

## AGONISTIC BEHAVIOR AND VOCALIZATIONS OF ORANGE-CHINNED PARAKEETS IN CAPTIVITY

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The behavior of neotropical birds has not been as extensively investigated as that of birds common to boreal and austral faunas. This is due not to lack of interest, but to factors of inaccessibility and distance from most institutions actively engaged in avian research. Thus, in 1963 and 1964 I undertook a study of captive Orange-chinned Parakeets (*Brotogeris jugularis*), a gregarious, neotropical species. The aim of the study was to investigate social interaction and communication between individuals, within pairs, and in different-sized flocks. Special attention was given to how certain "emotions" (e.g., levels of aggression, annoyance, appeasement) are communicated among members of a flock, and what integrated function this communication has in the daily activity and social structure of these birds. Orange-chinned Parakeets, as well as many other psittacids, become relatively well adjusted to captivity, and thus afford a nearly ideal situation for studies of this kind.

The present report deals with the agonistic behavior and vocal repertoire of Orange-chinned Parakeets. The two topics are interdependent. A subsequent report will describe epigamic and reproductive behavior.

*The distribution of Orange-chinned Parakeets.* *Brotogeris jugularis* is found in arid tropical woodlands, from southwestern México (Guerrero) south over the Pacific slope of Central America to northern Colombia and Venezuela (Peters, 1937:206-207). According to Eugene Eisenmann (personal communication) the local distribution in Central America is from the lowlands to about 3000-foot elevation. In Panamá the species favors second growth, cultivated and suburban areas, city parks, roadsides, forest border, open woodland and savanna mixed with trees. The parakeets are not found in the heavy forest or in dry, open grassland. In many areas of Central America the species is the most abundant and widely distributed parrot.

*Flock size in the wild.* Orange-chinned Parakeets in the wild most frequently move about and feed in flocks (Sturgis, 1928:156; Aldrich and Bole, 1937:63). Eisenmann reports that in Panamá feeding groups are ordinarily composed of pairs and occasionally trios; groups of two to six birds are commonplace, unless the feeding situation is exceptionally favorable, when greater numbers may be seen. At dusk on Barro Colorado Island, flocks of 20 or more flying to roost and actual roosting flocks of several hundred birds were also observed by Eisenmann. These reports indicate that flock sizes ranging from four to 28 birds, as used in the present study, are not so disproportionately large or small that serious alteration of behavior patterns would result.

### MATERIALS AND METHODS

Two birds (a mated pair) were housed in an indoor cage, 2 feet wide, 2½ feet long, and 4½ feet high, for the duration of the study, and flocks of from four to 28 birds were held at different times in an outdoor aviary, 6 feet long, 16 feet wide, and 12 feet high. Fresh fruit, water, and assorted seeds were provided regularly. Observations were made from a blind fitted with a small one-way mirror, or directly through a large window which opened into the aviary. Most observations were made in the morning. The aviary was entered by me only to clean it, to provide food, and occasionally to capture birds and examine nests. All birds were color-banded for

identification, and in most of them sex was determined by laparotomy. Motion and still pictures were used in part of the analysis. Vocalizations were recorded at 7½ inches per second on an Uher 4000 Report tape recorder utilizing an Altec model 684A microphone mounted in a parabolic sound reflector 24 inches in diameter. Audiospectrograms of vocalizations were made by playing master tapes at half speed on an Ampex 960 recorder into a Sona-graph 662-A audiospectrograph (Kay Electric Co.).

#### AGGRESSIVE COMPONENTS OF AGONISTIC BEHAVIOR

In Orange-chinned Parakeets a threat or act of aggression usually consists of one or more components, involving certain postures and/or movements, characterized by the tendency to displace one or more other parakeets. High-intensity Squawking and certain other vocalizations (see below) seem to increase the effectiveness of many of these acts, but vocalizations divorced from actual physical movement were seldom successful in displacing or intimidating an opponent. Initial aggressive behavior that was not successful in intimidation or displacement of an opponent was usually followed by more intense aggressive behavior or subsequent displacement of the original aggressor. Threat or aggression thus formed a sequence of postural and vocal components that usually continued until intimidation or displacement had been accomplished. Following is a description of the various aggressive and related components that were observed during this study. These are described in approximate ascending order of intimidatory effectiveness.

*Plumage-appression.* Appressing or "sleeking" the body feathers preceded and accompanied agonistic behavior. But a bird was never observed to displace another by the single act of Plumage-appression, and the act did not seem to convey aggressive intent to another parakeet. Appressing the body feathers was exhibited by any bird about to move from one place to another, and indicated change from a relaxed to an alert state, often denoting readiness to flee rather than to attack. The behavior was often given at the inception of aggressive behavior or at the approach of a predator, aggressive fellow, or human observer.

*Malar-fluff.* In Malar-fluff the body feathers are appressed and the feathers of the malar region fluffed, giving the bird a bilaterally bearded appearance (fig. 1). Malar-fluff causes the head to appear slightly larger and possibly serves to draw attention to the bill, with which painful bites may be inflicted. This behavior was indicative of annoyance or of an incipient tendency to attack, and was often associated with other components of both annoyance and aggressive behavior described below. Hardy (1963:173) observed Malar-fluff (termed "malar-puff") in *Aratinga canicularis*, when components indicating threat, defense, flight, and courtship all occurred nearly simultaneously; or, in a second instance, when the initial courtship feeding attempts of a displaying bird were thwarted by its partner.

*Turn-toward.* A bird that directed the anterior portion of its body toward an opponent, commonly with plumage appressed and malar feathers fluffed, engaged in the least intense behavior successful in displacing another parakeet. Turn-toward, an abrupt, positive action, was noticeably different from the casual turning toward a fellow in nonaggressive behavior. Turn-toward may be incipient Pecking behavior, and the threat of the aggressor delivering pecks may have served as motivation for displacement of an opponent. Turn-toward was most successful in intimidation of a bird far lower in the social order than the aggressor, and was less often decisive among birds of more nearly equal social standing.

*Head-up.* Upward extension of the head results in an erect posture in which a

bird appears most alert and ready to act. Head-up frequently accompanied the Turn-toward component in one continuous motion (fig. 2). With head above that of the opponent a displaying bird was exposed to possible pecks; however, this apparent disadvantage may have been outweighed by the fact that the aggressor appeared somewhat larger and from this position more powerful blows with the bill could be delivered should the encounter be carried this far. Head-up also denoted a state of alert and was frequently given at the approach of a potential predator (*e.g.*, domestic cat or dog, or human being).

Similar to the Head-up component is outward extension of the head. However, this act appeared to be involved in actual pecking of an opponent and is not considered a distinguishable threat component.

*Gaping.* Gaping involves turning toward an opponent, assuming a crouched posture, wide opening of the bill, and partial erection of nape and upper back feathers (fig. 3). The behavior indicated readiness of one parakeet to bite another and therefore denoted a more aggressive state than did previously discussed components. Gaping was performed by a bird close enough actually to peck another, and Pecking often followed Gaping even though an opponent appeared submissive. Gaping was commonly observed when many birds crowded around the rather restricted area of the feeding station in the aviary, and the "goal" in this, as in most other components, was apparently the displacement of another bird.

Gaping appeared to be a behavior on the threshold between physical aggression and a display of forceful intent. If an opponent was not readily displaced by Gaping, it indicated that he was in an aggressive state equal to that of the aggressor or was otherwise not intimidated, perhaps because of his relatively high position in the social hierarchy. In cases when Gaping was not effective, a brief bout of mutual pecking (discussed below as Bill-fencing) usually resulted in displacement of one of the birds.

Aggressive Gaping was occasionally performed by a bird that had not exhibited any other component of aggressive behavior immediately before the encounter. In such situations a performing bird first appeared in a relaxed state (body feathers slightly fluffed, crouching rather low on a perch) and was resting, feeding, or preening. When there was no forewarning of attack, an opponent was apparently displaced by mere surprise caused by the sudden Gaping by another parakeet. An opponent that occupied a relatively low position in the social hierarchy ordinarily fled in such a case. However, a more aggressive individual would retreat due to the initial surprise, then return and retaliate. In cases of renewed aggression both birds typically exhibited Plumage-appression, Head-up, Gaping, and Bill-fencing.

*Pecking.* An aggressive encounter may be terminated by any of the previous actions, or may continue until actual Pecking occurs. This is the most intense component of typical stationary threat behavior; "stationary" implies that neither bird moves more than an inch or two except for final displacement. Gaping was usually interspersed with Pecking, and retaliation by an opponent resulted in short pecking bouts termed Bill-fencing. It should be noted that Bill-fencing is not the same as "billing," "fencing," or "bill-sparring," which Armstrong (1947:43) referred to as incipient courtship feeding. An initial peck was directed to any part of an opponent's body; however, subsequent Bill-fencing involved extension of the heads by both birds. Only the bills of the two were ordinarily in contact. Bill-fencing usually lasted only several seconds, but in some cases continued for as long as a minute. Eventually one of the birds was displaced; undecided encounters were infrequent, and if a respite occurred it was ordinarily brief if the birds remained within striking distance of each

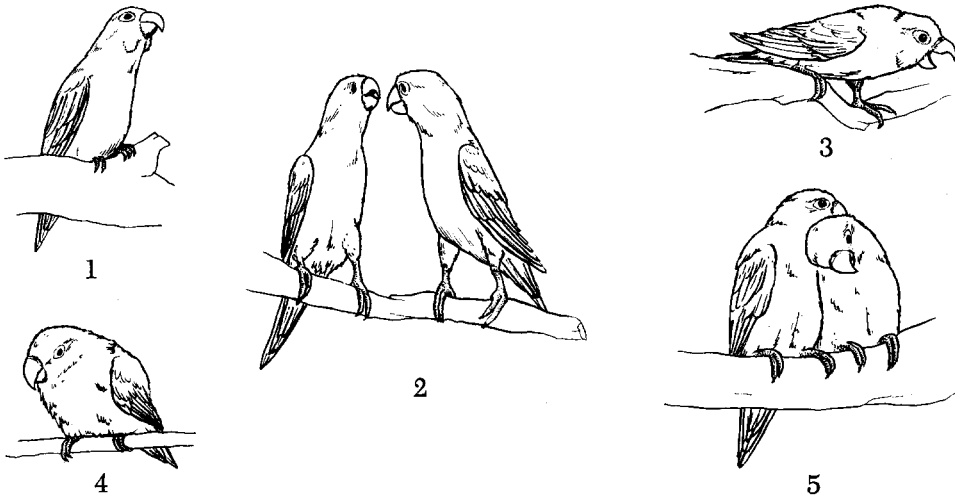


Figure 1. Malar-fluffing, a low-level agonistic behavior.

Figure 2. The bird on the left is exhibiting Head-up, while the bird on the right exhibits Head-up accompanied by Turn-toward.

Figure 3. Gaping, an act on the threshold between physical attack and a display of forceful intent, indicating the readiness of the displaying bird to bite another parakeet.

Figure 4. Typical resting posture, occasionally serving as appeasement behavior to thwart low-level aggression from a nearby parakeet.

Figure 5. Mutual preening, a common activity within pairs. This behavior apparently strengthens the pair bond and probably reduces intrapair aggression.

other. A brief series of squawks or a single squawk often accompanied Pecking, and High-intensity Squawks, Chirps, and Antiphonal Duets were often associated with Bill-fencing (vocalizations are discussed in detail below).

*Wing-jerking.* In Wing-jerking the area of the "wrist" and anterior edge of the flight feathers is moved away from the body in a quick, irregular motion. The wings are folded, and the distal ends of the flight feathers remain against the sides of the body and over the rump. The movement is rapid, and the irregular timing clearly distinguishes Wing-jerking from fluttering or quivering of the wings. Wing-jerking occurred most frequently when birds appeared extremely annoyed, and in situations involving pairs or small groups of birds, rather than only two individuals. Annoyance vocalizations almost always accompanied Wing-jerking.

Wing-jerking is also exhibited by Yellow-winged Parakeets (*Brotogeris versicolurus*) in an agonistic context. But the movement is more irregular in timing, and the entire wing is involved in the motion. In both species of *Brotogeris*, Wing-jerking may be derived from flight intention.

*Threat-sidling.* All components discussed above were performed while an aggressor remained relatively stationary. Other kinds of threat and attack behavior involved movement of an aggressor toward an opponent. These mobile components were frequently performed with High-intensity Squawks and Chirps; the opponent was usually silent. A pair often gave Antiphonal Duets in addition to Squawks and Chirps when a mutual attempt was made to displace an opponent.

Threat-sidling, the first of these mobile components, is a rapid, sideways

approach, with plumage appressed, head up, and malar feathers fluffed. If an opponent did not flee, the act was usually terminated with Gaping, Pecking, or Bill-fencing, and the subsequent displacement of one of the birds.

*Rushing.* In Rushing, a parakeet ran toward an opponent with feathers appressed, bill slightly agape, and head held low. The head-on approach apparently indicates more intense aggression. When displacement was not effected by Rushing alone, Gaping, Pecking, or Bill-fencing usually ensued until the encounter was decided.

*Flight-approach.* Flight-approach occurred when a parakeet directed aggression at a bird some distance away, or continued after initial behavior resulted in the displacement of an opponent. In Flight-approach, an aggressor flew at and supplanted an opponent, or flew to a spot near the opponent and continued Gaping, Pecking, or further chasing. Actual chases involving flight of both aggressor and opponent were rarely observed.

*Discussion of aggressive components.* Any one or all of the aggressive components discussed above may be given by a bird in an attack or threat directed toward others. Although these acts are listed approximately in ascending order of intimidatory effectiveness, this does not imply that they are always exhibited in this sequence. A bird that eventually exhibited high-intensity aggressive components did not always initially display lower-intensity acts. The pattern of agonistic behavior is not strictly ritualized. Appearance of one component instead of another appeared to depend in part on the behavioral incidents immediately preceding an encounter, on previously established relationships between the opponents, and/or on the prominence of aggression in the participants. Many of the aggressive components, in sequential arrangement and character, are similar to those described by Hardy (1965:140-156) for Orange-fronted Parakeets (*Aratinga canicularis*), but differ in that in the Orange-fronted Parakeet "stereotypy is . . . seen . . . in the order of aggressive components . . ." (Hardy, 1965:142).

The most intense aggressive encounters involved more than two individuals; usually one pair against another, a pair against a single bird, or aggression between two small groups of birds. Such cases included active chases, prolonged Bill-fencing, Pecking, Wing-jerking, High-intensity Squawking, Chirping, and Antiphonal Duetting.

The vocal repertoire of Orange-chinned Parakeets will be described in a separate section below. However, it may be noted here that certain vocalizations associated with various intensities of aggressive behavior appeared to reinforce aggressive components by presenting an audible signal of aggression in addition to the visual and physical signals of the actual display. Vocalizations most frequently accompanied the components of greater intimidatory effectiveness, and ranged from Medium-intensity Squawks in situations of moderate annoyance to High-intensity Squawks, Chirps, and Antiphonal Duets in situations of greater annoyance.

#### APPEASEMENT BEHAVIOR

Ritualized appeasement behavior was not observed in Orange-chinned Parakeets. However, an absence of aggressive tendencies and a lack of readiness to act was suggested when a bird crouched low on the perch, with head drawn in and plumage ruffled, as in the typical resting posture (fig. 4). This posture in some instances was observed to thwart low-level aggressive behavior from a nearby bird. In *Aratinga canicularis* (Hardy, 1963:178) the assumption of resting or roosting posture as a form of appeasement is also prevalent, but is more common in aggression related to courtship than is the same behavior in *B. jugularis*.

Aggressive tendencies between members of a pair may be reduced by mutual preening (fig. 5), which in addition to aiding in feather care is also significant in maintaining and strengthening pair bonds. In *B. jugularis* mutual preening is performed more extensively than it is in *Agapornis*. In the former, preening is directed to the head, nape, and crissum, but adult *Agapornis* indulge only in mutual preening of the head (Dilger, 1960). Mutual preening seems particularly well developed in *Aratinga canicularis*, in which preening is directed to the head, wings, and tail, and is apparently necessary for peaceful relationships between mates.

#### PECK ORDER

Through frequent, decisive aggressive encounters a loose peck order was maintained within the flock. A social hierarchy was especially apparent at the feeding station and roosting sites, where a majority of the individuals may attempt to congregate at the same time. The social system was not rigidly maintained, and a dominant bird was not always observed to win an encounter with a socially inferior fellow. Aggressive encounters between birds far apart in the hierarchy were infrequent, apparently because subordinate birds learn to recognize and avoid more dominant individuals. However, between flock members of more nearly equal social rank, peck order was maintained by peck dominance. This is a situation in which the relative status of two parakeets may be judged on the basis of which bird has won the majority of aggressive encounters with the other. Social organizations based on peck dominance have been reported by Allee (1958:137) in *Columba*, *Streptopelia*, *Serinus*, and *Melopsittacus*. Dixon (1965:298), however, questions use of the term "peck-dominance" since, in his argument, it has not been demonstrated as a form of internal organization in unconfined groups of vertebrates. By contrast, peck right, the social system in flocks of chickens, involves a rigid system in which relationships between birds are rather firmly fixed.

Ordinarily the members of nesting pairs of Orange-chinned Parakeets were socially superior to non-nesting birds, and thus pair formation and the advent of the breeding season often alter the social hierarchy. Increased dominance may be a result of heightened territoriality associated with the acquisition and excavation of a nest. In this study nest cavities were excavated in artificial arboreal termite nests, constructed of dark-brown cork and shaped and positioned high in the aviary to resemble nests of the termite *Eutermes (Nasutitermes) nigriceps* in which *B. jugularis* and other parakeets may excavate nest cavities in the wild. The members of a certain three-bird "pair" upon commencing nesting activity became the most dominant birds in the flock of 28, a position which they were not observed to hold previously either individually or as a unit. As a nesting group their social position was high, and frequently they chased as much as half of the flock from the vicinity of their nest to another part of the aviary. Yet when members of this group were apart, social encounters were individually decided. For example, although nests were closely guarded against intruders, occasionally one member of this group was observed to be unable singly to displace an intruder perched directly at the entrance of the former's nest. In other cases it was observed that single birds were usually more successful in an aggressive encounter if their mates were nearby, even though not actively participating.

#### TERRITORIALITY

The acquisition and defense of a sizable territory by a single bird or pairs has not been reported for *B. jugularis*, and there is no indication in the literature that such

activity exists at any time of the year. Likewise, personal observation of birds in captivity indicates that the birds are highly social the entire year. There are, however, certain situations in which individuals, pairs, or small flocks may effectively defend a small area against birds of the same species or other parakeets that may utilize the same food, roosting sites, or nesting space as *B. jugularis*.

One type of territoriality, or, more accurately, "microterritoriality," was defense by nesting pairs of areas immediately around nests or favored roosts (a distinction may not be warranted, since roosts were within 5 feet of nests). As mentioned above, nesting pairs of Orange-chinned Parakeets were highly aggressive toward all other parakeets that happened to be in the vicinity of nests or favored roosts. One isolated pair, housed in the small cage, was presented with stuffed mounts of *Brotogeris versicolurus*, *B. cyanopectus*, *B. chrysopterus*, *B. pyrrhopectus*, and *B. st. thoma*. All are similar in size but bear color marks distinctive from those of *B. jugularis* and from one another, and are allopatric with *B. jugularis*, occurring exclusively in South America. These mounts were wired to a perch about 12 inches away from the front of the artificial termitarium in which the pair had excavated a nest cavity. Only one mount was tested on a single day, and the trials were repeated twice for each species tested. Due to the immediacy and consistency of responses it was felt that additional testing was not necessary. In all cases the female, male, or both together (usually the male initially) would Rush, Gape, and Peck repeatedly at the specimen until it fell from the perch or was removed by me. Accompanying the attacks were High-intensity Squawking, Antiphonal Duetting, and Wing-jerking. Live *B. jugularis*, *Aratinga canicularis*, and *Aratinga astec*, when placed inside the cage or allowed to walk over the top of the cage (the top was about 12 inches away from the termitarium), evoked similar aggressive responses from the pair. In almost every case the intruders were successfully displaced. Aggressive behavior involved the components directed toward mounted specimens in addition to chasing since the opponents in some cases were able to flee repeated attacks.

Nest protection similar to that described above was noted for two different pairs that were simultaneously part of the 28-bird flock housed in the large outdoor aviary. As soon as nest excavation commenced, the pairs became highly territorial and continually chased other parakeets from the vicinity of their respective nests and favored roosts. In these cases aggressive behavior was directed toward intruding flock mates rather than toward introduced birds of the same or different species.

Territorial behavior in defense of a slightly larger area (the large aviary) was observed in a flock of four non-nesting birds in response to unfamiliar parakeets. Such behavior was not observed in birds of a larger flock (28 individuals). Perhaps when there were fewer birds a stranger was more readily noticed, and was thus more likely to draw aggressive behavior, than when there was a larger number of individuals. These four non-nesting birds were observed in several experimental encounters set up in the large aviary in order to observe various aspects of territorial behavior.

*Trial I.* Four parakeets that had been together for at least six months were released separately into an aviary that was completely unfamiliar to them. The following observations were made. Bird A was released into the aviary, and it immediately flew to a far wall and clung there in silence. Thirty-five minutes later bird B was released into the aviary. B flew to the wall opposite A and was immediately joined thereon by A. The two perched close together in silence. Within 30 minutes of B's release both birds began to preen intermittently and fly within the aviary. Three hours after the first release the birds had fed, flown considerably, and seemed relatively at ease in the new surroundings. The following day bird C was released into the aviary and flew to a perch

near A and B. B immediately pecked at C and drove the latter a short distance away. As soon as C was away from the others it evoked no further aggression. A and B acted as a pair and for the most part ignored C unless it happened to venture too near. About three and one-half hours later, bird D was introduced. D for the most part was ignored.

*Trial II.* A few days after trial I, the four parakeets (A, B, C, and D) had apparently become well adjusted to the new surroundings. At this time, a strange Orange-chinned Parakeet (E) was released into the aviary. E flew to a far wall, clung there in silence, and appeared quite passive. The initial responses by A, B, C, and D were Medium-intensity Squawking, increasing to high-intensity aggressive behavior including Squawking, Gaping, Pecking, and Chasing. After about 30 minutes the initial responses diminished, and E was left alone. E was never aggressive in return, and repeatedly fled all attacks. From this time on, E was largely ignored as long as it remained inactive. As soon as E flew about or moved toward the feeding area, it immediately met with aggressive behavior from the other birds. Three hours after E's release into the aviary, bird F (E's mate) was introduced. E and F immediately joined each other, were silent and inactive, and drew no aggressive responses from the other four. As a pair, E and F evoked less aggression and were able to feed several times in the following hours. This may have been due to A, B, C, and D becoming more familiar and more at ease with the strangers, or that E and F as a pair presented a potentially formidable adversary in aggressive encounters.

In these experiments it was observed that during aggressive encounters not only the flock behaved as a unit, but each pair functioned as a subunit. The first and most intense aggression in trial II was by two pairs in response to the presence of a single, unfamiliar parakeet. A situation in which one of the initial pairs was split up and a stranger subsequently introduced was tested as below.

*Trial III.* One bird (A of the original A-B-C-D group) was removed from the aviary, leaving a pair (C and D) and another bird (B). A stranger (E) was then introduced. B quickly moved close to E, much as it had done with its now missing mate, A. E did not behave as it did on its normal ground, but was silent and inactive. With E's reaction, B became aggressive toward E; soon thereafter C and D joined B and mobbed E. The pair responded upon noticing B's reaction, since prior to the time of their attack they had ignored the stranger, perhaps taking it to be A. A was then placed back into the aviary, and A and B immediately came together and acted aggressively toward the stranger.

From these and other observations it was concluded that Orange-chinned Parakeets probably have no formal greeting or recognition displays. Moreover, it appears that prior association is primarily important in recognition of flock members and mates. When a bird was on familiar ground or in the presence of its flock mates, it did not act passive and silent as did a bird in unfamiliar surroundings or with unfamiliar birds. In trial III there was an indication, judging from the response of the flock, that E, the stranger, would not have been mobbed had it behaved as a bird on familiar territory. The idea that prior association is necessary for peaceful relationships between birds within a flock was tested further by disguising birds familiar and unfamiliar to the flock with various color patches of paint. These experiments were designed to determine primarily if the orange chin patch characteristic of this species is useful in warning or threat display, is significant as an intraspecific recognition character, or is in some other way integrated with the behavior of the birds.

*Trial IV.* A parakeet was removed from the flock of four, and the chin patch was concealed with water-base paint blended to match the color of the body feathers. After allowing the paint to dry thoroughly the bird was released into the aviary. Although in the past a strange bird had usually met with aggression from the birds of this flock, the painted bird elicited no agonism and within an hour was closely associated with its fellows and its mate. On following days the experiment was repeated with two additional birds, and similar results were observed. Often a disguised



bird would solicit its mate to preen the painted area by lifting its head and exposing the chin; the paint was soon removed in this manner. The disguised bird probably felt the paint and solicited preening just as it would if a piece of fruit or other sticky material was adhering to the plumage.

*Trial V.* Another experiment involved concealment of the chin patch as above, plus the addition of a bright-yellow forehead patch. Except for the presence of yellow underwing coverts, characteristic of *B. jugularis*, the disguised bird was almost identical in appearance to the sympatric South American *B. st. thoma*. The disguised bird was released into the aviary and within 30 minutes had found its mate and had directed preening to the painted area. Again the bird was normal in its social integration.

The results of these experiments indicated that regardless of subtle differences in specific color patterns, a normally active bird was accepted by the flock and its mate, and a passive and "apprehensive" one was mobbed. This is not to say that the specific coloration is not important in intraspecific recognition in the wild, as, logically, it must be. The experiments indicate only that once relationships are established within a flock and between mates the way a bird behaves may be more important than specific coloration with regard to individual recognition and acceptance.

In *Aratinga canicularis* (Hardy, 1963:172-173, and personal observation) there are several components linked with courtship feeding and formation of pair bonds that often serve as greeting displays between strangers. Some of these components are Bill-wiping, Head-wagging, Bill-vibrating, and Pupil-flexing. No similar behavior has been observed as part of courtship or greeting displays in *B. jugularis*.

Mobbing was also elicited from the small flock of Orange-chinned Parakeets by individuals of *Aratinga canicularis* and *Aratinga astec* when introduced into the aviary. These parakeets are somewhat larger than Orange-chinned Parakeets, and it was surprising that the latter intimidated the larger birds as effectively as they did their own kind. Interspecific aggression in these cases might also have been in response to the behavior of the strangers. Individuals of the two species of *Aratinga* that elicited aggression from the Orange-chinned Parakeets were all rather passive birds when introduced into the aviary. When an *A. canicularis* with a history of dominance and familiarity with the aviary was introduced, the observed result was different. The *Aratinga* was very active, flew from perch to perch, and gave its species flock calls. When the *Aratinga* settled for a moment, one or both pairs of Orange-chinned Parakeets began to move toward it in a threatening manner. But when the *Aratinga* resumed flying about, the Orange-chinned Parakeets fled in the opposite direction and then perched in passive but watchful silence. It appeared that the Orange-chinned Parakeets were stimulated toward aggressive behavior, but in the presence of an active and vigorous intruder aggressiveness was thwarted. It seems, therefore, that small flocks of Orange-chinned Parakeets are territorial to some degree, but whether or not they successfully defend an area depends on the degree of aggressiveness and/or familiarity with the surroundings of both the birds occupying an area and the intruders they meet in defending that area.

#### REACTIONS TO PREDATORS

Orange-chinned Parakeets were observed to respond to the approach of a potential predator primarily in four different ways. These are classed as Immobility, Alert, Annoyance, and Fleeing. A particular form of immobility termed Rigid-immobility is seemingly the more intense "fear response," while progressively less

"fear" in a given situation elicits Alert and Annoyance behavior. Fleeing, or more exactly, attempts to flee, at the approach of a predator are easily visualized and will not be discussed further here except to mention that this response was observed in all contexts discussed below.

*Rigid-immobility.* In a flock confronted with the sudden approach of a potential predator, certain individuals crouched in a completely rigid, immobile state; the eyes are open wide, and the plumage is appressed. A parakeet may remain in this state for 15 minutes or more. Occasionally a bird would become immobile in curiously off-balance positions, such as leaning far forward as if ready to take flight. Such awkward postures were usually not maintained for more than five minutes.

Eugene Eisenmann (personal communication) in Panamá observed what appeared to be Rigid-immobility exhibited by two parakeets that had flown to and perched within about 20 feet of him. One bird hung upside down (as I have observed with captive birds) from a narrow branch and was well camouflaged in the surrounding foliage. Both birds remained immobile as long as they were watched; however, when the observer turned away the birds immediately fled.

A particular pair in captivity, during the first two weeks of nest excavation and nesting activity, repeatedly exhibited Rigid-immobility when confronted with an observer. If I approached and walked around the cage, the immobile position was maintained, even to the extent that the birds kept their heads perfectly still and made no attempt to keep me in their vision. When I attempted to touch either of the parakeets, they would first Gape and then attempt to flee. Ordinarily, the birds remained immobile for about two or three minutes after I moved behind the blind. After this time they gradually fluffed the plumage and settled on the perch with eyes closed as in resting. Initiation of activity anew involved typical components of post-roosting behavior, such as ruffling the plumage, scratching, stretching, preening, and mutual attentiveness. However, these activities were of shorter duration than when performed after normally assumed periods of rest.

When nesting activity had been underway for three or four weeks, the pair became steadily more aggressive toward a human being near their cage. Rigid-immobility gradually became more infrequent as a response to danger, while high-intensity annoyance behavior (discussed below) became more prevalent. A display of annoyance and aggression was the case only when the two birds were together. If one member of the pair was isolated from the other, or if one was out of the nest cavity while the other was in, the typical behavior was Rigid-immobility when confronted with a man, rather than a display of annoyance and aggression.

Rigid-immobility was also observed under slightly different circumstances. The behavior was employed by a few members of the large flock and, again, was usually in response to the presence of a human being. These responses were strictly those of individuals and seemingly not governed by the behavior of the flock in general. It appeared that those birds most frightened were the ones that most frequently employed Rigid-immobility. The fact that different birds react differently toward human beings was observed when I entered the aviary with food; some birds became immobile, others fled, while a few approached me, in some cases aggressively. In addition, the particular nesting pair mentioned above was always quite frightened of me, and on no occasion did I observe normal daily activity when I was fully visible to these birds, although such activity was frequently observed with certain members of the large flock when I was visible to them.

*Watchful-immobility.* Watchful-immobility seemed to be low-intensity alert

behavior, and was usually observed in response to a relatively mild fear stimulus (*e.g.*, a human being 50 to 100 feet from the aviary). I observed this reaction most frequently when the birds were at rest or involved in rather "casual" or passive self and mutual attentiveness. Birds performing Watchful-immobility were silent, remained in typical resting posture, and would occasionally move wings, head, or other parts of the body. Only those birds that actually saw the potential danger typically exhibited Watchful-immobility. Since most or all flock members were quiet when this behavior was observed, it is thought that it may be of survival value in the wild for birds to refrain from calling in alarm or from activity that would draw attention.

Both Rigid-immobility and Watchful-immobility may be directly correlated with the cryptic, green plumage coloration of this species. The birds, being basically green, would be well camouflaged in the foliage of their habitat.

*Roosting-immobility.* A few times during the course of this study I entered the aviary at night. At such times the birds usually remained silent and immobile, and, curiously, an approach to within about 1 foot of certain individuals elicited no alarm response. Under these conditions there was enough light to see the parakeets, and I made no special effort to be completely quiet. The posture in Roosting-immobility is similar to that in Watchful-immobility, but differs in that the birds may be approached without eliciting vocal responses or flight.

*Alert.* Orange-chinned Parakeets in Alert status assume an erect posture, appress the plumage, and utter single, high-intensity, chirp-like vocalizations. This behavior was usually initiated by only a few individuals, but in most cases the response was quickly taken up by other members of the flock. Example situations in which an alert reaction was observed were: a man appearing suddenly near the flock, a bird flying close to the aviary, a dog running toward the flock, or the slamming of a nearby door or window. Thus stimuli for the reaction may be visual, auditory, or both.

Typical Alert behavior was most often given when the birds were active (feeding, excavating at the nest, or engaging in mutual attentiveness), whereas Watchful-immobility was often the reaction if the birds were resting. A bird that appressed the plumage and assumed an erect posture was "ready to act" and was thus prepared to escape possible danger. However, it is also significant that the Alert reaction conveyed alarm to nearby fellows. Other parakeets became Alert merely if they saw another in typical Alert posture or heard the characteristic vocalization, regardless of whether or not the fear stimulus itself was perceived.

High-intensity, chirp-like calls are the most obvious aspect of Alert behavior. These single notes are loud enough to be heard by the human ear up to a distance of about 300 feet. Alert calls may be given repeatedly if potential danger is visible and near, or approaching, and seem to warn all members of a flock of impending danger. When tape-recorded high-intensity chirps were played to the flock, the initial reaction was that all of the birds became Alert. After the initial response, if the calls were played several times when no apparent danger was in sight, more normal flock activity was usually resumed. Thus the calls themselves do not continually evoke an Alert response without an obvious fear stimulus. Likewise, certain birds may continually exhibit Alert behavior in response to a fear stimulus that does not convey the same degree of Alert to other members of the flock. In such cases the latter may ignore the behavior of the "more frightened" individuals and resume activity after an initial response.

*Annoyance.* Annoyance behavior in *B. jugularis* may be elicited by a weak to moderate fear stimulus, such as the prolonged presence of potential danger (*e.g.*, a

man or a dog walking past or standing for some time near the aviary). In such situations the initial fear reaction evoked by the stimulus (as indicated by the birds fleeing, performing Alert behavior or becoming immobile) is in effect replaced by an Annoyance reaction in which the predator is intimidated by loud, repetitive squawks, which apparently announce the danger.

Moderate Annoyance is indicated by a bird in a relatively relaxed posture, uttering sporadic, Medium-intensity Squawks. A highly annoyed bird assumes an erect posture, appresses the plumage, and fluffs the malar feathers, but High-intensity Squawking is the most distinctive and immediately obvious aspect of this behavior. Very high-intensity Annoyance behavior, observed to be performed only by pairs in response to human beings near nests, is essentially the same as aggressive behavior discussed above. The reactions involved Plumage-appression, Gaping, Wing-jerking, and Antiphonal Duetting.

#### DISPLACEMENT BEHAVIOR

In stressful situations there were marked increases in head scratching, ruffling of the plumage, preening, and bill wiping. All were relatively common activities performed several times daily. Head scratching with the foot is a typical resting activity. Ruffling of the plumage and preening are also part of resting activity. In ruffling, the body feathers are elevated, the body is shaken, and the feathers are then compressed against the body. Wagging or shaking of the tail feathers often accompanies ruffling. Wiping the bill on a perch, or infrequently another object, is employed to clean the mandibles of adhering food, as when fleshy fruit is being consumed, and in removing wood and other particles from the bill during nest excavation.

When performed in stressful situations, and appearing as displacement behavior, the above activities appeared conspicuously out of context and were often incompletely performed or modified in other ways. I also observed movements that suggested flight intention, such as repeated crouching, bending low, or leaning forward on the perch, which seemed to be of the nature of displacement behavior.

#### VOCALIZATIONS

The vocalizations of adult Orange-chinned Parakeets are adapted to the highly social habits of the species. Many of the calls convey attitudes of fear, or annoyance and aggression, and in this way assist in the maintenance of a flock hierarchy or serve as vocal signals in the presence of potential danger. The vocal repertoire is composed of brief squawks and chirps given singly and in series, as well as highly specific vocalizations that appear to be unique among birds. The following discussion of this repertoire includes a physical and phonetic description, an audiospectrographic representation, and a discussion of the usual context in which the calls occur. Each type of vocalization has been given a descriptive name that will hopefully bring to mind the sound in question.

*Low-intensity Squawks.* These vocalizations are relatively quiet squawks, commonly heard as a single *chek* (fig. 6a), a two-syllable *chik-chek* (fig. 6b), or a brief series of five or six rapidly repeated squawks (fig. 6c). The double squawk (fig. 6b) was the most prevalent form and differed from a simple two-squawk series in lacking a distinct separation between the two syllables and in the increased intensity of the second syllable. The duration of a single squawk is about 0.08 to 0.11 sec. About 0.04 sec separates the squawks of a brief series. The frequency range of the double and single squawks is about 2 to 8 kc/sec, while the squawks of a series are slightly

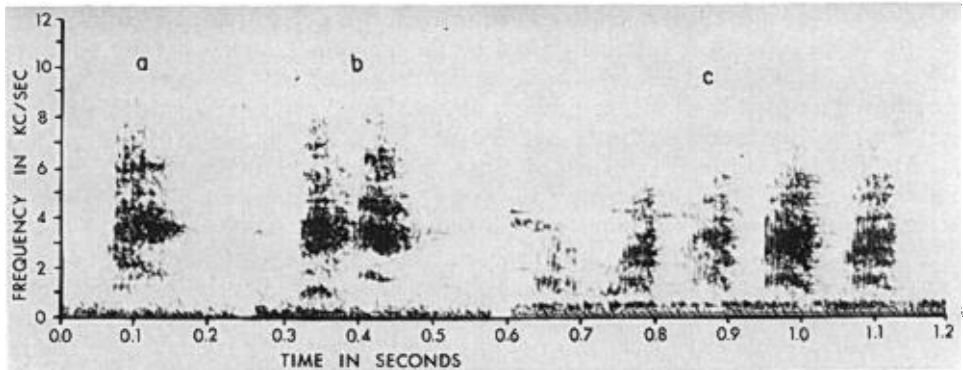


Figure 6. Sonagrams of Low-intensity Squawks. (a) single squawks; (b) double squawk; (c) brief series of rapidly repeated squawks. All sonagrams were made with narrow filter.

lower in pitch, ranging from about 1 to 6 kc/sec. Note that the sonagrams show a lack of clearly separated, harmonic bands, indicating that the calls are almost pure noise.

Low-intensity Squawking was frequently heard during the initial stages of aggression, when the feeding station became crowded with birds, and when a potential predator (*e.g.*, a man or a dog) was near or approaching the flock. An individual uttered Low-intensity Squawks and thereby drew the attention of nearby fellows, perhaps alerting flock mates to some impending danger, or assisting in the maintenance of individual distances and in the prevention of recurrent agonistic encounters.

*Low-intensity Chirps.* These vocalizations are single chirps, often barely audible to the human ear at a distance of 15 feet. Figure 7a shows these calls to be of about 0.05 sec duration, and of three fundamental harmonics at about 2, 4, and 6 kc/sec. Low-intensity Chirps are commonly heard during feeding and may assist in the maintenance of individual distances at the feeding station or serve as short-range contact notes between the members of a pair.

*Low-intensity Prolonged Squawks.* These calls (fig. 7b) are frequently associated with Low-intensity Chirps and are heard when a flock is engaged in some nonaggressive group activity such as feeding. A single squawk is about 0.20 to 0.30 sec in duration, is similar to a quiet mutter, is phonetically a low *r-r-r-r*, and, like the two vocalizations just discussed, seems to announce the presence of the vocalizing bird to fellows near at hand.

*Medium-intensity Squawks and High-intensity Squawks.* These two similar vocalizations differ from one another only in loudness. Single squawks are repeated rapidly, composing a series that usually lasts several seconds. A series is often repeated a number of times so that a bird may vocalize for several minutes. Single squawks vary from about 0.08 to 0.12 sec, and have an interval of about 0.05 sec separating the successive syllables of a series. The squawks are commonly of two types. The first are coarse and noisy (fig. 8a) in which two or three harmonic bands are roughly discernible among a greater amount of noise. The second are chirp-like in character (fig. 8b), in which most of the energy is in three distinct harmonic bands at about 2, 4, and 6 kc/sec, with greater emphasis being placed on the two lower frequencies. Both the noisy squawks and the chirp-like squawks may be given at either medium or high intensities.

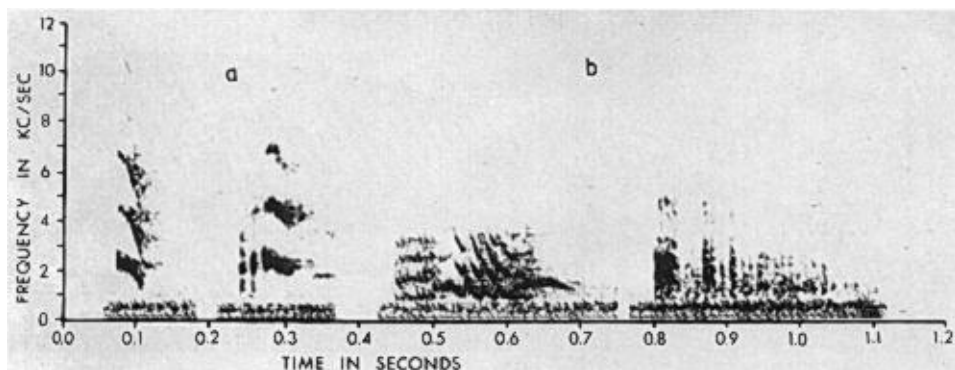


Figure 7. Sonograms of (a) Low-intensity Chirps and (b) Low-intensity Prolonged Squawks.

Repeated squawking is usually evoked by the presence of an annoyance stimulus and is the most frequently exhibited and easily noticed component of typical Annoyance behavior. Several members of a flock usually call concurrently. The intensity of the call seems to be directly correlated both with the strength of the stimulus and with the degree of annoyance in the vocalizing birds. Thus, Medium-intensity Squawking denotes relatively moderate annoyance, and High-intensity Squawking denotes relatively high annoyance. For example, Medium-intensity Squawks were elicited by a man or a dog about 50 feet away from the aviary. As the stimulus came closer to the aviary, High-intensity Squawking ensued. As the stimulus retreated or remained still for several minutes, Medium-intensity Squawking was again heard. These vocalizations were also indicative of annoyance or aggression between two or more individuals in the flock. Likewise, members of a pair repeatedly squawked as they drove intruders away from the vicinity of their nest; birds that are eventually displaced may also squawk during and after an encounter. Squawking was frequently heard as individuals attempted to acquire or retain preferred roosting sites or space at the feeding area, and may be elicited by the intrusion of Orange-fronted or Aztec Parakeets as well as by other Orange-chinned Parakeets.

Medium-intensity and High-intensity Squawks were frequently associated with group movements, such as movement of the flock from the high perches of the aviary to the feeding station below. Such vocalizations are probably correlated with the increase in encounters between individuals at this time, and are not "group-movement calls" per se. When taped squawks were played to the flock, the birds responded with similar squawks. If the calls were played continually for several minutes with the observer remaining out of sight, the intensity of the response gradually diminished, and in most cases more normal daily activity was resumed.

*High-intensity Chirps.* These are single calls of about 0.20 sec duration and are not rapidly repeated as in High-intensity Squawking. Figures 9a and 9b represent two variations of the High-intensity Chirp. Figure 9a shows four harmonic bands starting at about 1, 2, 3, and 4 kc/sec with each sharply rising in frequency until most of the energy is at 2, 4, and 6 kc/sec (after about 0.03 sec either the third or fourth fundamental may become less emphasized). After an initial 0.06 sec, and continuing for about 0.03 sec thereafter, there is an abrupt downward shift in frequency to about 1.8, 3.4, 5.2, and 7.8 kc/sec, respectively. This shift is often apparent

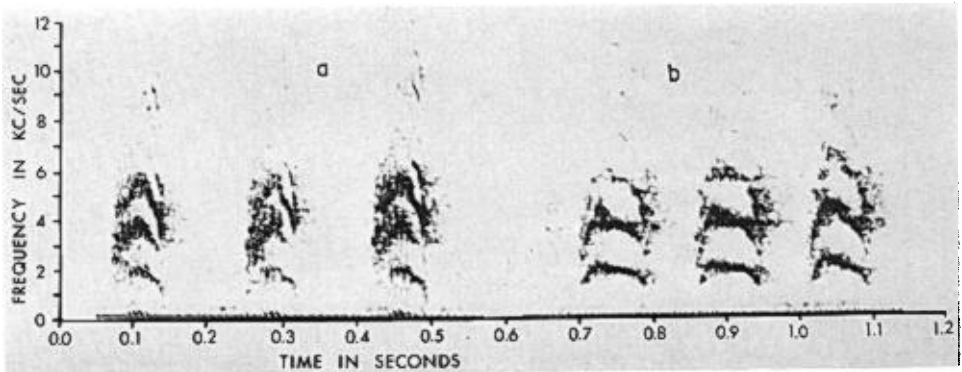


Figure 8. Sonograms of High-intensity Squawks. (a) "noisy" squawks; (b) chirp-like squawks.

to the human ear, giving the call a slight warble. Figure 9a clearly shows the harmonics of this call, but figure 9b is more nearly typical in that the basic pattern is often masked by a noisier, squawk-like quality.

I have heard High-intensity Chirps given by one to several birds at the sudden approach of a dog or man, or immediately following a loud noise such as the slamming of a nearby door or window. When the call was given, almost all birds of the flock became Alert, and several birds responded with similar chirps. Such was the initial response when I played taped High-intensity Chirps to the flock. However, if the calls were played repeatedly with no visual fear stimulus present, the birds showed habituation to the calls; general activity was resumed, and relatively few birds remained highly Alert, although a more watchful attitude usually prevailed. I judge this call to be an Alert signal that, when given by only a few birds, served to warn an entire flock of possible danger.

Figure 9c illustrates a High-intensity Chirp characteristic of *Brotogeris v. versicolurus* in a similar Alert situation. The similarity between this chirp and that of *B. jugularis* is clear; note the initial upward inflection followed by an abrupt downward

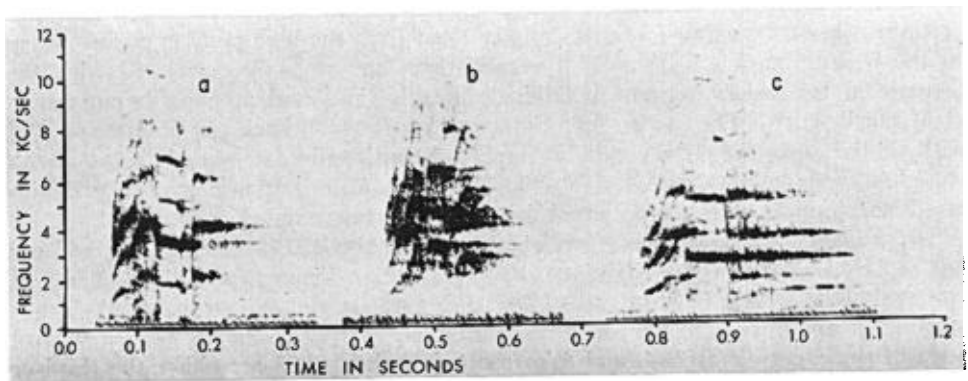


Figure 9. Sonograms of High-intensity Chirps. (a) chirp revealing the fundamental frequencies; (b) chirp masked by a more noise-like quality; (c) a High-intensity Chirp of *B. v. versicolurus*.

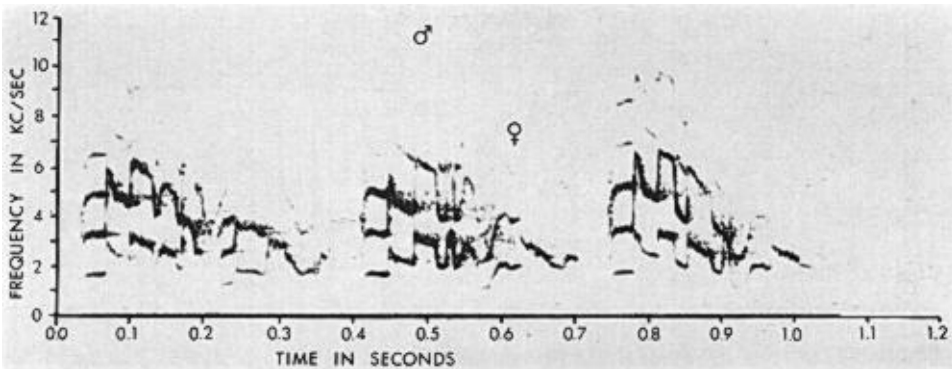


Figure 10. Sonagram of a High-intensity Antiphonal Duet. Note the separate syllables given by male and female.

shift of three fundamentals. The basic difference between the two calls seems to be terminal where frequencies of *B. versicolorus* do not shift upward.

*High-intensity Antiphonal Duetting.* High-intensity Antiphonal Duetting (fig. 10) is given as a vocal duet by two paired birds in a highly excited or aggressive state. Each member of the pair gives a sexually distinctive, melodious chirp. The louder and higher pitched of these is given by the male (phonetically, *chee*). These are at frequencies of 2.5 to 7 kc/sec, are about 0.16 to 0.17 sec duration each, and are given approximately every 0.35 sec. Alternating between the chirps of the male, and timed to fill the gaps, are the syllables given by the female (phonetically, *cher*). These are about 0.15 to 0.16 sec in duration, are less loud than those of the male, and are slightly lower in pitch (frequencies between 2 and 5 kc/sec). The resulting vocalization as given by both birds is a rapidly and precisely alternating *chee-cher-chee-cher-chee-cher*, continuing for about 2 to 5 seconds. From the audiospectrographic representation it can be seen that there are several abrupt shifts in frequency, and in this respect the chirps of dueting are similar to High-intensity Chirps, although somewhat more melodious. The male calls with the bill open wide and the body erect, often keeping the head in motion. The female calls with the bill slightly open

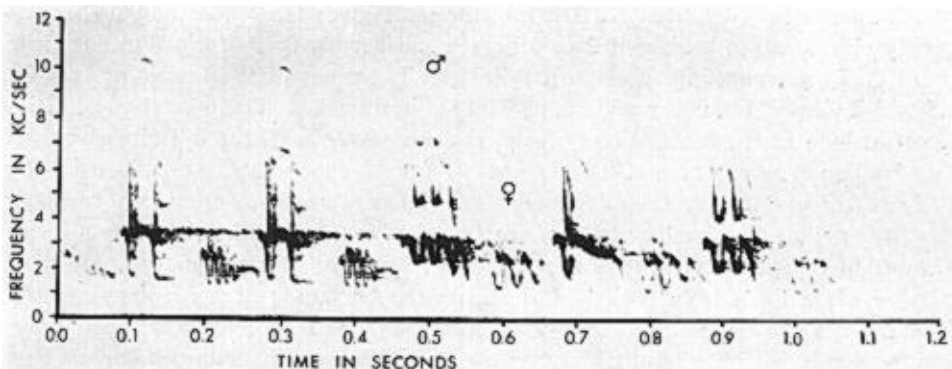


Figure 11. Sonagram of Medium-intensity Antiphonal Duet. Note the separate syllables given by the male and female.



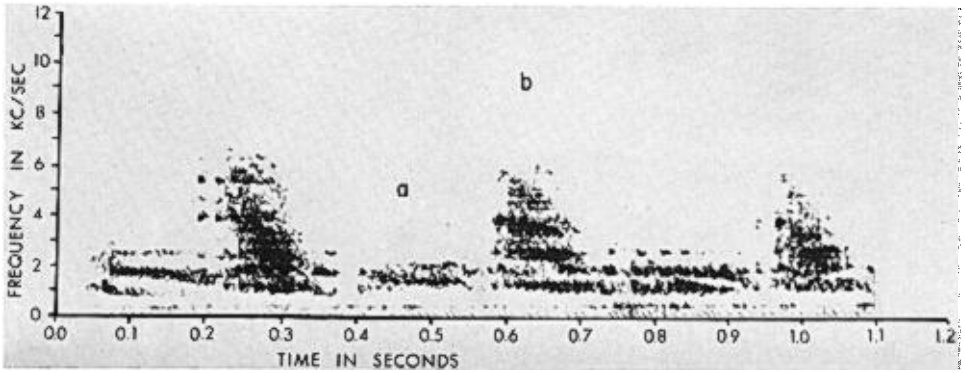


Figure 12. Sonogram of (a) Low-intensity Mutters, interspersed with (b) Low-intensity Squawks.

and is usually not as erect as the male. The initiation and termination of the duets seem to depend for the most part on the male, and he may solicit his mate to join in by uttering single, high chirps. Once a series of duets has been given, the female may begin several of the choruses. With the exception of the solicitation chirps uttered by the male, I have never heard a single bird utter its portion of the duet unaccompanied.

As mentioned, High-intensity Antiphonal Duetting was performed only when a pair was in a highly aggressive state. It therefore usually followed High-intensity Squawking and various other aggressive components of agonistic behavior. Duetting was frequently heard as a pair chased an intruder away from the nest or favored roosting site, or during prolonged or highly intense aggressive encounters between two pairs or two small groups of birds in which some of the birds were strongly paired. Duetting was also directed toward other species of parakeets (*Aratinga canicularis* and *A. astec*) and toward me when I tampered with nests or in some other way excited the birds.

*Medium-intensity Antiphonal Duetting.* This vocalization (fig. 11) is similar to High-intensity Antiphonal Duetting in that it was given only by members of a pair in a highly excited or aggressive state, and the sexes alternate with distinctive notes. In Medium-intensity Antiphonal Duetting the male gives the louder and higher frequency chirps, which are about 2 to 6 kc/sec and usually 0.10 sec in duration, with about 0.10 sec separating subsequent syllables. The notes of the female are usually 1.5 to 3 kc/sec in frequency and about 0.08 sec in duration. The overall vocalization is not as loud as the high-intensity form, and was given with the bill almost closed, thus lending a somewhat muffled quality. Figure 11 shows that the male may give at least three different sounding syllables. These variations are often regularly repeated, giving the vocalization a character of rising and falling intensity. Either member of the pair may initiate the call, and it was not uncommon for one bird to vocalize alone for a brief period of time. At the beginning of a Medium-intensity Duet at least two complete syllables were uttered by one bird before the other began, and frequently it took several trials until the two birds were in time with one another. Both birds when vocalizing would alternately sway up and down or from side to side on the perch.

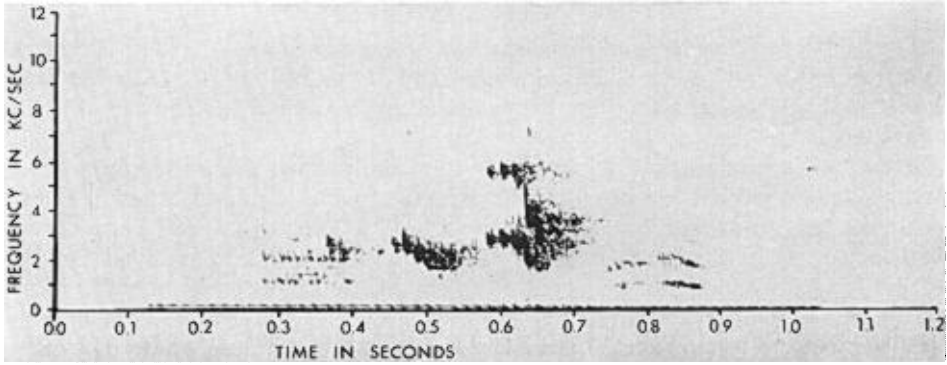


Figure 13. Sonagram of Stutter-squawk Duet.

The very precise and exactly maintained time intervals that are characteristic of both High-intensity and Medium-intensity Antiphonal Dueting are seemingly not achieved without a certain amount of practice. A flock of 28 first-year birds came into my possession during the month of December. These birds had been together about two months. At this time dueting was infrequent, but when given, the syllables were abnormally long and the antiphony poorly timed. In January, pair bonds were strengthened, and two pairs began nesting; dueting was now heard more frequently. By the end of February those birds that had begun nesting, and one other pair, in which the members were highly attentive to each other, had essentially mastered the call. The most precise duets I have recorded were those given by two birds that had been together as a pair for at least two years and had attempted nesting once during that time.

*Low Mutter.* Figure 12 depicts low-intensity, low-frequency mutters. The frequency is commonly between 1 and 3 kc/sec, and the time is variable although Low Mutter rarely lasts more than a second. Note that these are regularly interspersed with Low-intensity Squawks (fig. 12) in an almost antiphonal fashion. I have heard this call given only by birds near, but not directly involved in, a highly intense agonistic encounter, and such vocalizations are common background sounds during periods of aggression between two small groups of parakeets.

*Stutter-squawk Duet.* Frequently at the termination of several series of Medium-intensity and High-intensity Antiphonal Duets, a pair still in a rather excited state may give stuttering, squawk-like calls (fig. 13). These are usually in four parts, and each syllable is presumably given by one member of the pair in a relatively unprecise antiphonal fashion (the roles of the sexes were not determined as in other duets). The first syllable is from 0.15 to 0.25 sec duration and is a low-frequency squawk, usually of three fundamentals at 1, 2, and 3 kc/sec, with most of the energy at the two lower frequencies. The second syllable is about 0.15 sec, is louder and higher in frequency than the first (1.5 to 3 kc/sec), and is squawk-like but with a distinct stuttering quality. The third syllable is louder and higher still, with most of the energy between 2 and 6 kc/sec (two fundamental bands at about 3 and 5.5 kc/sec are the most distinctive), is about 1.5 to 2.0 sec duration, and also has a stuttering quality. The fourth syllable is like the first.

## SUMMARY

The agonistic behavior and vocalizations of captive Orange-chinned Parakeets (*Brotogeris jugularis*) were studied in pairs and flocks of four to 28 individuals. Birds of this neotropical species are highly social and become relatively well adjusted to captivity.

Agonistic encounters occurred frequently, especially when several parakeets were simultaneously attracted to a given area such as the feeding station or roosts. Aggressive intent was conveyed by behavior described as Malar-fluffing, Turn-toward, Head-up, and Gaping. Actual physical contact during aggression involved Pecking and Bill-fencing. Wing-jerking was performed by highly aggressive or annoyed birds. Certain mobile components of aggressive behavior were Threat-sidling, Rushing, and Flight-approach. Vocalizations frequently accompanied and presumably increased the effectiveness of many of these components. A bird may communicate a lack of aggressive tendencies by assuming typical resting posture, which in some instances was observed to thwart low-level threat or attack from a nearby aggressor. Within the flocks a social hierarchy was maintained by peck dominance, in which social position was judged on which birds succeeded in displacing an opponent in the majority of aggressive encounters.

Reactions to human beings and other potential predators involved Rigid-immobility, Watchful-immobility, Alert, and Annoyance, in addition to attempts to flee the danger. In stressful situations there were marked increases in head scratching, ruffling of the plumage, preening, and bill wiping, which, judging from their incompleteness and performance out of context, were probably displacement behavior.

The acquisition and defense of a large territory is not known in these birds, but one flock of four defended an aviary against unfamiliar parakeets of their own and other species, and pairs usually do not tolerate other birds in the vicinity of their nests or favored perches.

The vocalizations of Orange-chinned Parakeets were examined audiospectrographically. Low-intensity Squawks, Low-intensity Chirps, and Low-intensity Prolonged Squawks may serve as warning or contact notes, drawing the attention of nearby fellows to the vocalizing individual. Medium-intensity and High-intensity Squawks were given in situations of annoyance and aggression. High-intensity Chirps are flock-warning or alert signals. And High-intensity and Medium-intensity Antiphonal Duetting were performed by certain practiced pairs in a highly aggressive state.

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