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FIELD STUDIES ON THE BEHAVIOUR OF SEA-DUCKLINGS

During the summer of 1959 the writer was engaged in studies on the behaviour of sea-ducklings in the Belcher Islands, Hudson Bay. This work is centred on an ethological study of eider ducklings *(Somateria mollissima)* with comparative observations on ducklings of old-squaw *(Clangula hyemalis)* and red-breasted merganser *(Mergus serratus)*; it had been begun in the False River area, Ungava in the summer of 1958 [1, 2, 3]. Once again Mr. C. W. Nicol gave able assistance.

The objective of this work is to build up as complete an account as possible of the behaviour of the normal eider duckling in its natural environment, beginning shortly before hatching and ending with fledging. It is hoped that an account of the basic behaviour of this species will provide a sound foundation on which to plan analytical studies. The approach to this work is largely that of the present European vertebrate ethologists[4], but it is planned to develop the more "psychological" aspects of the work in future studies.

The most obvious single comment to be made about the behaviour of the eider duckling is that it is extremely complex, more so than has previously been recognized. This complexity is partly due to the mixture of innate and learned processes, which together enable the duckling to survive the difficulties of the pre-adult stages. One of the present aims therefore is to describe the part played by innate mechanisms and to correlate learning processes with them. A brief summary of the results to date follows.

Two or three days before hatching the duckling pushes its bill through the inner shell membrane into the air space in the large end of the egg. At this time the duckling begins to make significant movements with its head and to vocalize. Movements of the developing embryo have previously been commented on[5], but it seems that the activities shortly before hatching have escaped the notice of ethologists. Ducklings in the pre-hatching stage were watched through an observation hole cut into the end of the egg, which was kept covered at other times.

The most obvious movement of the head at this time is the *upward nod*. This, as the name implies, involves the raising of the bill and it enables the egg-tooth to be brought into contact with the shell. As the bird is in a very cramped position curled up in the egg, this is the only means of rupturing the shell at its disposal. As the bird turns round in the egg a series of breaks is made around the large end and this is eventually pushed off by the bird's struggles. Bill opening also plays a part in the rupturing.

Most of the vocalizations of the bird before it hatches are what may be called "non-descript". However, some of them can be recognized as imperfect renderings of two of the innate signals that are used in appropriate situations after hatching. These are the *brooding note* and the *complaint*. The former is a monosyllable on a rapidly rising — or sometimes falling — note and the latter an insistent disyllable with the second note higher and rising. It seems that the former is used when the duckling is being brooded by the female and the latter when it is uncomfortable, and it is of interest that the only signals to be recognized from the egg to date are those that are used in basically similar situations after hatching.

After the bird has hatched the upward note takes on other essential functions. On emergence the duckling's first response is to the feeling of contact, particularly around its head, and it is believed that this is the mechanism whereby it achieves the position of optimum warmth and comfort under the female. Using the upward nod the duckling pushes its head up into animate crevices in its vicinity, such as the plumage of the female or between the fingers of the investigator, and if it is warm it will then rest. It is thought that this mechanism is likely to be of fundamental importance in the imprinting process, which has received so much attention in recent years, both from ethologists and psychologists. Detailed observations have therefore been made of this mechanism and it has been tentatively named the *brooding reflex*[6].

A third vocalization of significance is the *cohesion call*. This is a phrase of four or five ascending notes that is uttered at frequent intervals by the ducklings and almost certainly functions in the maintenance of contact between members of the brood. The adult female has a different call for the same purpose. The cohesion call is often used in conjunction with the upward nod and in this context the latter is used as a *greeting*. The full greeting involves both the head movement and the call, but at low intensity the movement may be used alone.

Yet another manifestation of the upward nod is the movement used in drinking. This is present from the time the bird first enters the water.

A call similar to the cohesion call is the phrase that we may call the *contentment notes*, for it is used when the duckling has achieved the satisfaction of food or warmth, for example. The phrase is basically similar to the cohesion call, but is faster, higher pitched, and more monotonic. When a brood of ducklings is feeding in the water the most common acoustic signals are these two here described.

When danger threatens a number of innate reactions may be brought into play. The most obvious of these is the *distress call*. This is similar to that in all other Anatidæ, but is not broken up into phrases as has been suggested[7], but is a continuously repeated monosyllabic and insistent piping. In normal circumstances it results in the alerting of the brood including the female, and an appropriate response of the brood will usually reduce the danger. If danger is very imminent the duckling will usually *crash dive* if it is on water. This involves a backward and upward kick with the webs as the front of the body is forced down into the water. As our movie films show the time in which total submergence is accomplished is as little as one-fifth of a second.

At the time of hatching this crash dive is the only means available to the duckling for submergence. This is a very logical state of affairs as a crash dive may be essential for survival, but a smoother dive for feeding purposes is merely advantageous. The latter therefore is developed as a result of experience. When the duckling first learns that edible materials are to be obtained from below the surface it can only submerge by using a modified crash dive. By experience this changes into a smooth forward plunge so that the bird can submerge easily, but without the necessary haste and expenditure of energy of the crash dive. This *juvenile feeding dive* develops very rapidly during the first few hours of the duckling's experience of feeding conditions, and lasts until the duckling is about 3.5 weeks old. It is then replaced by the *adult feeding dive*. This involves a far less acrobatic submergence, being merely a kick forward and down from a head-under position. The young duck has become very heavy in its fore parts by this time and has only to put its head and neck under water to be over-balanced forwards and downwards. When the primary feathers develop fully from the age of about 8 weeks the young ducks begin to "fly" under water, using the wings partly flexed at the carpo-metacarpal joint as accessory propulsive organs.

The beginning of the feeding behaviour is particularly interesting as it involves both innate and learned behaviour elements. As soon as the duckling has left the nest and reached suitable conditions it shows an innate interest in *potential food objects*. These may be any objects that are small enough or dark or moving. The duckling investigates these and attempts to swallow them. From experience it learns that certain of these objects are edible and others are not. All this time its co-ordination is improving and on the second or third day it is able to catch insects in flight. The most attractive food objects however are Branchiopods or Amphipods, which are all under water. Hence the development of a feeding dive as explained above.

During these first few days preening has been developed on a basis of certain innate movements and the bird is able to dry out efficiently on emergence from the water.

Possibly the most interesting of all acoustic signals so far identified is the *question* or *investigatory note*. When the duckling finds itself in a situation that is puzzling to it — one that releases no definite reaction or that involves indefinite stimuli — it responds with this note. It is a thin ascending monosyllable lasting for about 1 second. This note may be released in both wild and imprinted ducklings by the sight of strangers on the horizon or of indefinite bird silhouettes in the sky. It would seem that the function of this note is to alert the other members of the brood to an unusual situation so that avoiding reaction may be taken if necessary. This is a most unusual item of equipment to find in a bird's armoury of behaviour patterns, but it seems to be a very definite and discrete mechanism.

The danger reactions of the eider ducklings also involve a response to the *alarm whirr* of the female. This is a descending throaty whirring call that results in the young "bunching" in the "danger shadow" of the female. The ducklings imprinted to the writer consistently reacted in this way in response to his alarm whirr and the presence of strange animals, including female eiders. The "bunch" is maintained as long as the danger call continues.

This very brief outline may give some idea of the results obtained in the study so far. No mention can here be made of many subsidiary items of interest nor of the evidence upon which these conclusions are based. A full report will be published on completion of the work, but it may be noted here that the study material has so far included 12 eider ducklings under the immediate care of the writer in the field and imprinted to him in deliberately varied degrees. Control observations have been made on wild ducklings varying from one-day old to almost fledged and from single individuals to many hundreds at one time[8,9].

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Glaciological studies of the Mendenhall Glacier, Alaska

In May 1960 a group of Japanese scientists from Hokkaido University, led by Dr. Akira Higashi, left Yokohama for Alaska to conduct a study of the Mendenhall Glacier for a period of 6 weeks.

The group included the following members: Dr. Higashi, Dr. Seiji Hashimota, and Mr. Kazuhiko Itagaki of the Physics Department; Mr. Hiromu Shimizu, of the Department of Meteorology; Mr. Sujio Kymano, of the Department of Geology; Mr. Katsuhiro Kikuchi and Mr. Tsutomu Takahashi, graduate students of the Department of Geophysics.

Objectives of the project were the collecting of large single ice crystals at a lake at the terminus of Mendenhall Glacier and glaciological investigations of the glacier to elucidate the mechanism of the formation of large single ice crystals. Single ice crystals of large size are urgently needed by physicists at Hokkaido University, who are studying the solid state physics of ice crystals. This is one of the reasons that prompted the University to send the field party to Alaska.

The planned glaciological investigations include measurements of the speed of flow at various points of the glacier; determination of crystal orientation, grain size, and impurity content in the crystal grain and grain boundary of each sample taken at different places. A geological survey of nunataks and cirques near the upper part of the glacier and studies of firn snow were also planned, as well as comparative studies of the Taku Glacier, which is apparently different from the Mendenhall Glacier in many respects.

The work schedule was planned as follows: first week, aircraft reconnaissance of the glacier and the Juneau Ice Field, determination of the location of observation sites from air photographs, establishment of a base camp at the terminus of the glacier; second week, search for and collecting of large single ice crystals at the glacier snout and putting them into cold storage in Juneau, establishing a base line across the glacier near the terminus for the determination of the speed of flow; third week, move to the second camp, routine glaciological work at two crevasses of medium altitudes; fourth week, move to the third camp, glaciological work at two