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DEVELOPMENT AND STRUCTURE OF CALLS IN YOUNG AMERICAN COOTS (*Fulica americana*)

BY

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ABSTRACT

The purpose of the study was to examine vocalizations of the American Coot (Fulica americana) from an ecological perspective, and to attempt to relate vocal behaviour to ecological, and other behavioural adaptations. Three aspects of vocal communication signals in young coots were studied. These included development of adult calls, potential cues for recognition in distress calls, and structure of calls in relation to transmissibility.

Recordings of laboratory-reared birds indicated that four call types were present after hatching including twitter, wit-ou, distress, and alarm calls. By about 8 weeks of age, juveniles used three call types, two derived from the wit-ou, and one derived from the distress call. Eleven adult calls were described. Of these calls, only two appear to be clearly derived from the distress call of chicks. Eight calls appear to be derived from the early wit-ou, and the origin of one call is unclear.

Analysis of distress calls for brood and individual differences showed that call length and minimum frequency differed significantly between broods. Significant individual differences were found for length, minimum frequency, maximum frequency, and frequency range. Coefficients of variation indicated that single cues are probably insuffi-

cient to distinguish individuals.

Measurement of pure tone attenuation and call attenuation indicated that call structure in young coots is related to transmissibility of vocalizations. High pitched twitters attenuate more rapidly than wit-ou, distress, or alarm calls which are lower pitched. These results are consistent with measurements of pure tones.

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GENERAL INTRODUCTION

Communication enables members of a species to interact and coordinate a wide range of activities (Scott 1968), presumably throughout all developmental stages from hatching or birth to adulthood. Any communication system involves a communicator, a signal, and a recipient (Klopfer and Hatch 1968). Analysis of such a system involves an understanding of the characteristics and information content of signals, the meaning of signals in light of their contexts, and their adaptive significance to interacting individuals (Marler 1961, Smith 1965, Smith 1977). This thesis is concerned mainly with the signal element, in particular, of vocal-auditory communication in young American Coots (Fulica americana). Though coots use vocalizations extensively in behavioural interactions, the only work to date on vocalizations (Gullion 1952) has been descriptive, lacking in quantitative analysis. This information is also limited to calls of adult coots. My study was designed to quantify characteristics of vocal signals during development from hatching to adulthood. Results are presented in three interrelated sections.

Vocal repertoires during three stages of development are examined in Part A. The purpose was not only to quantify calls, but more importantly to attempt to determine how vocal signals of the adult develop from those

present at hatching. Since both intraspecific interactions and communication signals change during an animal's development (Smith 1977), it is necessary to analyze communication systems throughout the ontogenetic period. Very little is known about what changes occur, or how they occur. Most studies of avian vocal-auditory communication have focused on adults, and ontogenetic studies have primarily been concerned with the influence of learning or genetics on vocal development (Lanyon 1960, Marler and Mundinger 1971). Since understanding communication involves a knowledge of the nature of selective influences on the signals (Klopfer and Hatch 1968), study of this aspect of communication is important at all developmental stages. This study has attempted to interpret changes in vocal behaviour in light of adaptations to the environment, and of other changes in behaviour during development.

Part B of the study focused on potential cues available for recognition in distress calls of young coots. Although studies have demonstrated individually distinct voices in adult birds (Beer 1970, Evans 1970a 1970b, White and White 1970), few studies have considered individual variation in the voices of the young (Miller and Emlen 1975, Noseworthy and Lien 1976). Studies of mammals, however, have indicated that individual recognition of distress calls of young by parents does occur (Espmark 1975, Petrinovich 1974), suggesting that the calls of the young

are individually distinctive. The further possibility that voices of the young may bear sibling resemblance appears not to have been examined. Cues that could provide information on both individual and family identity were therefore studied.

Part C of the thesis deals with the structure of vocalizations in relation to the habitat through which they are broadcast. Although several authors have discussed the potential for selective pressures on transmission of calls as a result of habitat structure (Emlen 1972, Moynihan 1967, Wilson 1975), studies providing quantitative data have been limited. Such studies (Chapuis 1971, Jilka and Leisler 1974, Morton 1975) have focused on bird song, and have not considered the possibility that functionally different calls within a single species might have quite different transmission characteristics, depending upon whether they normally function at close or long distances. While it has been suggested previously that calls functioning over different distances may differ in structure (Moynihan 1967), experimental evidence is lacking. The purpose of this study was to determine how long-distance and short-range calls of young coots differ, if at all, in transmissibility.

Part A. Development of Vocalizations in the American Coot

Introduction

There have been many studies of vocal-auditory communication in birds, however most have dealt with adults. Of developmental studies done to date, the majority have involved passerine song (Immelmann 1969, Konishi 1964 1965a 1965b, Lanyon 1960, Marler and Mundinger 1971, Marler and Tamura 1977, Nottebohm 1972). There have been several studies of call development in passerines (see Marler and Mundinger 1971), but similar studies in non-passerines are rare. A relatively detailed description of vocal development for two gull species has been provided by Moynihan (1959). Other ontogenetic studies have involved Galliformes. Konishi (1963) has looked at the effect of deafening on call development in Domestic Chickens (Gallus gallus), and Guyomarc'h (1971) has done a spectrographic analysis of the development of maternal calls in Japanese Quail (Coturnix coturnix japonica). The use of spectrographic analysis is lacking for all or a major portion of calls present during development for any species (Lanyon 1960, Smith 1977).

In this study I examined vocal communication signals of a non-passerine species throughout major stages of

ontogeny. Calls of young laboratory-reared coots were studied during the first four weeks after hatching. In addition, calls of these birds as juveniles and calls of wild breeding adults were examined to determine how calls of young coots change during development into adult vocalizations.

Methods

The early development of vocalizations was followed in laboratory-reared coots. Use of captive birds enabled easy access as well as controlled conditions for recording and observation purposes. Four clutches of eggs were collected on 10 June 1975 from the Minnedosa pothole area of Manitoba. Pipping had begun in two of the clutches at the time of collection. Eggs were placed in a Brower forced air incubator and checked several times daily for hatched birds. Newly hatched chicks were individually marked with coloured leg bands and transferred, when dry, to holding pens. There was a hatching success of 88%, and a mortality rate of 28% after hatching.

Rearing Conditions

Holding pens were approximately 70 cm by 70 cm, consisting of 1.3 cm wire mesh sides and panelboard flooring

which could be removed and brushed clean. A 25 watt incandescent bulb at floor level provided heat in each pen. Each brood was held in a separate sound-attenuated room so that interbrood interactions were not possible.

Chicks were provided with water, and initially were fed by hand. Moistened chick or turkey starter was presented to newly hatched chicks from a spoon or finger. After several days a spoon full of moist food was placed on the pen floor, and replenished when necessary. When older birds appeared to be feeding independently at about 10 days of age, a dish of moistened food was left in each pen. Fresh food was provided daily.

When the youngest of a brood was at least 5 days old, birds were removed from the holding pens and released into a larger enclosure in the sound-attenuated rooms. Each of three broods containing from 5 to 8 birds was provided with a plastic pool about 1 m in diameter, containing free-running tap water. One of the smallest broods, containing 5 young was placed in a small 2 m by 3 m holding area, provided with bathing water in a 35 cm by 70 cm styrofoam container. The incandescent heat source was maintained until all birds were well feathered, at about 6 weeks of age. Hand feeding continued until the youngest in a brood was about 2 weeks old. At this time birds no longer approached me for food.

Recording Conditions

Tape recordings were made primarily with a Uher 4000 Report L tape recorder. Some recordings were also made with a Sony TC 106, and a Sanyo MR-920 tape recorder. Recordings were made in several situations. Vocalizations were recorded when chicks were being hand fed, when undisturbed in holding pens and enclosures, and when being held in the hand. Calls given during isolation were obtained by placing individuals in a separate room where auditory contact with broodmates was minimal.

Once birds were feeding independently, they showed fear of humans. Observations were then made using a Sony Video Recorder which was especially valuable for subadults.

Analysis of Calls

Vocalizations of each recorded call type were randomly selected for analysis from unedited tape recordings. They were then printed on sonagrams, once using the wide band setting, and once using the narrow band setting with a Kaye Electric Co. Model 675 Missilyzer. Call duration was measured from the wide band sonagrams, while frequency was measured from the narrow band sonagrams. For purposes of illustration, ink tracings of these sonagrams were produced, which combined characteristics of both wide and narrow band

sonagrams.

Calls recorded during the first 4 weeks after hatching were divided into 3 age groups. One represented the youngest birds sampled for a given call, one represented the oldest birds for which samples could be obtained, and the third group represented an intermediate age. Differences in the ease with which various call types could be recorded resulted in slight differences in absolute age categories between some calls. Approximately equal numbers of calls were analyzed from each of the broods at each age.

Characteristics of most call types of young coots were analyzed for age changes using a one way repeated measures analysis of variance (Hays 1973). Only the alarm call, where two rather than three age levels were compared, was tested using a dependent samples t-test (Hays 1973). In older birds where sex differences were compared, dependent samples t-tests were used (Hays 1973).

When describing calls of adult coots, names proposed by Gullion (1952) will be used where possible.

Sexing of Birds

To determine sex of captive birds, they were dissected, and the gonads were examined at the end of the study period.

Field Observations

Calls and activities of wild, adult coots were observed at the University Field Station (Delta Marsh), located at the south end of Lake Manitoba, during 1975 and 1976.

Prior to egg collection in June 1975, adult coots were observed for two weeks during May, usually from a canoe at Crescent Pond (Fig. 1). During 1976, observations were made from early May to mid-August. A small plastic boat equipped with a burlap blind enabled prenesting birds to be observed while vegetation was relatively low. During and after nesting a 5.6 m high wooden tower, placed within a nesting area, enabled observations of both adults and broods. Activities at nest sites were monitored using the boat and blind. Recordings during hatching were made by placing a Uher M539 microphone, camouflaged with burlap, at the edge of the nest. Its presence did not seem to alarm the birds.

Field Study Site. Figure 2 shows the area in which the wooden observation tower was placed. Predominant vegetation was *Typha latifolia* L. Of 10 nests located in the area, 8 were placed in this vegetation type. One nest was located in *Phragmites communis* Trin., and one nest was located in a flooded stand of *Scolochloa festucacea* (Willd.) Link. Recordings of brooding females, nearby males, and hatching young were made at nests 3, 8, and 9. Observations

Figure 1. Study area at Delta Marsh showing observation sites from which both adult and young coots were watched during 1975 and 1976.

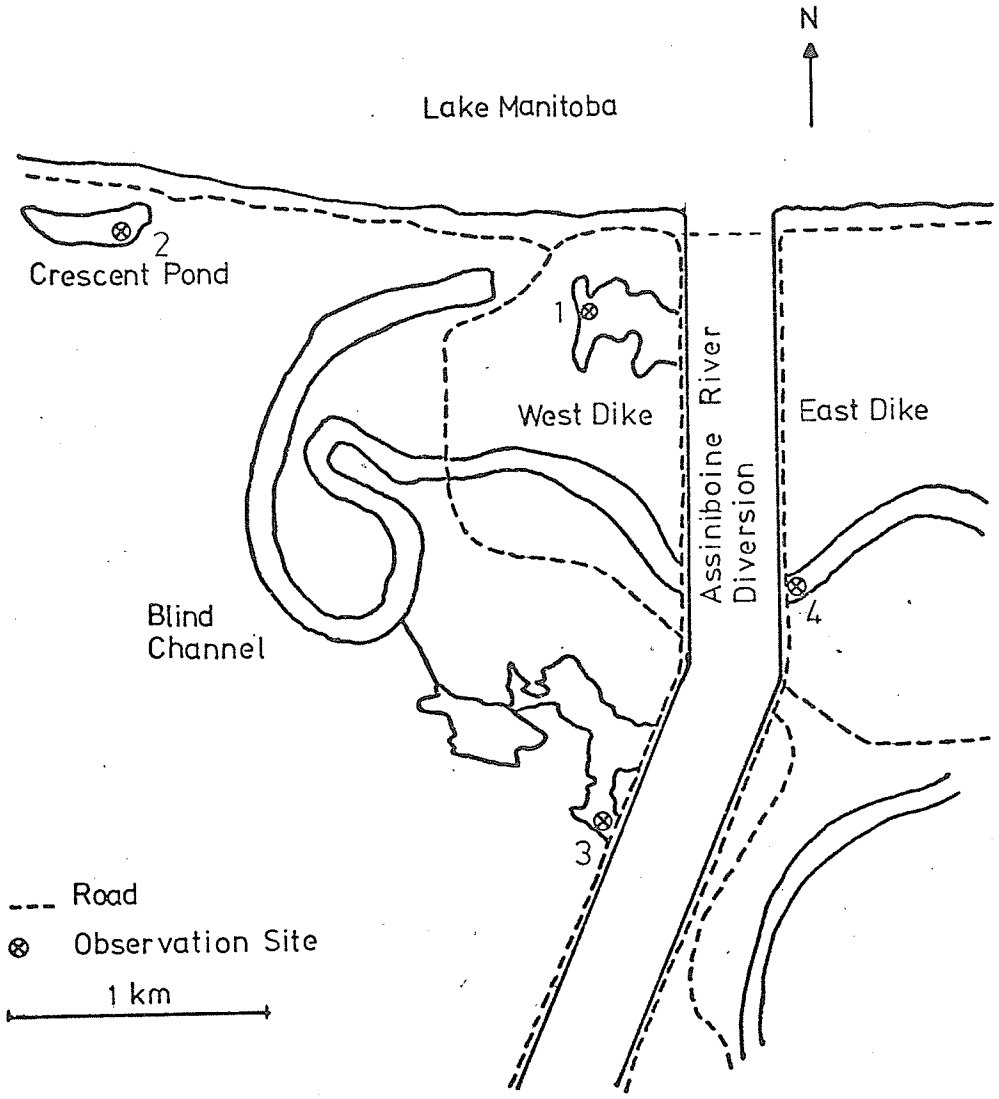
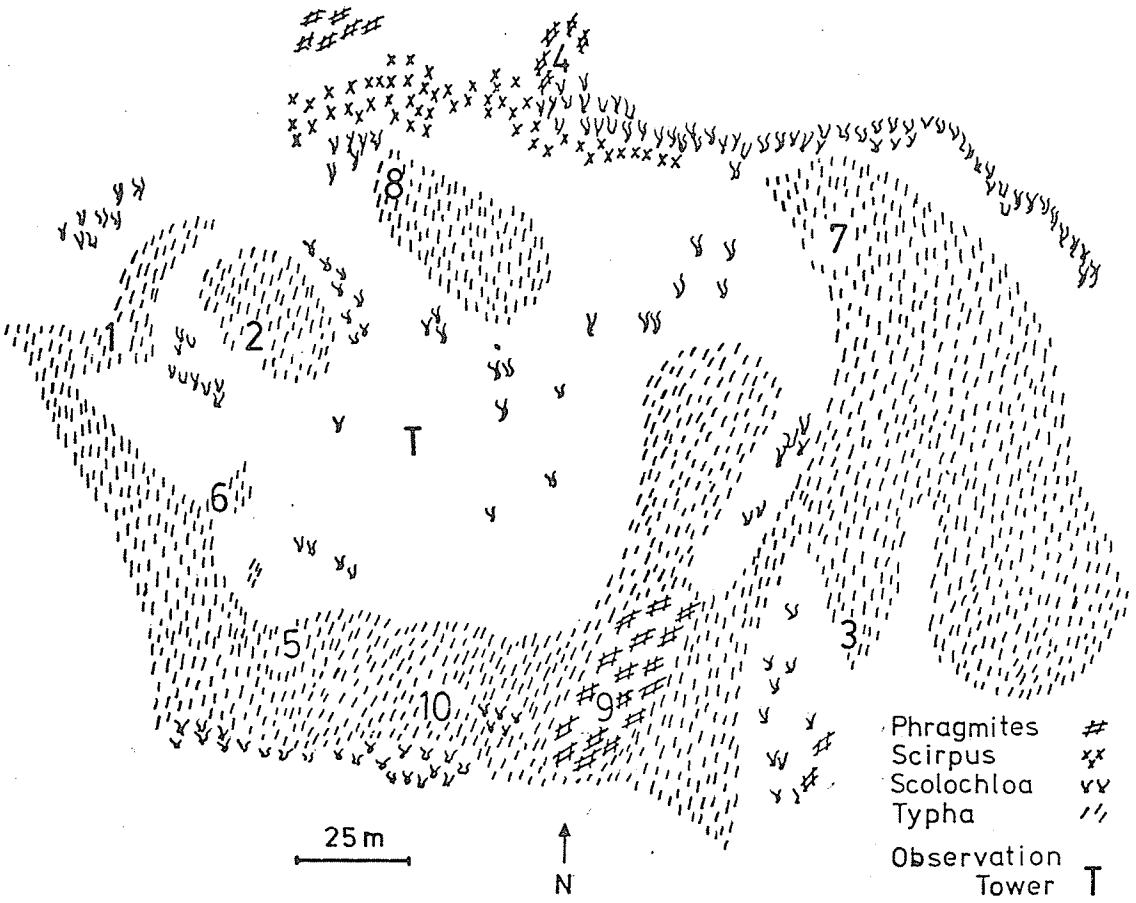

N
Lake Manitoba
2
Crescent Pond
1
West Dike
Assiniboine River Diversion
East Dike
Blind Channel
4
3
Road
Observation Site
1 km

Figure 2. Sketch of nesting area (Site 1 in Figure 1) of coots in which the observation tower was placed. Numbers designate locations of nests of individual coots.


1
2
3
4
5
6
7
8
9
10
T
25 m
N
Phragmites
Scirpus
Scolochloa
Typha
Observation Tower T

were made using 7 x 35 binoculars and a 15 power Bushnell spotting scope.

Drought conditions (Table 1) eventually resulted in drying of the study area in 1976. Until this occurred, birds could be easily watched from the tower even when in stands of vegetation. Once drying occurred, coots moved to other areas of the marsh. Observations were then made of broods in channels from the dike roads (Fig. 1). These birds were watched until premigratory flocking occurred in mid-August.

Results

Calls of Chicks

Four major call types were identified in young laboratory-reared coots: twitter, wit-ou, distress, and alarm. All types may be given during hatching by wild coots. Immediately after hatching, laboratory-reared birds gave all call types without clear contexts. After the first day of age, the situations evoking call types became differentiated.

Twitter. Termed contentment or pleasure notes by Collias and Joos (1953), twitters were the most common call of young coots. Immediately after hatching chicks placed alone in pens gave these calls. After exposure to brood-

Table 1. Temperature and precipitation data for Delta Marsh during 1975 and 1976.

Month	Mean Temperature (C)				Precipitation (cm)	
	Minimum		Maximum			
	1975	1976	1975	1976	1975	1976
April	-8.5	-1.3	4.8	9.1	4.1	2.8
May	4.4	6.2	16.3	17.6	7.7	4.6
June	11.6	12.1	21.8	23.0	7.9	6.9
July	15.1	12.5	26.6	25.5	7.8	4.4
August	11.4	12.5	21.4	24.9	13.9	1.8