until a week after its discovery when the male was observed feeding the incubating female (April 22). One week later (April 29) a swarm of bees and some lower branches were removed from the tree by a beekeeper, leaving the nest more visible, but undisturbed. After this event, the male could be seen feeding the female regularly, and the female was observed feeding the nestlings.

On the morning of May 1 a dead nestling was ejected from the nest (11 a.m.) and was dragged from the vicinity of the nest tree by one of the parents. The time involved from ejection to deposition of the dead nestling forty feet away was only four minutes, and was briefly interrupted by a passing pedestrian. Inspection of the nestling revealed a well developed chick with most of its feathers, approximately fifteen days old. The cause of death was unclear. I took this nestling to the Cork Oak territory and placed it conspicuously beneath the nest tree in which the female was brooding. The male foraged close to the dead nestling, but appeared undisturbed and ignored it.

On May 3 the two remaining nestlings were color-banded, R-YB and L-RY (Table 7). They appeared to be very close to fledging at this time and became so excited when handled that both leaped from the nest to the ground. Neither appeared injured and were replaced in the nest which was then covered with a light cloth. The nestlings remained in the nest that afternoon, but the following morning (May 4) the nest appeared deserted. This suspicion was confirmed on May 5.

One week after the desertion of Nest No. 1 (May 11), one of the parents was observed visiting Nest No. 2.

Nest No. 2 was approximately thirty feet off of the ground in an Arizona ash tree (Fraxinus velutina) on a branch overhanging a street. It was like Nest No. 1 in construction, but in contrast, was extremely conspicuous. One of the parents was observed sitting on the nest at this time.

Neither of the young from Nest No. 1 had been seen since their banding, but occasionally begging squeals were heard. On May 12 one of the parents was observed feeding young R-YB in a tree about fifteen feet from the Loquat nest tree. At this time the female seemed clearly to be incubating, remaining on the nest for long periods of time.

On May 16 the family was first observed together very close to Nest No. 2. The female was undoubtedly incubating at this time, being fed regularly by the male. Young R-YB remained close to the nest and was often observed in the nest during the female's absence. Upon her return she would prod R-YB from the nest, and he usually resumed a perch close-by. The male fed both his mate and R-YB during this time and the young fledgling was very vocal whenever the male appeared.

On May 28 the nest was inspected and contained three eggs. These eggs hatched on June 3, and the

nestlings were banded on June 14: R-BR, L-RB, and R-RB (Table 7). At this time they were about eleven days old.

Although it is not uncommon for Scrub Jays to renest several times in the event of nest-destruction (Woolfenden, 1973), the successful fledging of a single brood typically ends the breeding season for a pair. The Loquat pair clearly nested twice with success in fledging at both nests. Although the first nest was disturbed twice, first by the beekeeper and second when the nestlings were banded, neither event disrupted the nest itself nor injured the nestlings. After the departure of the beekeeper both parents appeared to continue their nesting behavior normally. The banding of the nestlings on May 3 may have been more disruptive, for both chicks leaped from the nest to the ground. However, even if this had served as a trigger for renesting behavior, a greater lapse in time would have been expected than the eight day period between Nest No. 1 desertion and Nest No. 2 discovery, at which time the female already appeared to be incubating.

Woolfenden's (1974) single observation of a second nesting in the Florida Scrub Jay indicated a twelve day lapse between the fledging of the first brood and the laying of the first egg of the second. He reports an average twelve day lapse between nest-destruction and the first egg-laying in the event of

renesting also. Scrub Jays have not been known to reuse old or take over the partially constructed nests of other species (Woolfenden, 1974), and typically lay an egg each morning until clutch-completion. This implies at most a five day lapse between fledging at Nest No. 1 and the laying of the first egg in Nest No. 2, making it likely that the pair was simultaneously engaged in the care of young at Nest No. 1 and the construction of Nest No. 2. However, since nest-construction usually requires only about five days (Woolfenden, 1974), it is possible that the pair immediately began nest-building upon fledging at Nest No. 1. This would have required the immediate commencement of egg-laying, whereas there is usually an interval between nest-completion and egg-laying (Woolfenden, 1974). Either way, the pair successfully nested twice with very little time between broods, and continued to care for the first brood throughout the entire second nesting.

Reasons for this occurrence cannot be postulated at this time, but one other observation of an older fledgling at a nest containing younger nestlings has been made at San Joaquin Delta College, Stockton, California (R. Tenaza, personal communication) in the spring of 1975. No further investigation of the Delta College nest was

made, but the two observations together suggest that this double-brooding is more common than was previously supposed. The Cork Oak pair exhibited similar re-nesting behavior during the first week after the successful fledging of their brood, but I was unable to locate a second nest. The male was observed breaking off and carrying twigs during this period, and the female was extremely inconspicuous during this time, perhaps attending a second nest.

Altruistic helping behavior is employed by the Florida Scrub Jay (Woolfenden, 1974; 1975), but this was not observed in the Loquat family group. Young R-YB was frequently observed perched close to Nest No. 2, and often entered and remained on the nest during incubation, but neither feeding of the nestlings nor nest-defense by young R-YB was observed. The Delta College fledgling was, however, on the single occasion of observation, carrying food to the nest (R. Tenaza, personal communication). This was extremely unusual behavior in a newly-fledged bird, for even in the Florida Jays, where helping is a common occurrence, it is never observed in the recently fledged young, but involves young of the previous year.

The unexpected nesting behavior observed in the

California Scrub Jays in Stockton contradicts the well defined behavioral system established for these birds. The observations may be representative for jays residing in this area, for the double-brooding was observed in one of only four closely watched pairs at the University of the Pacific, and the observation at Delta College was a chance, unlooked-for event. Renesting activities observed in other University of the Pacific pairs support this hypothesis.

Interspecific Interactions

Notes on all interspecific interactions, whether active or passive, were taken. It is interesting that smaller bird species (Anna's Hummingbirds, American Goldfinches, and Golden-crowned Sparrows) elicited no responses from the jays. Even in close proximity to the nest these birds were ignored by the jays. On several occasions these species were observed flying and perching close to the Cork Oak nest upon which the female was incubating. The female usually looked up, but neither threatened nor appeared defensive.

American Robins, Starlings, Rock Doves, Common Crows, Mockingbirds, and Brewer's Blackbirds (Table 8) were observed under threat by the jays, both vocally and in silent chasing (Table 2). These species all appeared to be submissive to the

jays. The majority of aggressive encounters against these species were observed during the breeding season, particularly in the immediate area surrounding the nest. None of these species ever elicited alarm calls by the jays, and if vocalizations were given, they were either squawks or screeches emitted as the other species were chased away. During nesting, when vocalization was absent near the nest, silent chasing of these other species occurred frequently. A Starling nest, only fifteen feet from the jay nest and at approximately the same height, elicited no aggressive behavior. The young Starlings were extremely conspicuous vocally, and although on two occasions a jay was observed perched on the ledge next to their nest, the jay exhibited no aggression. Other nests in the immediate vicinity of the Cork Oak nest included those of a Mockingbird, House Finch, Common Crow, and Brewer's Blackbird.

Hardy (1961) found Scrub Jays to ignore mounted specimens of Long-eared Owls and Sharp-shinned Hawks placed near their nests. Even when a dead nestling was placed in their talons the jays looked at the mount, perched upon its head, but exhibited neither aggressive behavior nor threatening vocalizations. The Barn Owl, placed near the Loquat and Cork Oak nests at the University of the Pacific, in contrast, elicited alarm calls in both

pairs. Earlier in the breeding season it also elicited mobbing behaviors and calls.

CONCLUSIONS

Vocalization

Although the squawk and scree calls proved to be the most common jay calls, this study revealed the presence of at least six other distinctive calls. The eight call repertoire resembles those of other jay genera for which vocalization studies have been conducted. The Steller's Jay with eleven calls (Brown, 1964; Pustmueller, 1974) and two species of Old World jays each with seven calls (Goodwin, 1951) have all exhibited enough variation within call-types to warrant classifying them as graded rather than discrete vocalization systems. The California Scrub Jay, however, has previously been charged with a limited and discrete vocal repertoire, both of which have been challenged in this study.

To the untrained ear, many of both squawk and scree calls sound identical, but as one devotes more time to listening, distinctions become apparent. The scree alone exhibited seven different varieties (Figure 3) based upon sonographic characteristics, duration and number of syllables per calling event, and behavioral context. The squawk, although not as obviously variable also exhibited some variation. It may have more distinct varieties than suggested in this study, which further

research might reveal. As the data taking portion of this study neared its end, I became aware of slight differences between the squawks, most of which were a result of variations in pitch and spacing between syllables. Some of the series appeared to have more distinct syllables while in others the syllables ran together.

Since all six of the less obvious jay calls became apparent only as breeding ensued, photoperiod-mediated endocrine involvement is an attractive hypothesis governing the development of these calls. Three of these calls appeared to be directly related to breeding behaviors (caw, song, and chut). The hiss-rattle and phew calls were associated with threatening and alarm behaviors near nests, possibly advantageous in drawing little attention to the nests and young. These calls may have functioned similarly to the more audibly obvious aggressive squawks and screees (both absent during nesting), serving both as an inconspicuous alert system and in nest defense.

Social Organization

In all jay genera there appears to be a compatibility between environmental conditions and social organization (Hardy, 1961; Balda, 1971; Brown, 1974). The evenly distributed clumps of oaks surrounding small

flocks of communal Mexican Jays provide natural territories ideally suited for the nesting and foraging of small groups (Brown, 1970, 1972). Their regular spacing and adequate food supply make interflock encounters unnecessary, diminishing the need for aggression. This species is the most social observed within the genus Aphelocoma (Brown, 1970). There appears to exist a permissible range of variability in the social structure within the species A. coerulescens, as well, which may also be correlated with environment. The densely wooded areas of the Florida peninsula provide suitable habitat for the Florida Jays, and the abundance of predatory snakes makes cooperative breeding highly efficient (Woolfenden, 1974, 1975) in that nest defense by helpers serves to increase the survival rate of young birds.

The pair-in-territory social system employed by coastal California Scrub Jays is thought to be encouraged by the harsh winters and sparse food supply available to these jays (Brown, 1974, 1975). The jays on campus at the University of the Pacific exhibited more social tendencies than were expected based upon the observations on coastal populations. The complexity of the vocal repertoire was also somewhat unexpected, and may be correlated with increased social tendencies (Hardy, 1969).

The jays at the University of the Pacific experience abundant food throughout the winter provided by the numerous oak trees. All social tendencies observed, late dispersal of young, decreased territoriality in fall and winter, and double brooding may be related to this abundant food supply. Energy conservation, being of prime importance in all species may be important in allowing for the development of more social attitudes. Spacing in animals is thought to occur as a result of competition for an essential resource (i.e. food, mates, shelter) (Brown, 1975). If these resources become abundant, energy expenditure for maintenance of territories would be wasteful.

If simplicity in vocal repertoire can be correlated with decreased sociality (Hardy, 1969), a simple communication system in coastal jays would be expected, as implied. Conversely, more social systems would be expected to employ more complex communications systems, as observed in the jays at the University of the Pacific in Stockton.

SUMMARY

Social behavior in the California Scrub Jay (*Aphelocoma coerulescens californica*) was observed for a fourteen month period beginning in November, 1975 and ending in March, 1977 at the University of the Pacific, Stockton, California. Vocal communication, nesting, and territoriality are discussed in this report, and in some instances appear to contradict behaviors cited for coastal jays of the same subspecies.

Vocalization observations revealed the presence of eight different call-types, two of which exhibited distinct varieties. Seven varieties of the scree call and four varieties of the squawk call were differentiated on the basis of sonographic, durational, and behavioral qualities. Most of the calls appeared to have seasonal qualities as well, appearing only during specific times of the year. These calls often seemed to be associated with specific breeding behaviors.

Most of the breeding pairs exhibited reneating activities after fledging young birds, and one of the pairs actually nested twice, successfully fledging young from both nests. This pair and their first brood often gathered at the second nest, being the most social group observed.

Territorial behaviors were relaxed in fall and winter, and late dispersal of young birds was observed.

Family groups existed through most of the winter until the young were chased from their parents' territories at the beginning of the breeding season.

The double-brooding and all of the social tendencies observed (relaxed territorial behavior, late dispersal of young, and family groups) were unexpected based upon previous studies conducted on coastal populations. An attempt was made to relate these behaviors to the environmental conditions existing on campus, placing an emphasis on the abundant winter food supply available to the jays.

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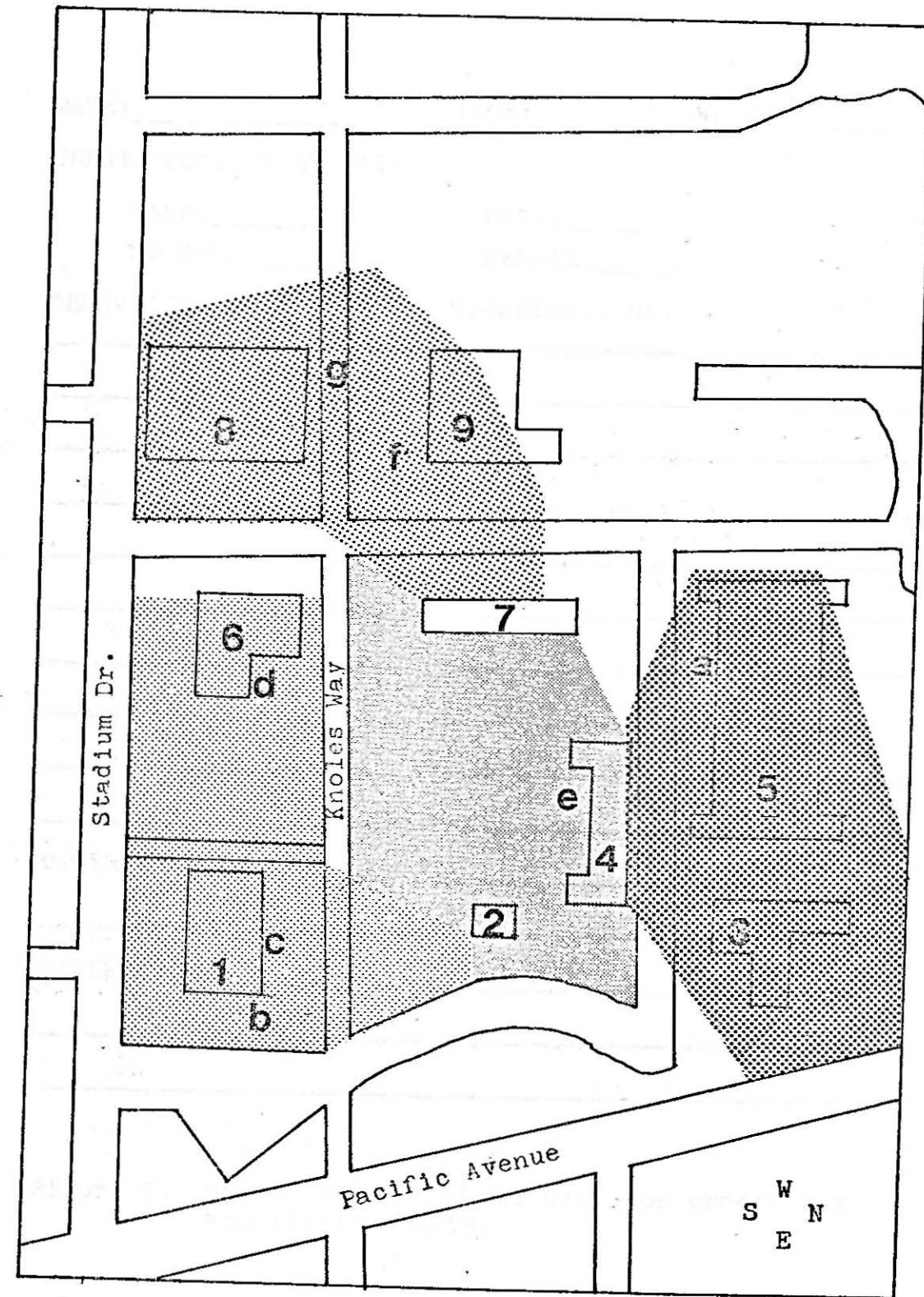
APPENDIX

Figure 1. Map of the observational area at the University of the Pacific, Stockton, California. The four nesting territories are defined in shaded areas, and the jay nest locations are marked with lower case letters.

- Index of numbers: 1-Music Conservatory
 2-Burns Tower
 3-Chapel
 4-Weber Hall
 5-Grace Covell Dormitory
 6-Irving Martin Library
 7-Knoles Hall
 8-Wendell Phillips Center
 9-Anderson Y Center

Nesting Territories:

-  Chapel
-  Conservatory
 - a-Holly or Holm Oak (Quercus ilex)
 - b-Laurel (Laurus nobilis)
 - c-Lawson cypress (Chamaecyparis lawsoniana)
 - d-Common cherry laurel (Prunus laurocerasus)
-  Cork Oak
 - e-Cork Oak (Quercus suber)
-  Loquat
 - f-Loquat (Eriobotrya japonica)
 - g-Arizona ash (Fraxinus velutina)



SCREE 58.34

DATE: _____ ALARM 1.02 TIME: _____ WEATHER: _____

IDENTIFICATION OF JAY:

BAND: _____ MALE: _____

NO BAND: _____ FEMALE: _____

BEHAVIORS: _____ VOCALIZATIONS: _____

OTHER JAYS IN AREA: _____

OTHER NOTES: _____

Figure 2. Sample of data sheet used for organizing vocalization data.

SCREE 58.3%

ALARM 1.9%

MOBBING 1.2%

OTHER 55.2%

Mate Contact 6.5%

Patrol 5.2%

Family Contact 17.1%

Announcement/Aggressive 26.4%

SQUAWK 31.1%

ANNOUNCEMENT/AGGRESSIVE 25.5%

FAMILY CONTACT 4.5%

SONG 0.1%

CHUT 7.7%

CAW 0.8%

HISS-RATTLE 0.7%

TSCH 0.7%

SONG 0.5%

PHEW 0.1%

Figure 3. Percentage breakdown of all vocalizations noted for the California Scrub Jay (Aphelocoma coerulescens), from January 1976 through September 1976 excluding the months of June, July, and August. Percentages in all cases refer to the total number of vocalizations (728).

Figure 4. Sonograms of the three distinct types of scree calls given by the California Scrub Jay (*Aphelocoma coerulescens*). A. Mobbing scree. B. Scree referred to as "other.". C. Alarm scree. D. Unusually long scree where transition from mobbing scree into alarm scree occurs.

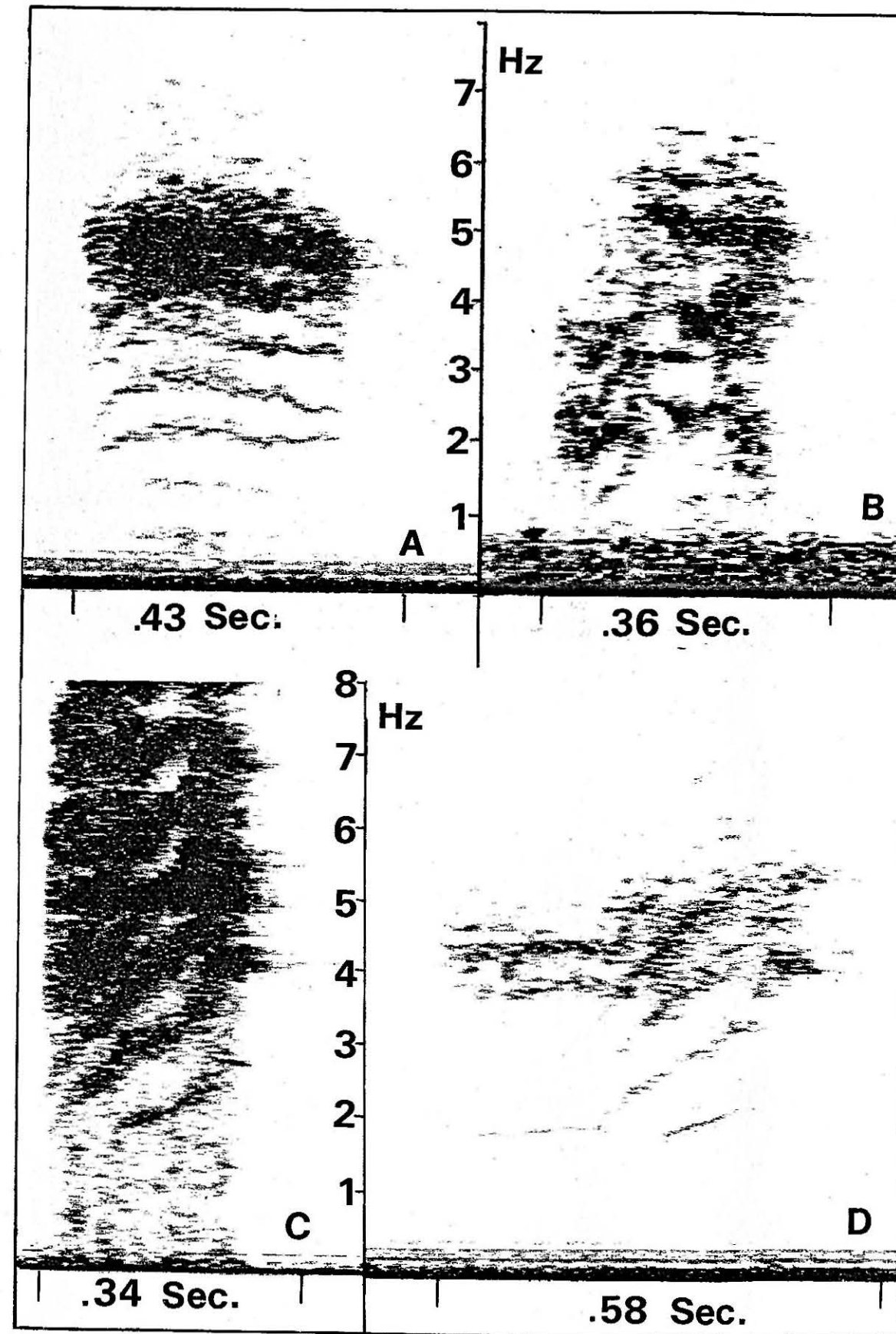


Figure 5. Sonograms of two varieties of multi-syllabled screees given by the California Scrub Jay (*Aphelocoma coerulescens*). A. Patrol scree. B. Aggressive scree. Note the less distinct pauses between syllables in the aggressive scree series (B).

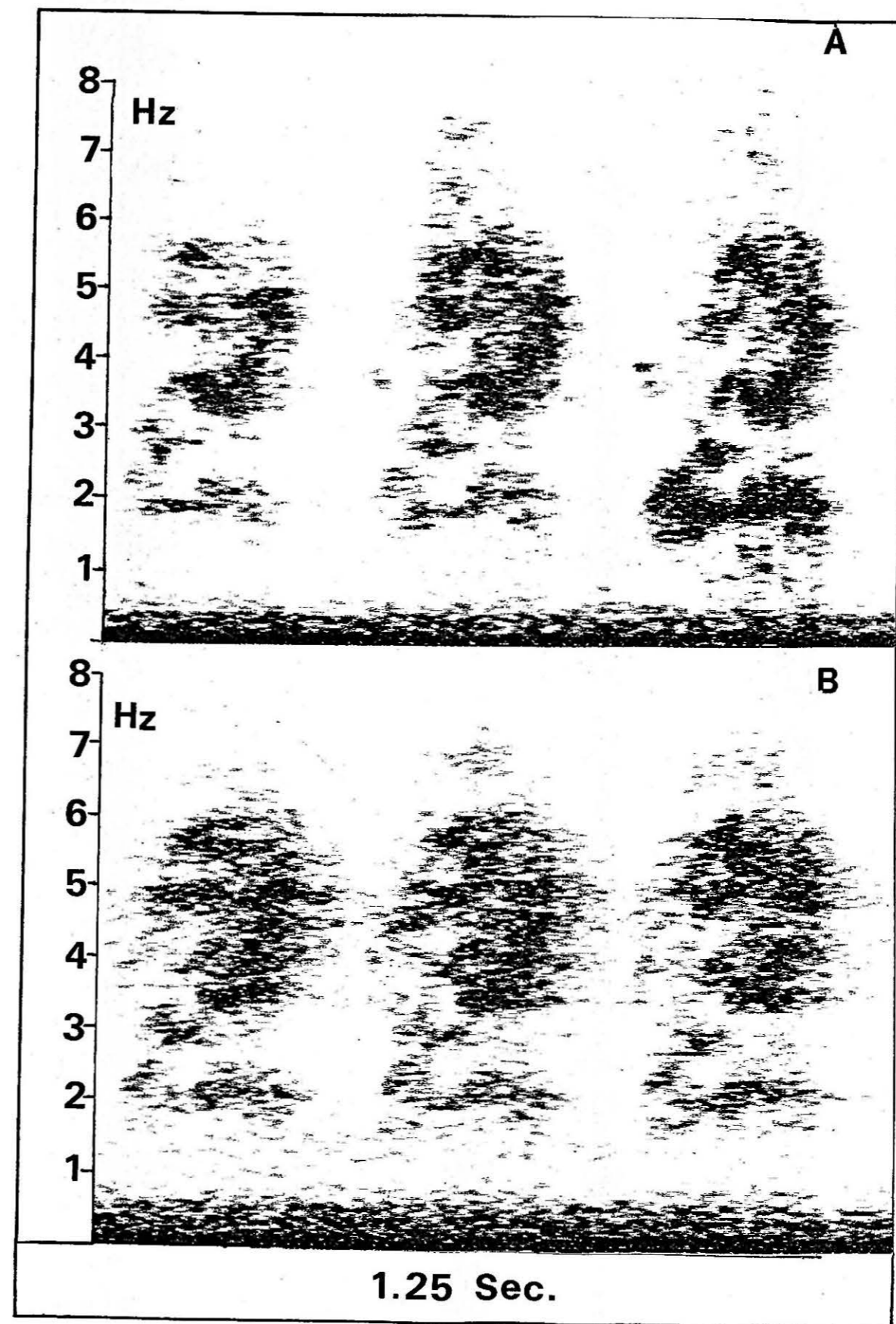


Figure 6. Sonograms of three distinct call-types given by the California Scrub Jay (Aphelocoma coerulescens). A. Announcement squawk series. B. Tsch call. C. Chut call.

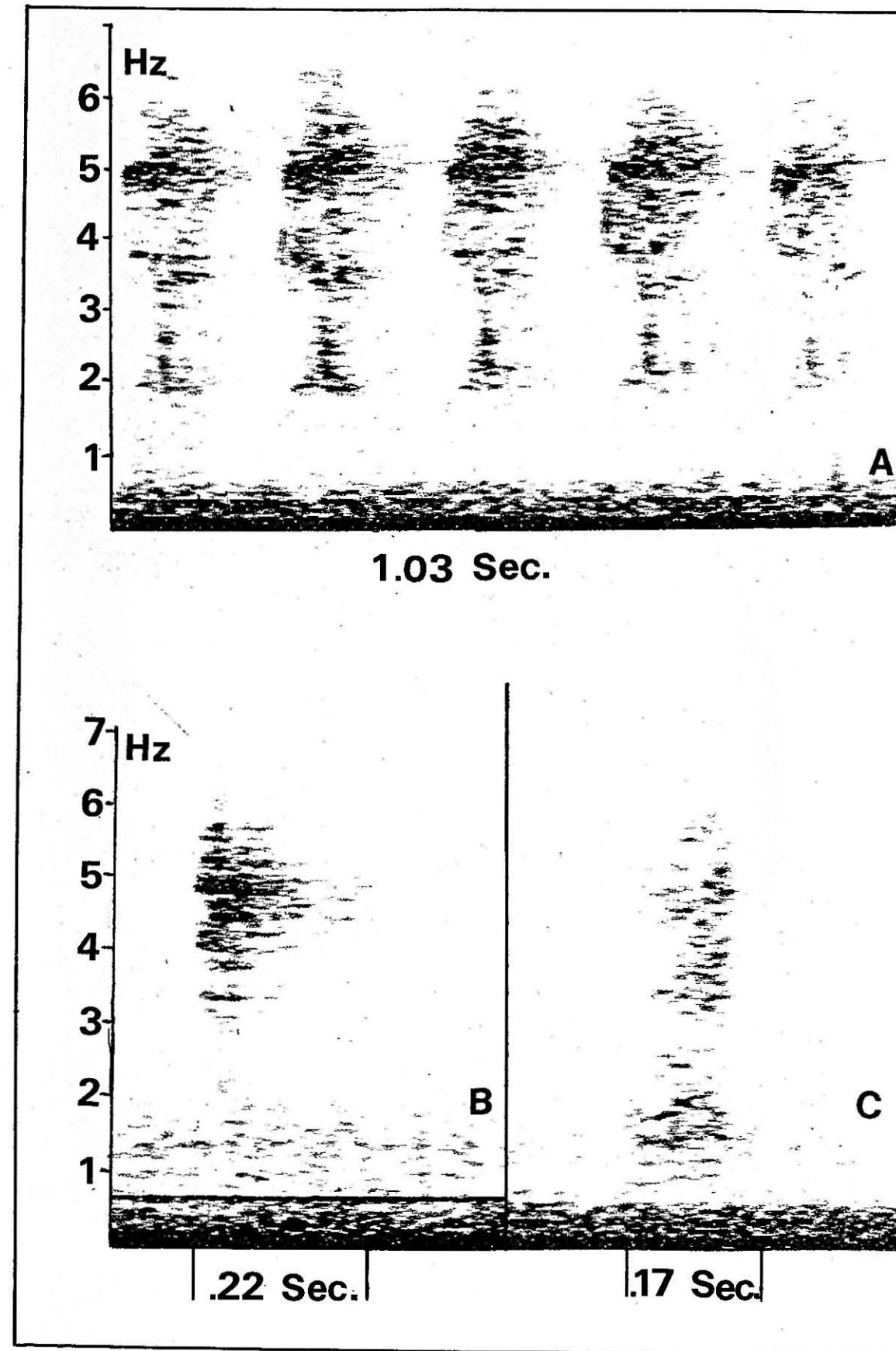


Figure 7. Sonagrams of two distinct call-types given by the California Scrub Jay (Aphelocoma coerulescens). A. Hiss-rattle. B. Phew call.

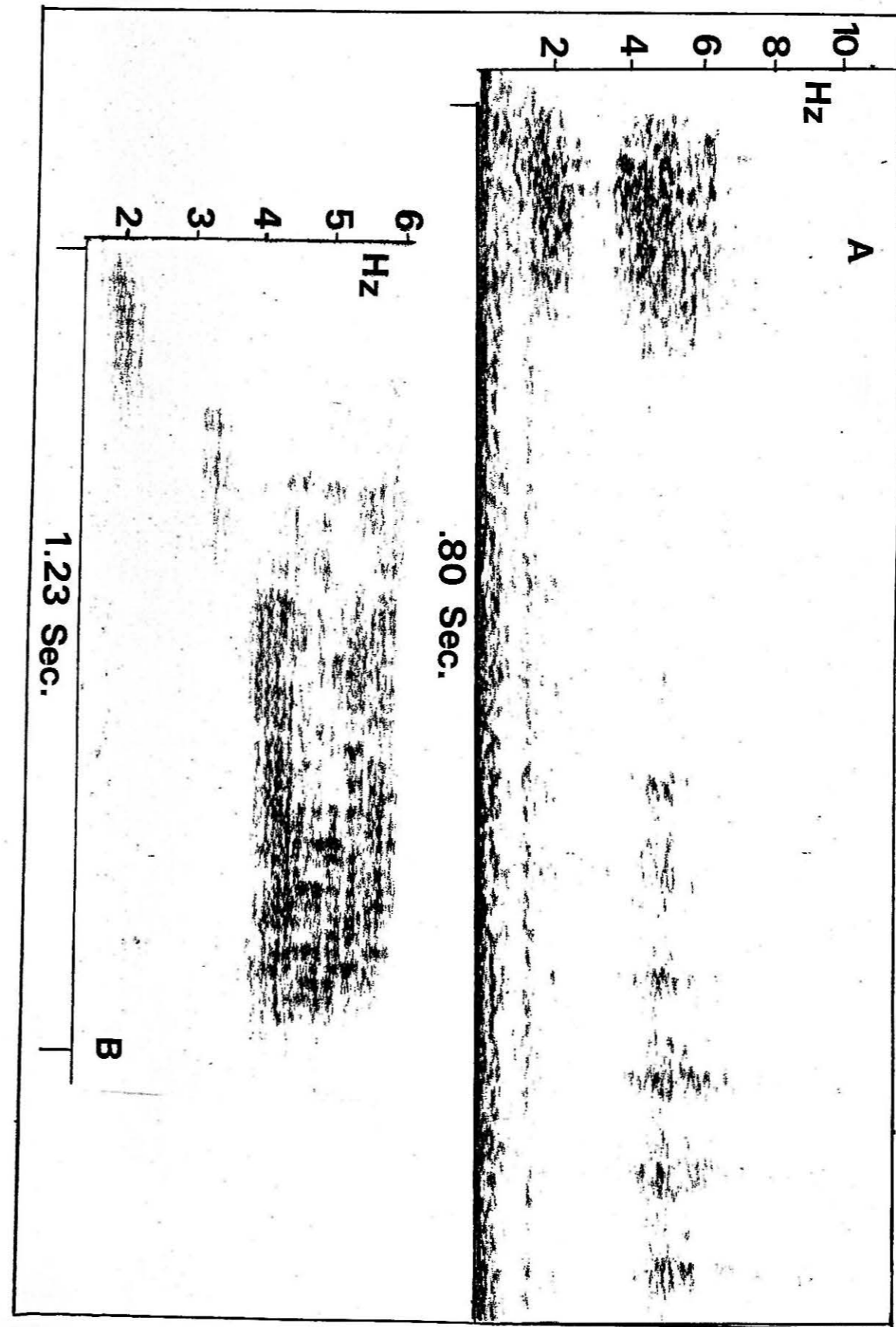


Figure 8. Proportion of total calls given by the California Scrub Jay (*Aphelocoma coerulescens*), that were screees for each of the six months of observation (JFMAMS=January, February, March, April, May, September). Screees referred to as "other" in this context include announcement, aggressive, alarm, and mobbing screees.

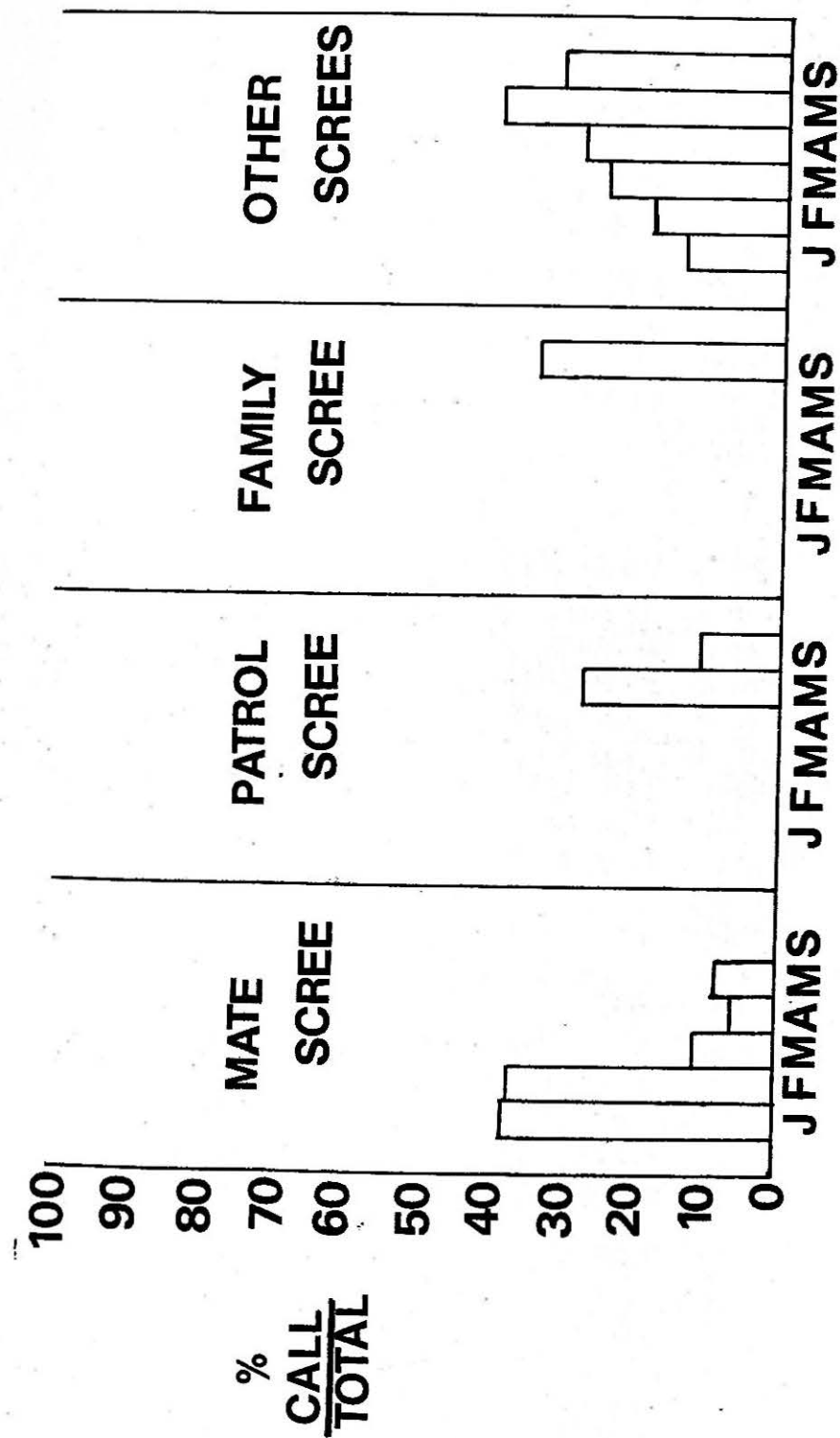


Figure 9. Proportion of total calls given by the California Scrub Jay (*Aphelocoma coerulescens*), that were squawks, chut, and all other calls except screees (hiss-rattle, tsch, caw, song, and phew). JFMAMS=January, February, March, April, May, September.

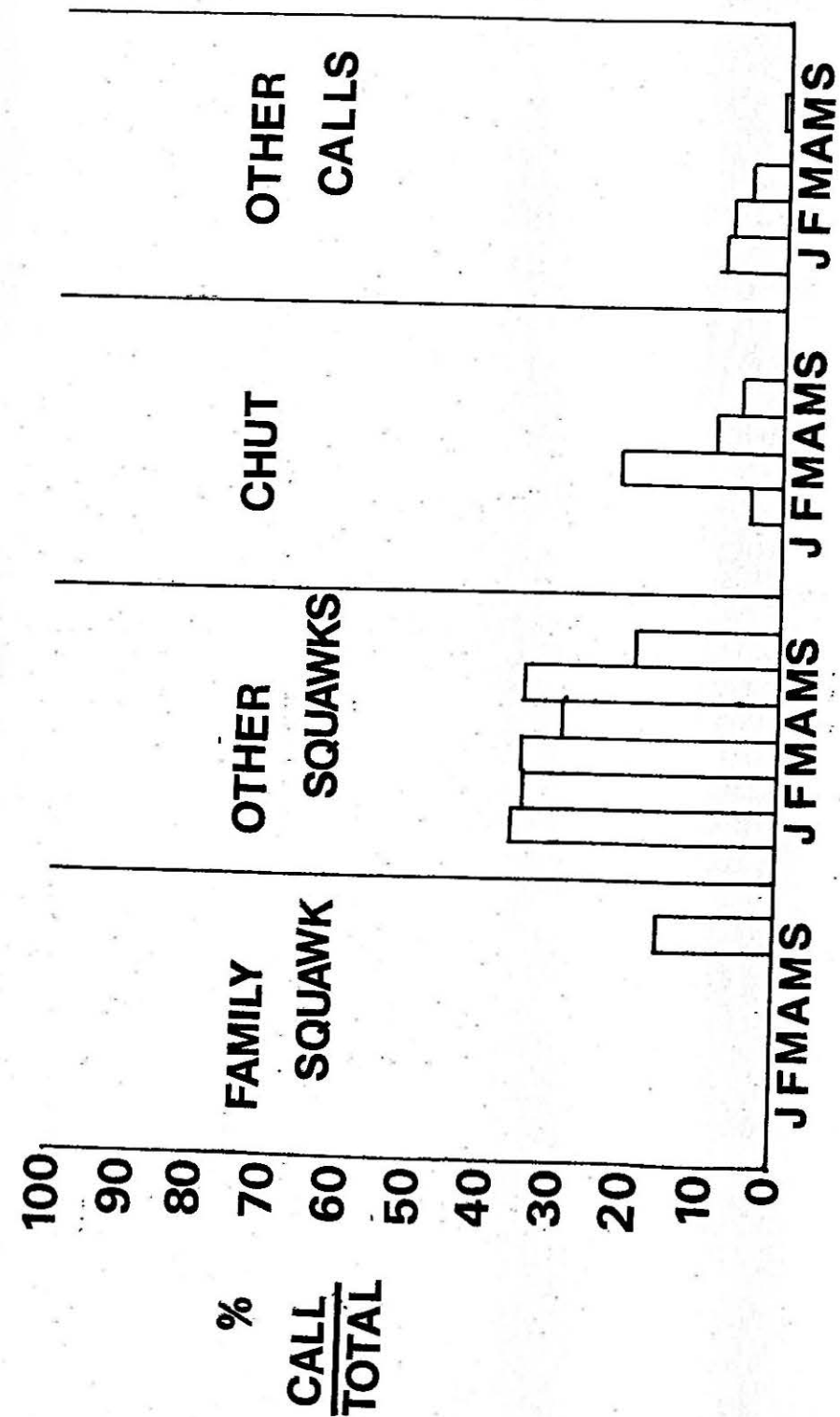


Table 1. Behavioral contexts associated with vocalizations given by the California Scrub Jay (Apheleocoma coerulescens).

CONTEXT	VOCALIZATIONS													
	Alarm Scree	Mobbing Scree	Patrol Scree	Mate Scree	Family Scree	Other Scree	Family Squawk	Other Squawks	Chut	Caw	Hiss-Rattle	Phew	Song	Tsch
In flight	-	-	32	-	36	40	15	93	17	-	-	-	-	-
Perched	-	-	-	8	50	37	8	17	11	-	-	-	-	1
Bobbing	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Foraging	-	-	1	22	-	7	-	-	7	-	-	-	-	-
Chasing	-	-	-	-	-	21	1	51	-	-	-	-	-	-
Fleeing	-	-	-	-	-	9	2	6	1	-	-	-	-	-
Running in tree	-	-	-	-	-	-	-	-	7	-	-	-	-	-
Nest-construction	-	-	-	-	-	-	-	-	5	-	-	-	-	-
Courtship	-	-	-	-	-	-	-	-	-	5	-	-	-	-
Directed towards potential threat	14	9	-	-	-	7	-	13	-	-	5	1	-	-
Unseen	-	-	6	18	41	75	5	16	7	1	-	-	4	4
Total	14	9	39	48	127	196	31	200	57	6	5	1	4	5
Percentage of total	1.9	1.2	5.2	6.5	17	26.4	4.2	27	7.7	0.8	0.7	0.1	0.5	0.7

SPECIES	VOCALIZATIONS						
	Mobbing Screees	Alarm Screees	Hiss-Rattles	Other Vocalizations	None	Silent chasing	Vocal chasing
American Robin	-	-	-	-	2	16	-
Geese (overhead)	-	-	-	1	-	-	-
Stuffed Barn Owl	6	-	-	-	-	-	-
Common Flicker	-	-	-	-	1	-	-
Rock Dove	-	-	-	1	-	-	-
Common Crow	-	-	-	1	-	1	7
Mockingbird	-	-	-	-	1	6	1
Brewer's Blackbird	-	-	-	-	-	8	2
Starling	-	-	-	-	1	3	2
Golden-crowned Sparrow	-	-	-	-	3	-	-
Goldfinch	-	-	-	-	2	-	-
Anna's Hummingbird	-	-	-	-	1	-	-
Cat	-	2	1	-	-	-	-
Human	1	12	1	4	1	3	1

Table 2. Interspecific interactions noted between the California Scrub Jay (Aphelocoma coerulescens) and other species in the observational area. All observations were made when jays and other species were within 12 inches from one another or when apparent that jay behaviors were directed towards other species.

RESPONSES

Vocalization

Scree

Robbing

Alarm

Other

	Mate Scree	Family Scree	Aggressive Scree	Alarm Scree	Aggressive Squawk	Family Squawk	Chut	Fleeing	Joining
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VOCALIZATIONS

Mate Scree	14	-	-	-	2	-	1	-	8
Family Scree	-	31	-	-	2	29	-	4	44
Aggressive Scree	-	2	14	-	11	-	1	23	3
Alarm Scree	-	-	-	7	-	-	-	2	7
Aggressive Squawk	1	-	20	-	17	2	-	23	3
Family Squawk	-	9	-	-	-	7	-	1	8
Chut	-	-	-	-	1	13	-	-	3

Table 3. Vocalizations and responses from one California Scrub Jay (Aphelocoma coerulescens), in apparent response to another's calls.

Vocalization	Duration Range (Sec.)	Lowest Frequency (Hz)	Highest Frequency (Hz)	n
<u>Scree</u>				
Mobbing	0.38-0.53	1500	7000	6
Alarm	0.34-0.38	0	12500	7
Other	0.24-0.34			26
Patrol		1000	7500	
Mate		1000	7000	
Family		sonagram unavailable		
Announcement		sonagram unavailable		
Aggressive		1500	7000	
<u>Squawk</u>				
Announcement	0.29-0.36	1750	6000	10
Aggressive		sonagram unavailable		
Family		sonagram unavailable		
Song		sonagram unavailable		
<u>Chut</u>	0.12-0.15	500	5500	3
<u>Caw</u>		sonagram unavailable		
<u>Song</u>		sonagram unavailable		
<u>Hiss-Rattle</u>	1.01-1.06			2
Hiss		0	7000	
Rattle		3000	1100	
<u>Tsch</u>	0.18-0.22	1500	6250	4
<u>Phew</u>	1.01-1.34	1500	6000	3

Table 4. Physical characteristics of the vocalizations of the California Scrub Jay (Aphelocoma coerulescens), taken from sonagrams.

DATE	EVENT(S) OBSERVED
April 15	Nest #1 discovered
April 22	Male parent observed visiting Nest #1 with food
April 29	Beekeeper removed swarm of bees and lower branches from nest tree, making Nest #1 more visible, but leaving it undisturbed
	Male observed feeding female at Nest #1, who in turn was observed feeding nestlings
May 1	Dead nestling ejected from Nest #1 and dragged away from nest tree area
May 3	Two nestlings in Nest #1 banded for identification
May 4	Nest #1 appeared deserted
May 5	Nest #1 verified empty
May 11	Nest #2 discovered
May 12	Parent observed feeding banded fledgling from Nest #1
May 13	Female observed incubating at Nest #2
May 16	Loquat family group observed together in nest tree near Nest #2
May 18	Nest #1 fledgling observed in Nest #2 during absences of female parent
May 28	Three eggs observed in Nest #2
June 3	Egg-hatching at Nest #2
June 14	Three nestlings in Nest #2 banded for identification

Table 5. Calendar of nesting events observed for the Loquat pair of California Scrub Jays (*Aphelocoma coerulescens*), who nested twice during the 1976 breeding season, and successfully fledged young birds from both nests.

	February	March	April	May	September
January	-	-	-	+	+
February		-	-	+	+
March			-	+	+
April				-	+
May					+

Table 6. Monthly comparison of all vocalizations observed for the California Scrub Jay (Aphelocoma coerulescens), during 1976. A + indicates a significant difference between the frequencies of calling (calls/hour) for the two months listed in the corresponding rows and columns. Significant differences were based upon the nonparametric Mann-Whitney U test at the 99% probability level.

DATE BANDED	BAND #	COLOR BAND LEFT LEG	BAND RIGHT LEG	LOCATION/ IDENTIFICATION
12/18/75	832-17400	Red (L-R)		Conservatory territory
4/15/76	832-17305	Yellow (L-Y)		Cork Oak territory (Male)
5/4/76	832-17306		Red over yellow (R-RY)	Cork Oak territory (Nestling)
5/4/76	832-17307	Red over yellow (L-RY)		Loquat territory (Nest #1 nestling)
5/4/76	832-17308		Yellow over blue (R-YB)	Loquat territory (Nest #1 nestling)
5/20/76	832-17309	Yellow over blue (L-YB)		Dr. Funkhouser's yard
5/28/76	832-17310		Red over blue (R-RB)	South campus UOP
6/14/76	832-17311		Blue over red ((R-BR)	Loquat territory (Nest #2 nestling)
6/14/76	832-17312	Red over blue (L-RB)		Loquat territory (Nest #2 nestling)
6/14/76	832-17314		Red over blue (R-RB)	Loquat territory (Nest #2 nestling)

Table 7. List of all California Scrub Jays (Aphelocoma coerulescens), banded in Stockton, California during this study.

COMMON NAME

SCIENTIFIC NAME

American Robin	<u>Turdus migratorius</u>
Starling	<u>Sturnus vulgaris</u>
Anna's Hummingbird	<u>Calypte anna</u>
Brewer's Blackbird	<u>Euphagus cyanocephalus</u>
Common Crow	<u>Corvus brachyrhynchos</u>
American Goldfinch	<u>Spinus tristis</u>
House Finch	<u>Carpodacus mexicanus</u>
Yellow-rumped Warbler	<u>Dendroica coronata</u>
Rufous-sided Towhee	<u>Pipilo erythrophthalmus</u>
Golden-crowned Sparrow	<u>Zenotrichia atricapilla</u>
Mourning Dove	<u>Zenaida macroura</u>
Rock Dove	<u>Columba livia</u>
Common Flicker	<u>Colaptes auratus</u>
Dark-eyed Junco	<u>Junco hyemalis</u>
Mockingbird	<u>Mimus polyglottos</u>
Red-tailed Hawk	<u>Buteo jamaicensis</u>
White-crowned Sparrow	<u>Zenotrichia leucophrys</u>
Yellow-bellied Sapsucker	<u>Sphyrapicus varius</u>
Ruby-crowned Kinglet	<u>Regulus calendula</u>

Table 8. List of all other avian species observed in the observational area throughout the study period.

Table 9. Mean number of vocalizations per hour, 95% confidence limits of the means, and standard deviations for some of the vocalizations of the California Scrub Jay (*Aphelocoma coerulescens*). N represents the number of hours in each of the months for which data was taken.

VOCALIZATION	JAN.	FEB.	MAR.	APR.	MAY	SEPT.
Mate Scree						
\bar{x}	0.75	1.73	0.61	0.28	0.13	0.00
\bar{x} limits \pm	0.17	0.36	0.22	0.12	0.08	-
S. D.	0.30	0.53	0.68	0.36	0.25	-
n	16	11	36	37	45	11
Patrol Scree						
\bar{x}	0.00	0.00	0.00	0.89	0.18	0.00
\bar{x} limits \pm	-	-	-	0.32	0.14	-
S. D.	-	-	-	0.95	0.45	-
n	16	11	36	37	45	11
Family Scree						
\bar{x}	0.00	0.00	0.00	0.00	0.00	13.18
\bar{x} limits \pm	-	-	-	-	-	4.33
S. D.	-	-	-	-	-	6.44
n	16	11	36	37	45	11
Other Screes						
\bar{x}	0.25	0.82	1.44	0.92	0.64	1.09
\bar{x} limits \pm	0.15	0.80	0.38	0.38	0.14	0.47
S. D.	0.27	1.20	1.14	1.14	0.46	0.71
n	16	11	36	37	45	11
Chut						
\bar{x}	0.00	0.18	1.22	0.30	0.09	0.00
\bar{x} limits \pm	-	0.20	0.36	0.32	0.06	-
S. D.	-	0.31	1.11	0.98	0.21	-
n	16	11	36	37	45	11
Family Squawk						
\bar{x}	0.00	0.00	0.00	0.00	0.00	3.00
\bar{x} limits \pm	-	-	-	-	-	1.90
S. D.	-	-	-	-	-	3.05
n	16	11	36	37	45	11
Other Squawks						
\bar{x}	0.75	1.64	1.92	0.89	0.47	3.60
\bar{x} limits	0.26	0.82	0.45	0.71	0.16	1.90
S. D.	0.46	1.23	1.33	2.14	0.54	2.82
n	16	11	36	37	45	11
All Calls						
\bar{x}	1.75	4.27	5.27	3.30	1.55	20.87
\bar{x} limits	0.36	1.40	1.04	1.48	0.03	6.78
S. D.	0.68	2.09	3.07	4.44	1.14	10.07
n	16	11	36	37	45	11