THE CONDOR

VOLUME 58 JULY-AUGUST, 1956 NUMBER 4

# AVIAN MOBBING BEHAVIOR AND PREDATOR RECOGNITION

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Birds sometimes mob their predators even though the predator is not attacking them at the time. The behavior known as "mobbing" has been defined as "a demonstration made by a bird against a potential or supposed enemy belonging to another and more powerful species; it is initiated by the member of the weaker species, and is not a reaction to an attack upon the person, mate, nest, eggs or young" (Hartley, 1950:315).

## METHODS

In a series of experiments, stuffed specimens of owls were used to represent predators. The species used were the Screech Owl (*Otus asio*), the Horned Owl (*Bubo virginianus*), the Burrowing Owl (*Speotyto cunicularia*), the Short-eared Owl (*Asio flammeus*), and the Pigmy Owl (*Glaucidium gnoma*). Some of the Screech Owls, Burrowing Owls, and Horned Owls were fairly realistic in appearance. The rest of the owls were typical museum study skins, with their faces turned upward and with cotton eyes. All these specimens differed from live owls in that they were motionless and silent.

The owls were placed either on objects upon which a live owl might perch or on a set of collapsible poles that could be arranged to stand 8, 16, or 24 feet high. The specimens were placed in a wide variety of habitats, including those in which the species that was being used might naturally occur and those where it was presumably absent. Most of the experiments were carried out in various parts of Los Angeles County, California. The remainder were conducted in Tehama, Butte, and Nevada counties of California, and in Washoe County, Nevada.

Certain requisites for the sites of these experiments were established. The sites were in areas which (1) had a population of small birds, (2) were near cover suitable for the birds, (3) were reasonably free from interruptions by people, (4) had not previously been used for such experiments, and (5) were as far as possible from known or suspected nests. The second qualification was adhered to so that the responses of the birds would not be limited. The fourth qualification reduced the possibility of previous conditioning to the site of the experiment, such as was demonstrated by Nice (1943). The fifth requirement was an attempt to avoid the familiar hypersensitivity of birds that are near their nests.

I would like to thank Dr. George A. Bartholomew, Dr. Theodore H. Bullock, Dr. Thomas R. Howell, and Dr. Donald Kalish, of the University of California at Los Angeles, and Dr. William E. Miller, of Ohio State University, for their valuable assistance with various parts of this paper and the research upon which it was based.

## RESULTS

*Interspecific differences.*—Because there are few descriptions of mobbing behavior in the literature, brief descriptions of the "attack" of some of the birds may be useful. Species differ in their mobbing behavior patterns, even in response to the same species of predator. Such interspecific differences will be illustrated by descriptions of the typical behavior of several species when mobbing Screech Owls.

Wren-tits (*Chamaea fasciata*) stayed in the dense shrubbery when mobbing. They fluffed out their feathers and made a sound like a spinning wooden ratchet-wheel. Where the dense shrubbery was continuous around the owl, they approached to within a few inches of the specimen. But when the owl was on a perch surrounded by a small clear space without undergrowth, the Wren-tits approached only as close as they could without entering the clearing; then they called toward the owl from that position. The Wren-tits sometimes continued their agitation for two or three hours.

Audubon Warblers (*Dendroica auduboni*) apparently responded every time they observed one of the owls. In a typical case, the first warbler to attack flew to a perch about two feet from the owl. From there it looked toward the owl, chipping once per second. After some 15 seconds, the warbler flew off into low shrubs 20 feet from the owl, chipping three times per second. The other Audubon Warblers in a radius of about 40 feet around the owl then began chipping rapidly. Two or three of the warblers flew from one shrub to another, staying about 20 feet from the owl, and chipping as they went. The warblers in the shrubs and trees entered by these first warblers began to chip and flutter also. Six or more of the warblers then perched on the tree tops in a circle around the owl, 20 to 30 feet from it, still continuing their chipping and fluttering. Each of them flew from its perch directly toward the owl. When about four feet from the owl, a warbler would turn sharply and fly back to its perch. This flight, which is similar to the insect-catching behavior of this warbler, was repeated by each of the birds about once a minute for 15 minutes, without any apparent correlation in their timing.

One of the most spectacular methods of attack was that used by the Anna Hummingbirds (*Calypte anna*). They flew around the owl, two or three inches from its head, facing it and making little jabbing motions in their flight. Seen from above, these flights would look something like those shown in figure 2*d*. The bills of the hummingbirds seemed, in all cases, to be directed at the eyes of the owl. While circling around the owl in this manner, they called a short, repeated, high-pitched note.

Flocks of Brewer Blackbirds (*Euphagus cyanocephalus*) circled around the tree that sheltered the owl or stood on the ground facing the owl, repeating a harsh, nasal, call note. Red-winged Blackbirds (*Agelaius phoeniceus*) behaved quite differently. On the one occasion that I tested their reactions to Screech Owls, they sat in the same tree as the owl, the males calling *teeyee* and the females, *chack*. Some of the females and the males with yellow-orange epaulets (yearlings?) fluttered in the air in front of the owl. One of the adult males flew straight at the owl from a distance of 30 feet, swerving sharply a foot in front of the owl, then it flew back to the tree from which it came. Another of the adult males perched silently a foot behind the owl, then leaped out at it, clawing at the top of the owl's head. From there it quickly flew out of the tree, fluttered behind the owl for half a minute, and then returned and repeated its clawing action. After four such attacks, this blackbird flew to a nearby tree and called a rapid *chick-adick* several times. At the end of this experiment, a small bald spot had been clawed on the top of the owl's head.

*Failure to mob.*—Members of some species never attacked any of the owls that were presented to them, except occasionally during the breeding season, or when other birds had already begun to mob an owl. For example, a Brown Towhee (*Pipilo fuscus*) spent a half-hour hunting and feeding within eight feet of a conspicuous, realistic Horned Owl specimen, sometimes approaching to within three feet of it, without reacting in any way that was distinguishable from the Brown Towhee's usual feeding behavior.

During another experiment, two California Thrashers (*Toxostoma redivivum*) had been feeding in the duff at the base of a leafless bush. Three feet above them was a mounted Screech Owl. When other birds began to mob the owl, the thrashers stopped

feeding and remained standing in one place, occasionally cocking their heads from side to side. Twenty minutes later, when the other birds had quieted down and flown away, the thrashers resumed their feeding, still only four feet from the owl, and with an unobstructed view of it. This occurred during the breeding season of the thrashers.

Few data on failure to respond were obtained because of the difficulty in determining whether birds that did not respond actually saw the owls.

*Taxonomic correlation.*—No correlation of the presence or absence of mobbing behavior with taxonomic relations has been detected in this study. Three factors may be responsible for this: The sampling may be too limited to show any correlations that do exist. The behavior may be learned. Mobbing may have arisen independently several times in the evolution of avian behavior.

*Intraspecific differences.*—There are intraspecific differences in the mobbing reactions to the same predator, as well as the interspecific differences mentioned previously. Thus, not all of the Audubon Warblers that reacted perched on the tree tops and flew at the owl. Some of them stayed in the lower branches and called at the owl, occasionally flying to other branches. Among the Red-winged Blackbirds, there were several behavior patterns, depending upon the age and sex of the individuals. In addition, several species were found in which some of the members mobbed but others did not. Certain implications of such variation will be discussed later.

*Reactions to various predators.*—In addition to the inter- and intraspecific differences in the mobbing reactions to the *same* predator, already discussed, there is the possibility of inter- and intraspecific differences in reactions to different species of predators. Intraspecific differences in reactions to different species of predators would be indicated by a marked difference in reactions to one species of predator as opposed to another. No such difference was detected nor were interspecific differences.

Table 1

Seasonal Changes in Mobbing Behavior

| Month | Bird-minutes of reaction/minute of trial | | | |
|---|---|---|---|---|
| | All experiments | | Santa Monica Mountains | |
| January | 59/263 | 0.224 | 59/63 | 0.936 |
| February | 8/90 | 0.089 | 8/75 | 0.106 |
| March | 409/663 | 0.611 | 366/140 | 2.61 |
| April | 389/523 | 0.744 | 337/290 | 1.16 |
| May | 667/352 | 1.90 | 341/70 | 4.87 |
| June | 220/50 | 4.40 | 0/0 | ..... |
| July | 0/65 | 0.00 | 0/0 | ..... |
| August | 0/67 | 0.00 | 0/0 | ..... |
| September | 0/20 | 0.00 | 0/0 | ..... |
| October | 0/0 | ..... | 0/0 | ..... |
| November | 2/190 | 0.010 | 0/0 | ..... |
| December | 155/204 | 0.759 | 140/146 | 0.959 |

*Seasonal differences.*—There are seasonal changes in the numbers of birds that will mob a predator and in the duration of their mobbing, as shown in table 1. "Bird-minutes of reaction/minute of trial" designates the sum of the number of minutes that each bird reacted divided by the number of minutes involved in the experiment. These seasonal differences cannot be explained by corresponding fluctuations in the numbers of birds in the area. The influx of winter residents into southern California would, if anything, result in a greater number of bird-minutes of reaction per minute of trial during the

winter. The spring increase is probably due to seasonal changes in hormone concentrations associated with breeding activities.

*Contagious reactions.*—Not all the reactions observed in these experiments were responses to the owls themselves. Birds will often respond "by contagion" to the reactions of other birds. If an owl is being mobbed by a group of birds, other birds that cannot, because of their position, see the owl will also begin calling and fluttering. Contagious reactions are the basis for the large aggregations that sometimes form around predators.

Such responses to reactions can be very remarkable. During an experiment on a part of the campus of the University of California at Los Angeles in the winter of 1952, the responses of 6, out of a flock of 200, Audubon Warblers to the sight of a Pigmy Owl excited apparently all the other members of the flock.

Birds also reacted to the calls of birds of other species. Large mixed aggregations sometimes formed shortly after the first bird had begun to attack.

The range of the number of species of birds actually attacking the owls was from 1 to 7, with a mean of 2.13. The number of individuals ranged from 1 to 29, with a mean of 6.1. The number of bird-minutes of reaction ranged from 1 to 300, with a mean of 63.7.

Birds of some species reacted "by contagion" but not spontaneously, except during the breeding period. In the case of the Brown Towhees, this reaction consisted of nothing more than a soft chirping and a flicking movement of the tail.

After one bird or group of birds has begun to mob an owl that is readily visible, there is usually no way to determine whether the behavior of the other mobbing birds is triggered by the sight of the owl or by the reactions of these first birds. The reactions of the birds of the first species to begin mobbing in any experiment will be designated as "primary reactions," and the reactions of the birds of all subsequent species will be designated as "secondary reactions." A primary reaction is never a reaction by contagion; a secondary reaction may or may not be. If the members of a species are never the first to mob (never primary), but do mob after others have begun (secondary), the reactions are probably triggered only by the reactions of other birds (contagious reactions).

*Spatial orientation.*—One day in May, 1953, an Anna Hummingbird had been attacking a Screech Owl in the manner described. The hummingbird had flown out of sight. Without waiting to see whether it would return, I took the owl from its perch. When the owl had been carried about five feet from the perch, the hummingbird returned and circled around the place where the owl had been, making the same jabbing movements. Similar spatial orientation has been reported in the Blue Tit, *Parus caeruleus* (Hinde, 1954:330), the English Robin, *Erithacus rubeculus* (Lack, 1953:160), the House Finch, *Carpodacus mexicanus* (Howard, 1935:42), and the Bewick Wren, *Thryomanes bewickii* (Selander, 1955:64).

Another peculiarity of mobbing birds is that a human can approach nearer to them than usual. I have stood three feet or less from Wren-tits, Bush-tits (*Psaltriparus minimus*), and Anna Hummingbirds while they were mobbing Screech Owls.

## DISCUSSION

In the presence of a predator, a bird may do one of several things. It may fly into dense foliage or fly away. It may remain within sight of the predator, but indicate by its voice or actions that it has recognized a foreign object in its environment. It may not respond to the predator at all. It may attack the predator. The first three types of reactions are not restricted to predators, but are the typical responses of birds to a wide variety of objects. In contrast, the attacks of birds known as "mobbing behavior" are almost entirely restricted to natural enemies or to stimuli resembling them. As an exam-

ple, Schaefer (1953:425) found that among Swallow-Tanagers (*Tersina viridis*) "the only bird of prey specifically recognized and *really feared* was the Bat Falcon (*Falco albigularis*)," which may be the only serious predator of the Swallow-Tanager. Because of this restriction, "predator recognition" and "mobbing behavior" are used synonymously in this paper. Neither term is intended as anything more than an abbreviated description of the birds' behavior.

The character or characters of a predator to which members of the prey species respond are designated as "stimulus characters." If they are found only in one species of the predators of the animal in question, they will be designated as "specific." If they are found in more than one species of predator, they will be designated as "interspecific."

The properties of stimuli that are designated by the terms "specific" and "interspecific" are completely independent of the complexity of the stimulus (Tinbergen, 1951). These terms refer to the taxonomic distribution of the stimulus characters, not to their components; the features of an owl to which another bird reacts may be either very simple or very complex, regardless of whether or not these characters are found in other species of predators.

The methods for studying the configurational nature of the sign stimuli of reactions of birds to birds of prey have been presented by Goethe, Krätzig, Lorenz (reviewed by Tinbergen, 1951:31, 54, 77), Nice (1943), Nice and ter Pelkwyk (1941), and Hartley (1950). These methods are adaptable to a study of the specificity of the stimulus characters. Such a study would, however, involve testing the responses to the components of the stimulus for each of the species of predators. If, for example, an Audubon Warbler mobbed both Horned Owls and Screech Owls, it does not necessarily follow that the Horned Owls and the Screech Owls have a common stimulus character or pattern of characters. It is also possible that the Horned Owls have one set of sufficient stimulus characters and the Screech Owls have a partially or totally different set.

Thus, any study of reactions of birds to predator models that are essentially complete in terms of visible external characters cannot fully delimit the specificity of the stimulus characters. It can, however, set certain limits on such a determination; it can partially solve the problem. How this can be accomplished will be discussed in conjunction with the heritable aspects of mobbing behavior. The application of the method to the available data is summarized in table 2.

It should be borne in mind that this paper is based on a study of sufficient, rather than necessary stimuli, and that there may be sufficient stimuli for mobbing other than the particular visual stimuli on which these experiments depended. Miller (1952) got responses from many birds to his excellent imitations of owl calls, indicating that auditory stimuli may be sufficient.

The heritability of mobbing behavior and the specificity of the stimuli can be deduced from certain information, including a knowledge of which species of owls the birds had seen in these experiments, whether or not they had mobbed the owls, the location of the experiments, and what species of predators each bird may have encountered previously.

There are four possible relations of experience of a species of prey and of a given individual of that species, with a species of predator. It may be that neither the individual nor any other member of its species encounters this species of predator (relation I, fig. 1*a*); or that some of the members of the species, but not this particular member, encounter this species of predator (relation II, fig. 1*b*); or that some members of this species, including this member, encounter this species of predator (relation III, fig. 1*c*); or that this member of the species of prey, but no other, encounters this species of predator. The last case is so unlikely to occur in nature that it will not be considered.

The best available criteria for distinguishing these three relations are the ranges of the members of each species and the relative distribution of each species of predator and prey. The distinctions are probably more accurate for crepuscular and diurnal owls, but even the completely nocturnal forms are sometimes discovered by birds during the day. Range and distribution data were obtained primarily from Grinnell and Miller (1944).

In addition to agreeing with the definition of mobbing behavior given at the beginning of this paper, the reactions that will be used must comply with two other qualifications. First, the reactions must be primary ones. This qualification avoids the possibility that the birds' reactions were triggered, not by the sight of the owl, but by the reactions of the birds that were already mobbing. Second, the data must be obtained outside of the breeding season. During the period of breeding activities, many birds will attack almost any strange object.

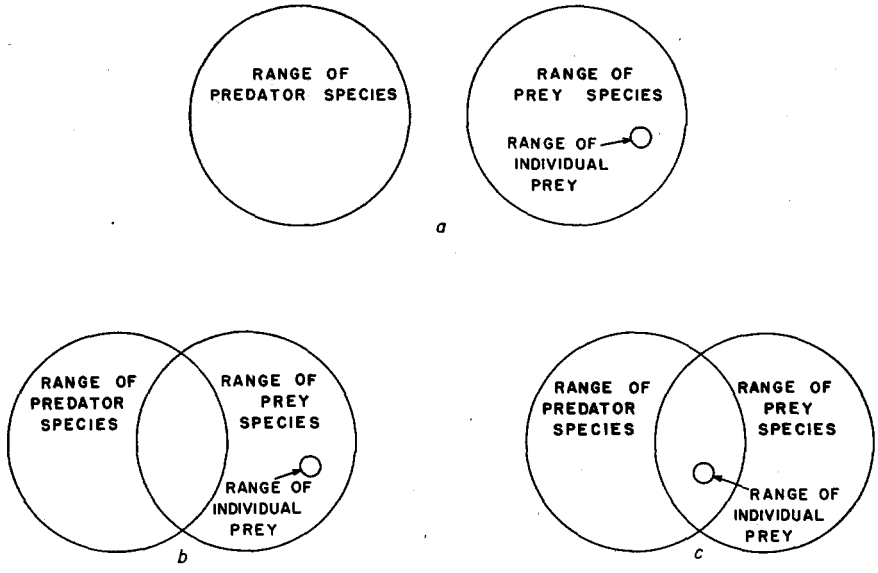


Fig. 1. Relations of experience of prey species and prey individuals with species of predators (see text). *a*, Relation I; *b*, Relation II; *c*, Relation III.

*Relation I.*—The reactions of a bird to an owl of a species which neither it nor any other member of its species encounters (relation I, fig. 1*a*) could not be a learned reaction in response to characters that are found only in this species of owl (specific characters). No opportunity for such learning has existed.

In addition, if relation I represents the relation between the two species during the evolution of the present behavior of the species of prey, a response to specific stimuli could not have been selected for. Also if such a complex behavior pattern is inherited, there is little chance that it could have originated by any non-selective mechanism such as drift and mutation pressure. Since a reaction to a specific stimulus pattern could not have been inherited or learned in this relation, the conclusion may be made that those reactions which do occur cannot be reactions to specific stimuli.

This reaction to interspecific stimuli could have been learned or selected for by previous experience of this individual or this species with other species of predators having the interspecific characters.

A bird that mobs an owl which neither it nor any other member of its species encounters is not mobbing one of its potential predators. Consequently, the definition of mobbing behavior that has been given includes the phrase "or supposed enemy," and the term "encounters" (a species of owl) that is used in this discussion does not necessarily mean "encounters in an attack," but only "experiences."

An assumption made in this and subsequent discussions is that mobbing reduces the frequency of predation. If this is true, mobbing behavior has a positive selective value. Unfortunately, there are not sufficient data available to determine the accuracy of this assumption.

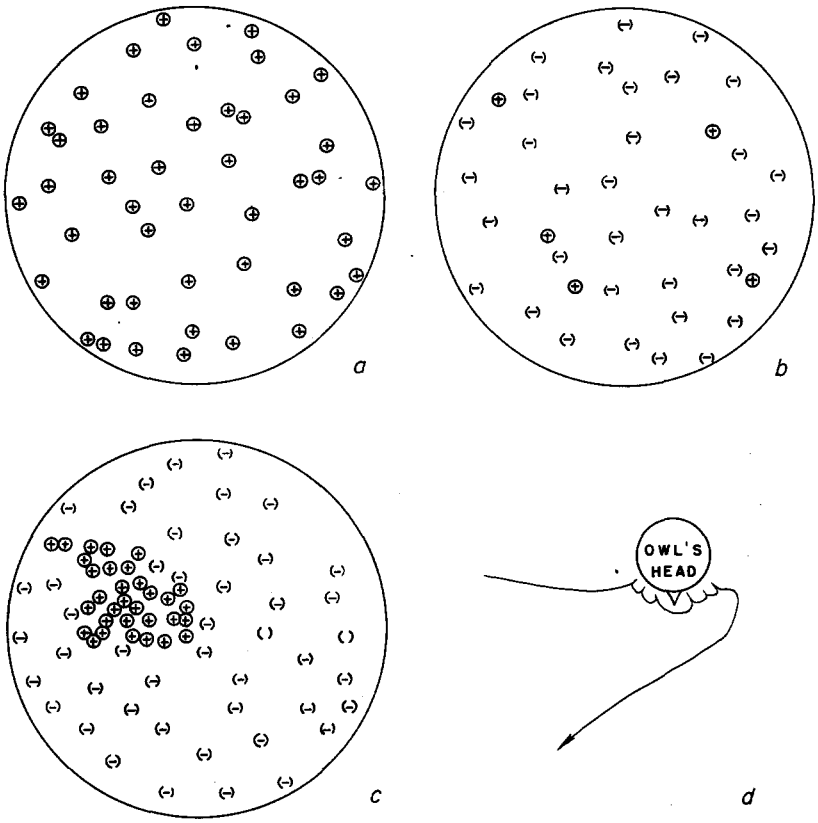


Fig. 2. *a*. All adults giving primary reaction outside of breeding period. *b*. Scattered adults giving primary reaction outside of breeding period. *c*. Localized adults giving primary reaction outside of breeding period. *d*. Path of Anna Hummingbird attacking Screech Owl.

If the results of a large number of experiments are plotted on a map of the distribution of the species, using the symbol "+" for primary mobbing reactions outside of the breeding season, and "—" for all failures to respond, and if the data assumes a pattern like that of figure *2a*, the behavior is probably inherited. This is true only if the opportunity for conditioning does not occur in all members of the species. This seems to be a reasonable assumption for wild birds, although again, documentation is lacking.

Lehrman (1953) has criticized the concept of innate behavior, pointing out that stereotyped reactions depend upon certain previous environmental conditions. The fact

that stereotyped reactions occur within the context of an environmental background that does not include either cultural heritage or previous experience with the particular stimulus pattern in question makes it probable that such reactions depend upon a fairly specific genetic background, not just a generalized modifiability. Such reactions are therefore termed "innate" or "inherited." If these reactions vary and if they affect the reproductive differential, they are subject to evolution.

If some of the birds of a species react and others do not, the members of these two classes may be randomly distributed geographically, as shown in figure *2b*, or they may be localized, as shown in figure *2c*. If the distribution is random, the responses are probably learned. If the reactions are more localized than the species of predators having the interspecific characters, but not so localized that they might all be accounted for by previous experience with a single owl, the birds in such a local population probably have an innate mobbing behavior. Such a situation would be difficult to detect in the field. As in the case of the species represented by figure *2a*, in which all members react, it seems doubtful that all the members of this population could have encountered an owl of this or a similar species before the experiment was performed. An analysis of universality as a criterion of instinctive behavior has been given by Riess (1950).

Experiments may reveal a species of bird that will instinctively mob only a species of predator which no member of this species of prey encounters. The range of the species of predator may have overlapped that of the species of mobbing bird at some time in the past, or such a reaction may be a response to characters common to both this species of predator and an extinct species which the ancestors of the modern bird encountered. Such stimulus characters are interspecific only in a temporal sense.

In summary, if a bird mobs a species of predator that neither it nor any other member of its species has ever seen (relation I), the stimulus characters are interspecific. If an entire population of this species of bird (either all or a part of the total species, figs. *2a* and *2c*) mobs such a predator, the reaction is hereditary. If those members of the species that mob and those that do not are randomly distributed through the population (fig. *2b*), the behavior is learned.

*Relation II.*—If a bird mobs a species of predator which it has never seen before, but which other members of its species have seen (relation II), the reaction may have been learned by experience with other species of predators that share an interspecific stimulus character or combination of characters. In the case of such a learned behavior pattern, the stimulus characters could not be specific; no opportunity for such learning has occurred.

If the behavior is innate, it may have been selected for in previous encounters with predators of the species in question, or of other species sharing an interspecific pattern with this species. Thus, the only possibility that has been eliminated in this situation is that of a learned response to specific stimulus characters.

The geographic distribution of the birds that mob and those that do not can again be used to determine whether the behavior is learned or innate.

In this as in the other relations, if the members of a species of bird fail to mob all other species of predators, the stimulus characters are specific.

*Relation III.*—If a bird mobs a species of predator which may previously have been encountered by this bird and by other members of this species (relation III), the behavior may be either innate or learned, and the stimulus characters may be either specific or interspecific. In addition, either type of behavior may be a response to either type of stimulus pattern. If such reactions occur among members of the species only in the region where the species of owl is found, the reaction is probably learned. Again, a failure to mob any other species of predator implies a specific set of stimulus characters.

*Data on heritability and specificity.*—The data that have been obtained and the conclusions that have been drawn from them are summarized in table 2. Many more data will have to be obtained before any final conclusions can be drawn. The symbols and designations in this table are as follows:

*Order of reactions.*—Primary reactions are indicated by "p"; secondary reactions, by "s."

*Relation.*—The relation between the species and the individual whose reactions were tested, and the species of owl are indicated by roman numerals. These correspond to the three relations described in this paper and shown in figures 1*a*, 1*b*, and 1*c*. The letter "B" indicates reactions during the breeding period.

*Conclusion.*—Species of owls to which primary mobbing reactions were given outside of the breeding period are indicated by capitals. Species of owls that were not mobbed are printed in lower case. Except where otherwise indicated, the data are not sufficient to determine whether the characters to which the birds responded are interspecific (indicated by "intersp.") or not. "Indet." (indeterminate) refers to data that are not sufficient to support any conclusion.

## SUMMARY AND CONCLUSIONS

Descriptions of the mobbing behavior of several species of wild birds are given based on behavior shown to the same and to different species of mounted owls. There is a vernal increase in the number of birds that mob.

The presence or absence of mobbing behavior could not be correlated with taxonomic position.

Spatial orientation of mobbing birds is described, and their insensitivity to the presence of man is indicated.

Of the 39 species that have been observed, the members of 5 species initiated 10 mobbing reactions outside of the breeding season. Nine of these reactions were to species of owls that occur in the area in which the observations were made (relation III), while one was a reaction to a species of owl that is encountered only by other members of the species (relation II). The members of 13 species initiated 20 mobbing reactions during the breeding period. Six of these reactions were to species of owls that are sympatric with members of the species other than the one that reacted (relation II). One of the reactions fell into the relation I group; the remaining 13 were of the relation III type. Members of 13 species attacked owls after members of other species had initiated the attacks. In 19 species, no member that was tested mobbed any of the owls that were presented to it.

A method is outlined for determining whether mobbing behavior is learned or innate. The primary criterion is the universality of mobbing behavior among populations of birds that probably have not previously been exposed to the stimuli that elicit their mobbing. More data that fit the criteria have been obtained for Audubon Warblers than for any other species that has been tested; for this species, the hypothesis that mobbing is innate is proposed.

The origin and perpetuation of the type of gene complex that would underlie innate mobbing behavior depend upon a decreased probability of predation on those birds, or the offspring of those birds, that mob their predators.

Table 2

Heritability and Specificity Data

| Species tested | Owl used | Presence of mobbing behavior | Order of reactions | Date | Time | Relation | Conclusion |
|---|---|---|---|---|---|---|---|
| Mourning Dove (*Zenaidura macroura*) | Screech | — | — | 3–28–53, | 4:35 p.m. | ..... | Screech |
| Chinese Spotted Dove (*Streptopelia chinensis*) | Pigmy | — | — | 5–17–52, | 8:29 a.m. | ..... | Pigmy |
| Costa Hummingbird (*Calypte costae*) | Sh.-eared | + | s | 4–4–52, | 2:17 p.m. | ..... | indet. |
| | Sh.-eared | + | s | 4–4–52, | 2:36 p.m. | ..... | |
| Anna Hummingbird (*Calypte anna*) | Sh.-eared | + | p | 4–4–52, | 1:56 p.m. | IIB | Screech |
| | Screech | — | — | 3–28–53, | 1:07 p.m. | ..... | Mobbed during |
| | Screech | + | s | 3–28–53, | 4:04 p.m. | ..... | the breeding |
| | Screech | — | — | 3–28–53, | 4:33 p.m. | ..... | season or |
| | Screech | + | s | 4–29–53, | 8:03 a.m. | ..... | secondarily |
| | Screech | + | s | 5–24–53, | 6:21 a.m. | ..... | |
| | Pigmy | + | p | 3–13–52, | 4:00 p.m. | IIB | |
| Allen Hummingbird (*Selasphorus sasin*) | Pigmy | — | — | 3–21–53, | 12:10 p.m. | ..... | Pigmy |
| Calliope Hummingbird (*Stellula calliope*) | Pigmy | + | p | 8–4–52, | 9:45 a.m. | III | PIGMY |
| Red-shafted Flicker (*Colaptes cafer*) | Screech | — | — | 11–23–51, | 3:50 p.m. | ..... | Screech, |
| | Burrow. | — | — | 3–22–52, | 11:18 a.m. | ..... | Burrowing |
| Black Phoebe (*Sayornis nigricans*) | Screech | + | p | 5–25–52, | 9:05 a.m. | IIIB | Indet. |
| Western Flycatcher (*Empidonax difficilis*) | Screech | — | — | 5–9–53, | 8:25 a.m. | ..... | Screech |
| Western Wood Pewee (*Contopus richardsonii*) | Screech | — | — | 8–23–53, | 10:40 a.m. | ..... | Screech |
| Scrub Jay (*Aphelocoma coerulescens*) | Sh.-eared | — | — | 4–4–52, | 2:11 p.m. | ..... | Sh.-eared, Screech |
| | Screech | — | — | 4–12–53, | 11:13 a.m. | ..... | Mobbed |
| | Screech | + | s | 5–24–53, | 6:21 a.m. | ..... | secondarily |
| Clark Nutcracker (*Nucifraga columbiana*) | Screech | — | — | 8–9–53, | 8:26 a.m. | ..... | Screech |
| Mountain Chickadee (*Parus gambeli*) | Burrow. | — | — | 8–30–53, | 11:20 a.m. | ..... | Burrow. |
| | Burrow. | — | — | 8–30–53, | 11:35 a.m. | ..... | |
| Bush-tit (*Psaltriparus minimus*) | Sh.-eared | + | p | 4–4–52, | 2:10 p.m. | IB | Screech |
| | Screech | + | p | 3–19–53, | 4:04 p.m. | IIIB | Mobbed only |
| | Screech | + | s | 4–12–53, | 11:59 a.m. | ..... | during the |
| | Screech | + | s | 4–29–53, | 8:01 a.m. | ..... | breeding season |
| | Screech | — | — | 11–23–51, | 10:15 a.m. | ..... | or secondarily |
| | Pigmy | + | s | 3–8–52, | 10:19 a.m. | ..... | |
| | Pigmy | + | p | 3–13–52, | 4:08 p.m. | IIB | |
| Brown Creeper (*Certhia familiaris*) | Burrow. | — | — | 8–30–53, | 12:00 m. | ..... | Burrow. |

| Species tested | Owl used | Presence of mobbing behavior | Order of reactions | Date | Time | Relation | Conclusion |
|---|---|---|---|---|---|---|---|
| Wren-tit | Screech | — | — | 4–4–53, | 12:50 p.m. | ..... | Screech |
| (*Chamaea fasciata*) | Screech | — | — | 4–4–53, | 2:15 p.m. | ..... | Mobbed only |
| | Screech | + | p | 4–4–53, | 2:45 p.m. | IIIB | during the |
| | Screech | — | — | 4–4–53, | 2:49 p.m. | ..... | breeding season |
| | Screech | + | p | 4–12–53, | 11:53 a.m. | IIIB | or secondarily |
| | Screech | — | — | 4–29–53, | 10:31 a.m. | ..... | |
| | Pigmy | + | p | 3–8–52, | 10:18 a.m. | IIB | |
| | Pigmy | + | s | 3–13–52, | 4:25 a.m. | ..... | |
| | Pigmy | + | s | 12–18–51, | 2:12 p.m. | ..... | |
| Mockingbird | Screech | — | — | 5–25–52, | 9:10 a.m. | ..... | Screech |
| (*Mimus polyglottos*) | Screech | + | s | 5–30–53, | 8:03 a.m. | ..... | Mobbed only |
| | Screech | — | — | 12–1–51, | 11:53 a.m. | ..... | during the |
| | Burrow. | + | p | 3–22–52, | 9:43 a.m. | IIB | breeding season or secondarily |
| California Thrasher (*Toxostoma redivivum*) | Screech | — | — | 4–12–53, | 12:15 p.m. | ..... | Screech |
| American Robin (*Turdus migratorius*) | Burrow. | — | — | 3–22–52, | 11:10 a.m. | ..... | Burrow. |
| Swainson Thrush | Screech | — | — | 4–12–53, | 10:15 a.m. | ..... | Screech |
| (*Hylocichla ustulata*) | Screech | + | s | 4–12–53, | 11:55 a.m. | ..... | Mobbed only secondarily |
| Ruby-crowned Kinglet (*Regulus calendula*) | Burrow. | — | — | 3–22–52, | 11:13 a.m. | ..... | Burrow. |
| Bell Vireo | Screech | + | p | 4–18–53, | 8:20 a.m. | IIIB | Indet. |
| (*Vireo belli*) | Screech | + | p | 4–29–53, | 8:00 a.m. | IIIB | |
| Solitary Vireo (*Vireo solitarius*) | Screech | — | — | 8–23–53, | 10:43 a.m. | ..... | Screech |
| Warbling Vireo (*Vireo gilvus*) | Screech | — | — | 5–9–53, | 8:27 a.m. | ..... | Screech |
| Yellow Warbler (*Dendroica petechia*) | Screech | — | — | 4–18–53, | 8:35 a.m. | ..... | Screech |
| Audubon Warbler | Screech | + | p | 12–23–51, | 3:57 p.m. | III | SCREECH, |
| (*Dendroica auduboni*) | Horned | + | p | 1–22–52, | 3:25 p.m. | III | HORNED, |
| | Horned | + | p | 12–18–51, | 2:10 p.m. | III | PIGMY |
| | Pigmy | + | p | 1–11–52, | 4:05 p.m. | III | Hereditary? |
| | Pigmy | + | s | 3–13–52, | 4:22 p.m. | ..... | |
| | Pigmy | + | p | 12–18–51, | 2:10 p.m. | III | |
| Hermit Warbler (*Dendroica occidentalis*) | Burrow. | — | — | 8–30–53, | 11:20 a.m. | ..... | Burrow. |
| English Sparrow | Pigmy | — | — | 5–17–52, | 8:08 a.m. | ..... | Pigmy |
| (*Passer domesticus*) | Pigmy | — | — | 5–17–52, | 1:00 p.m. | ..... | |
| Red-winged Blackbird (*Agelaius phoeniceus*) | Screech | + | p | 6–4–53, | 3:00 p.m. | IIIB | Indet. |
| Brewer Blackbird (*Euphagus cyanocephalus*) | Screech | + | p | 5–30–53, | 8:00 a.m. | IIIB | Indet. |

Table 2 (continued)

| Species tested | Owl used | Presence of mobbing behavior | Order of reactions | Date | Time | Relation | Conclusion |
|---|---|---|---|---|---|---|---|
| Cowbird | Screech | — | — | 5–25–52, | 9:22 a.m. | ..... | Screech, Pigmy |
| (*Molothrus ater*) | Pigmy | — | — | 5–17–52, | 8:51 a.m. | ..... | |
| Black-headed Grosbeak | Screech | — | — | 4–29–53, | 9:15 a.m. | ....., | Screech |
| (*Pheucticus* | Screech | — | — | 4–29–53, | 11:28 a.m. | ..... | |
| *melanocephalus*) | Screech | — | — | 5–24–53, | 6:05 a.m. | ..... | |
| | Screech | + | p | 5–24–53, | 6:20 a.m. | IIIB | |
| House Finch | Screech | + | p | 3–28–53, | 4:04 p.m. | IIIB | Screech, Pigmy |
| (*Carpodacus* | Screech | — | — | 5–25–52, | 9:12 a.m. | ..... | Mobbed during |
| *mexicanus*) | Screech | + | s | 5–30–53, | 8:01 a.m. | ..... | the breeding |
| | Screech | — | — | 12–1–51, | 11:25 a.m. | ..... | season or |
| | Screech | — | — | 12–1–51, | 11:45 a.m. | ..... | secondarily |
| | Pigmy | — | — | 5–17–52, | 9:05 a.m. | ..... | |
| | Pigmy | — | — | 5–17–52, | 2:00 p.m. | ..... | |
| Spotted Towhee | Screech | + | s | 4–12–53, | 11:55 a.m. | ..... | HORNED, |
| (*Pipilo maculatus*) | Screech | + | p | 4–29–53, | 9:57 a.m. | IIIB | PIGMY |
| | Horned | + | p | 2–23–52, | 10:10 a.m. | III | |
| | Pigmy | + | p | 2–23–52, | 9:40 a.m. | II | |
| Brown Towhee | Sh.-eared | + | s | 4–4–52, | 2:16 p.m. | ..... | Screech, Horned, |
| (*Pipilo fuscus*) | Sh.-eared | + | p | 4–29–52, | 1:05 p.m. | IIB | Pigmy |
| | Screech | — | — | 4–4–53, | 10:46 a.m. | ..... | |
| | Screech | — | — | 4–29–53, | 12:00 m. | ..... | Reacted only dur- |
| | Screech | + | p | 5–24–53, | 6:21 a.m. | IIIB | ing the breeding |
| | Screech | + | s | 5–30–53, | 8:08 a.m. | ..... | season or |
| | Horned | — | — | 1–22–52, | 3:55 p.m. | ..... | secondarily |
| | Burrow. | — | — | 3–22–52, | 10:16 a.m. | ..... | |
| | Pigmy | + | s | 1–11–52, | 4:09 p.m. | ..... | |
| | Pigmy | + | s | 3–13–52, | 4:36 p.m. | ..... | |
| | Pigmy | — | — | 5–17–52, | 1:15 p.m. | ..... | |
| | Pigmy | — | — | 5–17–52, | 8:47 a.m. | ..... | |
| Savannah Sparrow | Pigmy | + | s | 3–13–52, | 10:55 a.m. | ..... | Indet. |
| (*Passerculus* | | | | | | | |
| *sandwichensis*) | | | | | | | |
| Golden-crowned | Screech | + | p | 3–28–53, | 4:25 p.m. | III | SCREECH |
| Sparrow | | | | | | | |
| (*Zonotrichia* | | | | | | | |
| *atricapilla*) | | | | | | | |
| Song Sparrow | Screech | — | — | 3–28–53, | 4:01 p.m. | ..... | HORNED |
| (*Melospiza melodia*) | Screech | + | s | 3–28–53, | 4:04 p.m. | ..... | |
| | Screech | + | p | 5–9–53, | 9:03 a.m. | IIIB | |
| | Screech | + | s | 5–24–53, | 6:21 a.m. | ..... | |
| | Horned | + | p | 2–23–52, | 10:55 a.m. | III | |

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*The Biological Laboratories, Harvard University, Cambridge, Massachusetts, October 3, 1955.*