to Costa Rica though extensive forests reach their southern limit in Nicaragua. The clearing, and with it the planting of Guatemalan Cypress in the cool highlands of Costa Rica during the last 50–70 years, may account for the appearance of these warblers. Cypress plantings have been present on the versants of the volcanic Cordillera Central above San José for a much longer period than in the northwestern divide, where few plantings exceed 20 years of age. These small stands in the northwest may be acting as stepping-stones for the extension of winter ranges of the warblers. Isolated stands of cypress are now found south and east along the Cordillera Talamanca of Costa Rica and on into the highlands of western Panamá. These provide potential habitats for future range extension. I cannot assess the relative abundance of Townsend's Warblers at Monteverde and elsewhere in Costa Rica, but the occurrence of "waves" of birds in the fall at Monteverde suggests substantial movement to more southern regions.

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DESCRIPTION OF AN AERIAL-PREDATOR ALARM CALL FOR MALLARD (*ANAS PLATYRHYNCHOS*) DUCKLINGS

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Although aerial alarm or "hawk warning" calls have been frequently described for gallinaceous birds (Collias and Joos 1953; Hale et al. 1969; Schleidt 1961; Williams 1969), there are few such references for waterfowl. Numerous authors have studied the response of waterfowl to overhead objects such as models of various raptors (McNiven 1960; Melzack 1961; Melzack et al. 1959; Tinbergen 1948), but these studies do not contain descriptions of an aerial alarm call.

Driver (1960) heard Common Eider (*Somateria mollissima*) ducklings give a "thin ascending note" in response to strangers on the horizon or unfamiliar overhead objects. Fabricius (1951) noted that young Tufted Ducks (*Aythya fuligula*) had a "note of terror" which was released when they saw flying gulls, and Weidmann (1956) reported that a one-week-old Mallard (*Anas platyrhynchos*) duckling crouched and gave a call described as "piii" when an airplane passed overhead. Weidmann was also able to elicit this call with models. These authors did not include sonagrams of the calls.

Purely by chance, we were able to hear such an alarm or fear call when, like Weidmann, we observed an airplane passing over a small group of 2-week-old Mallards that we were raising on our lawn. One of the ducklings noticed the airplane and gave a shrill whistle. The group immediately crouched and became immobile. The call appeared to convey rather specific information concerning the presence of an overhead object. Whether or not this response was learned we do not know, because the call may have been a fear call that the ducklings had learned to associate with aerial danger during their first 2 weeks of life.

While spending the summer at the Delta Waterfowl Research Station, Delta, Manitoba, Canada, we constructed several models in an attempt to obtain a tape recording of the call. The models resembled the silhouette of a hawk and had wing spans of 10–18 inches. They were suspended from the tip of a long fishing rod and presented to ducklings of various ages.

Neither strong escape responses nor aerial alarm calls were observed when models were presented to ducklings less than one week old. This may reflect a lack of fear in young ducklings. Ramsay and Hess (1971) found that Mallard ducklings' response to a conditioned escape or alarm call increased with age during the first few days after hatching.

The best tape recording of the call was obtained by sailing a paper airplane, from the cover of a blind, over a brood of 2-week-old Mallards in a small pen. (We are grateful to F. Dale Caswell for obtaining this recording.) The recording was made on a Uher 4000 Report-L tape recorder at a speed of 7.5 inches/sec. The sonagram of this call (fig. 1) may be compared to those of "pleasure notes" (fig. 2) and "distress

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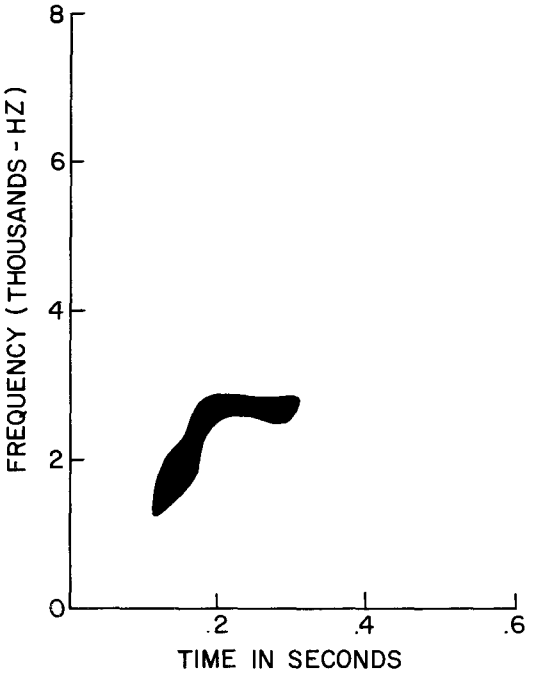

FIGURE 1. Sonagram of Mallard duckling "aerial alarm call."

calls" (fig. 3). Distress calls are commonly given when ducklings are separated from their mother or siblings, and in a variety of stressful situations, whereas pleasure notes are often emitted when siblings are reunited after separation or during feeding and preening (Kear 1968). Sonagrams were made in the Acoustics Laboratory at Washington State University

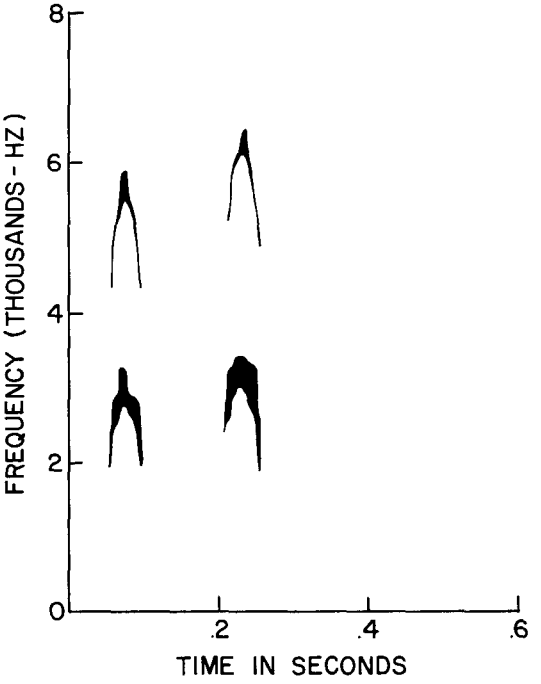

FIGURE 2. Sonagram of Mallard duckling "pleasure notes."

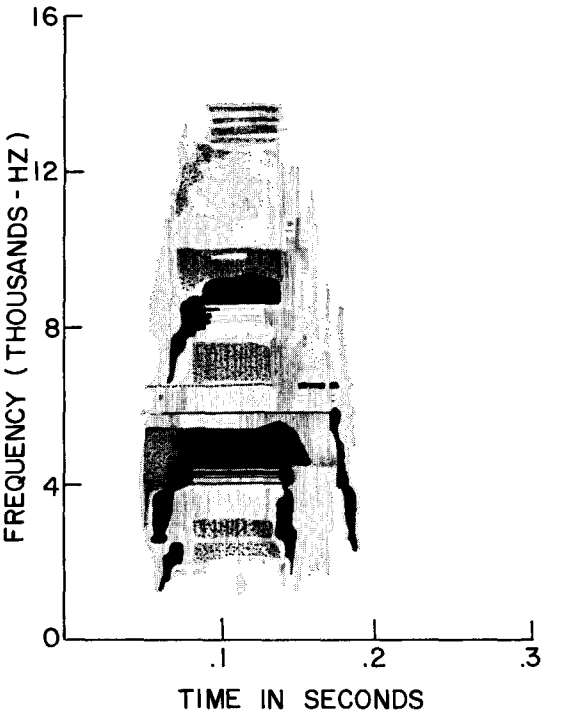

FIGURE 3. Sonagram of Mallard duckling "distress call," analyzed at one-half speed (3.75 inches/sec) to extend frequency range.

on a Kay Model 6061 Sound Spectrograph, using Wideband and FL-1 settings.

Several audiometric differences among the calls may be detected from examination of figures 1–3. The aerial alarm call extends from 1250 to 3000 Hz with a duration of 200 msec and is nonrepetitive. Pleasure calls are variable in frequency, but generally have a fundamental ranging from 2000 to 3000 Hz with an overtone between 4000 and 6500 Hz. Pleasure notes are repetitive, with the duration of individual notes approximately 50 msec. Distress calls typically occupy an extremely wide range of frequencies, from 1000 to 14,000 Hz, with the fundamental at about 1000 Hz and overtones extending up to 14,000 Hz. Note that the first, third, and fifth overtones are emphasized (fig. 3). Second and fourth overtones are occasionally absent entirely. Distress calls stimulated by mild stress may lack harmonics altogether. This may indicate a direct relationship between sound intensity and the number of harmonics generated by the syrinx (E. W. Greenfield, pers. comm.). Distress calls have durations of about 150 msec and are repetitive, although figure 3 only shows one note. Individual notes of both pleasure notes and distress calls have inverted U shapes, while the aerial alarm call lacks the descending leg.

These calls, like other avian sound signals, probably show certain relationships between structure and function. Marler (1955, 1957, 1967) has suggested that relative ease of localization has been important in the evolution of the structure of certain bird calls. Repetitive sounds with a wide range of frequencies seem to be the most easily located, while nonrepetitive and relatively pure tones at intermediate frequencies provide very few directional cues (Marler and Hamilton 1966).

It thus seems that distress calls contain the greatest

number of location cues, with pleasure notes providing fewer, and aerial alarm calls containing the fewest. These audiometric differences are consistent with the function of the respective calls.

The selective advantage of an aerial alarm call for young waterfowl is obvious. Such a call may be especially significant for the various diving ducks in which the mother-brood bond is not as strong as in the river ducks.

With the exception of the Common Eider (Driver 1960) and the Tufted Duck (Fabricius 1951), descriptions of such calls for divers do not exist, perhaps because of the relative elusiveness of the call. W. R. Siegfried (pers. comm.) states that young Common Goldeneye (*Bucephala clangula*) ducklings have a very pronounced fear whistle which causes immediate immobility of siblings, but the call has not been observed in response to overhead flying objects.

The Mallard, Common Eider, and Tufted Duck are probably not the only species of waterfowl with such a call in their repertoire, and its occurrence will probably become widely documented for the Anatidae. Additional research is needed to determine whether the response to these calls depends on prior experience.

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