supplying comparative skua data from C. Hallett. Thanks are also extended to Dr. R. A. Falla (Dominion Museum) and Mr. G. W. Markham (Antarctic Division, D.S.I.R.) not only for permitting this deviation from the established programme but also for giving it the necessary authority. Grateful thanks are extended to the U.S. Navy who supplied transport and equipment and without whose considerate co-operation the survey would not have been possible.

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SPEED OF ADELIE PENGUINS ON ICE AND SNOW

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The Adelie Penguin (*Pygoscelis adeliae* Hombron and Jacquinot) is well known as a bird superbly adapted for movement in water, a proficiency gained at the expense of its power of flight. The purposes of this note are to draw attention to the Adelie's remarkable performance "overland" and to record some observations on its speed over ice and snow.

When ashore Adelies have two main methods of progression, walking and tobogganing. When tobogganing they slide on their breasts, pushing themselves forward with their feet. On a journey they alternate between the two methods (see Plate XI), both to "relieve the monotony" and to suit the nature of the snow surface, usually walking on firm or rough going and tobogganing on softer snow (Levick, 1915). Their normal rate of travel is the same, walking or tobogganing, and in a group moving together over the ice both methods are often simultaneously in use by different birds.

That Adelies can travel vast distances ashore is well illustrated by records of penguins found wandering far inland in Antarctica. Both Wilson (1907) and Shackleton (1909) noted Adelie Penguins, or their tracks, 60 miles from the sea on the Ross Ice Shelf, and Sladen and Ostenso (1960) recorded penguin tracks (probably those of an Adelie) found in January 1958 on the Ellsworth Highland, 186 miles from the nearest known coast.

When Adelies first arrive at the breeding rookeries during October, they must often have travelled over fast ice for more than 30 miles, and sometimes up to 60 miles, from the nearest open water

(Sladen, 1958). Even when feeding chicks later in the season adults may have to travel considerable distances ashore. For instance, at the Cape Royds rookery in 1959, open water was still about four miles north when the first chicks hatched on 10th December. Even so, most parents changed guard duties every day (Taylor, 1962), having travelled over the ice, collected food for the chicks, and returned to the rookery within 24 hours.

The Antarctic literature contains several apparently conflicting reports on the speed at which Adelies normally travel over sea ice. Murphy (1936) stated, "the normal rate is the same by both means, namely anything up to 8 kilometers [5 miles] an hour." On the other hand, Levick (1915) wrote, "their little legs enabling them to advance only about six inches at each step; but going at the rate of about 130 steps per minute, they covered some two-thirds of a statute mile per hour," and Bernacchi (1901) estimated their speed over ice as about one mile an hour. Murray (1909) gave their top walking speed on level ice as "about as fast as a man at a smart walk," and Sapin-Jaloustre (1960) who followed a group of penguins over sea ice for several hours, estimated their speed at about four to five kilometers (2.5 - 3.0 miles) per hour.

To check the rate at which birds were crossing the ice at Cape Royds, on 11th and 12th December 1959, groups of penguins travelling together were timed over marked distances, varying between 250 and 350 yards, on several approach routes about a quarter of a mile out from the rookery (Table 1). Nearly all the penguins were walking on these measured routes over the sea ice, which was sparsely covered with snow and free of major obstacles. Occasional, usually momentary, pauses were not deducted from the recorded times. On both days there was a 15 knot southeast wind which favoured penguins leaving the rookery for the sea. This could account for the apparently faster rate of outgoing birds, but it could equally be argued that these had only just started their journey, whereas those coming in had already travelled four miles.

TABLE 1

Rate of Travel of Adelie Penguins over sea ice at Cape Royds

No. of Penguins in group	Direction of travel	Miles per hour
18	to rookery	1.86
11	to sea	2.43
11	to sea	2.39
2	to sea	2.11
1	to sea	1.75
1	to rookery	1.62

* Recorded while author seconded to Antarctic Division, D.S.I.R.

These few records suggest that the Adelie's normal rate of travel over level sea ice is between 1.5 and 2.5 miles per hour; though of course when frightened, or hurrying for some other reason, they can toboggan at much greater speeds for short distances (Brown, 1913), and this might explain the apparent discrepancy in some of the early accounts.

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THE EXTINCTION OF MOAS AND OTHER ANIMALS DURING THE HOLOCENE PERIOD

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The Holocene Period comprises in round figures the last ten thousand years, and is equated with the post-glacial. During the Pleistocene (i.e. the previous one or two million years) world climate underwent severe fluctuations. In New Zealand a large number of plants and animals with more or less long histories in the Tertiary became extinct during the Pleistocene, and the Holocene began with an impoverished biota which lacked organisms sensitive to the types of environmental changes that had characterised the ice ages. Any such stenothermal organisms had disappeared long before during the earlier Pleistocene climatic catastrophes. Among marine organisms, for instance, most of the Pleistocene extinctions took place in the first two glaciations.

The early post-glacial time of warming climate and rising sea-level, from ten thousand to six thousand years ago, is not characterised by extinction, but on the contrary by faunal diversification and active colonisation. Thus, a recent analysis of the likely age of mainly Australian derivatives among New Zealand birds (Fleming 1962), suggests a considerable number of immigrations and some speciation during the early Holocene. The Holocene culmination of post-glacial warming, often termed the Climatic Optimum or Thermal Maximum, apparently during the interval from 6000 to 4000 years ago, was followed by minor cooling that could have led to extinctions, but I can only think of one that falls in that period. The "Sydney cockle," *Anadara*, came to New Zealand during at least one of the early inter-glacials, and returned to Northland for a brief interval in post-glacial time, judged by its occurrence as fresh shells near present sea level at Hokianga, in shallow wells at Marsden Point and elsewhere. Its absence as a living animal suggests the only known post-glacial extinction among marine invertebrates.

The Late Holocene, i.e. the last 4000 years, has been characterised by building out of coasts, advance of dunes, ponding of streams to produce coastal peat swamps, and moderate alluviation of many inland valley bottoms after the interval of early Holocene down-cutting that followed the Last Glaciation. The deposits formed in this late Holocene phase are the main sources of bones of the moa, of extinct birds of

[Photo by R. H. Taylor

XI — Trail in snow of an Adelie Penguin that ceased tobogganing and started to walk. Adelies toboggan by sliding on their breasts and pushing themselves along with alternate strokes of their feet, and sometimes also with their flippers. When they walk the tail drags. Notebook for scale measures 7.25 x 4.75 inches.