Mosses from the Mackenzie Mountains, Northwest Territories*

A recent collection by W. J. Cody (Canada Department of Agriculture) from the Mackenzie Mountains, continental Northwest Territories, arctic Canada, included 2 mosses of some phytogeographical interest. These were collected on the Plains of Abraham (64°30'N., 127°13'W.), on a shattered limestone plain at approximately 1,400 m. altitude. The specimen (containing both species) was collected on 9 July 1970, W. J. Cody, collection number 19078.

Bryum wrightii Sull. and Lesq. *Cody 19078,* with numerous sporophytes.

This is the first report of this moss from the continental Northwest Territories, and a substantial southwestward range extension. The species is also known from a few of the Queen Elizabeth Islands[1], Banks Island, Southampton Island[2], and Greenland[3], but it is rare and local throughout its distribution.

Voitia hyperborea Grev. and Arnott. *Cody 19078a,* a few plants, with sporophytes.

This species, whose distribution was recently mapped[1], was known from the eastern part of the continental Northwest Territories but not from the western part. The present collection extends the species' range to the southwest, and provides the closest locality yet to the Alberta populations of its vicariant, *Voitia nivalis* Hornsch. The Plains of Abraham specimens are, however, definitely the high arctic *V. hyperborea.*

The presence of *Bryum wrightii* and *Voitia hyperborea* on a high-altitude plain which was unglaciated in the Pleistocene is significant. They have probably remained in this locality during the Pleistocene Glaciations. Both species undoubtedly also survived the glaciations in other Nearctic refugia. *Bryum wrightii* is also known from Banks Island but has not yet been reported from unglaciated Arctic Alaska. *Voitia hyperborea* seems also to have survived glaciation in several other widely scattered refugia, including arctic Alaska, northern Ellesmere Island, and Greenland.

The discovery of these 2 mosses in an unglaciated part of the continental Northwest Territories may well indicate that the Plains of Abraham and other high unglaciated plateaus in the Mackenzie Mountains have a flora rich in high arctic bryophytes.

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Peregrine Falcon Survey, West Greenland, 1972

INTRODUCTION

A conference at the University of Wisconsin in 1965 discussed the rapid decline of peregrine falcons (*Falco peregrinus*) in North America and Europe[1]. By 1965 the peregrine had become extinct as a breeding bird east of the Mississippi River and had suffered drastic population reductions in western United States and Europe. At the Wisconsin conference, reports on the peregrine falcon were presented for most areas except Greenland.

A second peregrine falcon symposium was held at Cornell University in November 1969. This meeting reported continued decline in numbers of peregrines and presented overwhelming evidence about the cause of this decline: chlorinated hydrocarbons, the hard pesticides, including DDT and dieldrin[2]. Both field evidence and laboratory experiments showed that high residue levels of DDE (a metabolite of DDT) and other pesticides in birds are associated with thin eggshells, resultant eggshell breakage, and low hatching rates[3,4]. This situation seemed to apply, in varying degrees, to all the North American subspecific populations of *Falco peregrinus:* the continental *anatum,* the Pacific Northwest and Aleutian *pealei,* and the northern *tundrius,* although the marine *pealei* falcons in the Aleutians appear to be a rather healthy population[5].

As in 1965, the 1969 peregrine falcon symposium heard no evidence from Greenland, where general reports in the past had described the peregrine as a relatively com-

mon breeding bird[6]. The Cornell meeting in 1969 planned a large-scale survey of peregrine falcons in North America in 1970. Greenland (with its North American fauna) was to be 1 of 6 large study areas. Although other regions were studied, plans for the Greenland survey never materialized in 1970 or 1971. Cade and Fyfe stated in 1970[2]: "Greenland unfortunately remains an unknown region, but the diminished trapping success and number of sightings of migrant Peregrines on Assateague Island in recent years (R. B. Berry, unpublished report) suggest that all is not well even in this 'remote' part of the North American arctic." It was to begin studies in Greenland that the Peregrine Falcon Survey of West Greenland, 1972, was planned by Lt. Col. R. A. Graham and Dr. W. G. Mattox.

General descriptions of the peregrine falcon in Greenland have been published[6], but little quantitative data exist on nesting density, breeding success, and possible existence of pesticide residues in this population. Recently, White[7] included most of West Greenland as a breeding area of the newly-described *tundrius* subspecies — the tundra peregrine. Previously, peregrines in Greenland (as well as in Alaska and northern Canada) were classified as *F. p. anatum*. Only 2 records of peregrines banded in Greenland and recovered elsewhere are known: a nestling banded in southwest Greenland in August 1941 was found dead near Cienfuegos, Cuba, in December of the same year; another nestling banded in West Greenland in July 1956 was recovered 150 miles north of Montreal in October of that year[8]. Two peregrine falcons banded in October 1956 and 1957 at Assateague Island, Maryland were recovered (shot) later in West Greenland. The falcon banded in 1956 was recovered in November 1959, the other in September 1958[8]. These few returns suggest that at least some peregrines from Greenland migrate past eastern Canada and the United States to winter in Central and South America, and the Caribbean Islands. In a continuing study of migrating peregrine falcons at Assateague Island, Ward and Berry[9] have shown that the numbers of migrants they trap and band each autumn often fluctuate greatly. The fall migration in 1971 was unusually large, while that in 1972 was minimal (Ward, personal communication). Research on nesting peregrine falcons in Greenland might help to explain these fluctuations and is especially urgent because these birds might not be subjected to the same environmental threats as the declining populations in northern Canada and Alaska[9].

PURPOSES OF THE PRESENT STUDY

The main purpose of the 1972 survey was to study a sample area of West Greenland to supply baseline data about peregrine falcons from which future surveys could determine the status and trends of this bird in Greenland.

The main part of the study had as its goals:

1) to determine the density, distribution, and reproductive success of nesting peregrines in a sample area;
2) to band all peregrine nestlings found;
3) to determine prey species of the peregrine;
4) to make interspecific observations of peregrines and gyrfalcons;
5) to make detailed observations from a blind of a sample peregrine falcon eyrie;
6) to conduct a small-bird census in the area of the sample eyrie;
7) to make a photographic record in colour slides and movies of the investigations.

FIELD METHODS

The survey team of 5 men was in the field in Greenland from 20 June to 14 August. During most of that time 2 men (Clement and Harris) made detailed observations at a selected peregrine falcon eyrie. They lived in a permanent camp within good sight and hearing distance of the peregrine cliff from 23 June until 3 August, with an additional visit to the eyrie on 12 August. The 6 weeks covered a period from 1 week before hatching to 1 week before fledging. During the second week after hatching, a blind was placed on the cliff 30 feet (9 m.) from the eyrie. A total of 231 hours of direct observation was recorded, including 51 hours from the blind and 157 hours from a lookout position about 330 feet (100 m.) from, and of equal elevation with, the eyrie. The observers collected data on development of the young, activity cycle, prey species, and the behaviour and role of the parents. This included intra- and interspecific behaviour, hunting, and care of eggs and young. Pellets and eggshell fragments were collected for analysis. In addition, notes on weather conditions and the reproductive and diet activity cycle of the prey species were obtained. A census of breeding birds in a sample area in the immediate vicinity of the nesting cliff was also made. Photographs and movies were taken mainly of the parents and young in the eyrie.

Three men (Burnham, Graham, and Mattox) traversed the survey area on foot to locate nesting sites of both peregrines

and gyrfalcons in a land area of approximately 700 sq. mi. (1,800 sq. km.), including fiords and lakes. Later in the season, Clement joined these men to form two-man parties to revisit the located eyries to band nestlings (eyasses) and collect prey remains. The survey traverses were made by self-supporting back-packing trips varying from 2 to 8 days from the main basecamp. The maximum total distance covered by one man (Burnham) in back-packing was about 600 miles (965 km.). Limited use of helicopter (*c.* 2 hours) and small boat (*c.* 12 hours) aided the survey. In all, 1,500 colour slides, 540 black-and-white negatives, and 3,500 feet of colour movie film were exposed.

RESULTS

Eight peregrine falcon eyries and 3 gyrfalcon eyries were found in the survey area. In all, 18 nestlings were found in the 8 peregrine eyries. Of the 8 eyries, 1 had no young, but showed signs of occupancy (a scrape, bits of down, etc.) and was defended by an aggressive pair of falcons. Of the other 7 eyries where we found hatched young, 1 had 4 young, 4 had 3 young, and 2 had 1 young bird each. Of the total of 18 nestling peregrines, 13 were banded and 5 were fully-fledged, on the wing, and unable to be caught for banding. Of the peregrine nestlings banded, 9 were males and 4 were females. The number of nestlings (18) in the 8 peregrine eyries gave a production rate of 2.25 per eyrie, or 2.57 if an average is taken of the 7 eyries actually producing young. At 1 eyrie a young falcon was found dead (the eyrie with 4 young). We know that at least 8 of the remaining 17 young fledged successfully, but we are uncertain about the success of the others and cannot therefore make a definite statement on fledging ratio. We estimate, however, that the fledging rate of the peregrines in our survey area was at least 2.00 per producing eyrie. The maximum dimensions of our irregularly-shaped survey area were 39 x 34 miles (63 x 55 km.). The estimated area of the survey was about 800 sq. mi. (2,072 sq. km.), or about 700 sq. mi. (1,800 sq. km.) when the surface area of fiords and lakes is excluded. The nesting density of the active, young-producing peregrine eyries (7) was about 1 pair per 100 sq. mi. (260 sq. km.). Large portions of the area were gently rolling and had no cliffs, and were therefore unsuitable habitat for peregrine requirements.

At the 3 gyrfalcon (*Falco rusticolus*) eyries we found 8 nestlings or fully-fledged young, of which we were able to band 3. Peregrines and gyrfalcons (and a rare white-tailed sea eagle, *Haliaetus albicilla*) are the only avian predators nesting in southern West Greenland, although ravens (*Corvus corax*) competed for some nesting cliff sites.

We collected remains of prey species and pellets at each falcon eyrie. Addled eggs (2) from 2 peregrine eyries were collected for pesticide analysis. Eggshell fragments for thickness determination were gathered at 5 peregrine eyries.

To preclude the possibility of disturbing the parents and causing egg cooling before the eggs had hatched, we purposely did not attempt to locate the exact eyrie site early in the nesting season. At 2 eyries, however, we located the eyrie to determine the number of eggs laid, which in each case was 4.

PRELIMINARY CONCLUSIONS

Peregrine falcons in West Greenland appear to be in a healthy state as evidenced by a high nesting density (1/100 sq. mi.) and a high production rate (2.25/eyrie), especially in light of the unusually severe conditions in West Greenland during the winter and late spring of 1971-72.

We found little interspecific competition for prey species between peregrines and gyrfalcons. The gyrfalcon is already nesting in West Greenland before the peregrines arrive from their winter migration to the south. The gyrfalcons could therefore be expected to be aggressive in defence of their nesting cliffs and thereby occupy optimal cliffs. Despite this, all the peregrines we studied occupied high, sheer, and quite optimal nesting cliffs. Gyrfalcons seemed to prefer a nesting site lower down on a cliff face than peregrines, and both falcons preferred high, sheer cliffs with a southern exposure. Ravens were relegated to lower, less desirable (more accessible) cliffs for nesting.

We await pesticide analysis of the peregrine falcon eggs and prey species collected, as well as eggshell thickness determination. Before these facts are determined we can say nothing definite about the status of peregrines in Greenland. Nesting density and production, however, suggest that the status of the peregrine is better in Greenland than in other areas of the north.

FUTURE RESEARCH NEEDS

Research on peregrine falcons in Greenland in the future should be concentrated on obtaining more observations from coastal areas, in addition to re-surveying and expanding upon the 1972 survey area. A survey might also be made of traditional nesting sites scattered along the west coast as record-

ed in the literature. Both a resurvey of the 1972 sample area and visiting historic nesting cliffs to determine current occupancy would provide a good indication of the present status of peregrines in West Greenland. Also required is a larger sampling of falcon eggs and prey species (and perhaps fat biopsies of the adult falcons) for pesticide analysis. This should be done for both peregrines and gyrfalcons. A time-lapse photographic study of several eyries, as developed by Enderson *et al.*[10], would be desirable if conducted in conjunction with detailed observations by skilled observers from a blind.

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