STUDIES ON CENTRAL BAFFIN VEGETATION
I. BRAY ISLAND *)

(with 6 figures and 3 tables)

by

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Arctic vegetation poses many problems and its study will certainly reveal much that is pertinent to the central issues of community ecology. For instance, there is considerable controversy at this time on the *reality* of the plant association and on the universal applicability of the climatic climax concept. If the view is taken, and if observation shows, that no two species coincide in their adjustment to one or more environmental elements, and these have different optimal "peaks", then it is argued that a *continuum* exists rather than a series of truly discontinuous communities (CURTIS and MCINTOSH 1951). If the floristic cohesion of the community is disputed, it follows that any linear or convergent arrangement of synecological units is also contestable. Moreover, as far as Arctic conditions are concerned, there is some doubt as to whether the dynamic equilibrium which is postulated for climatic climaxes is at all possible, since the soil never "settles down" as it apparently does in cool temperate regions (RAUP 1950).

In fact, the dynamics of the analogous alpine vegetation (where permafrost is not involved) which were outlined many years ago by BRAUN-BLANQUET (1932) are also contested by DAHL (1953).

Since ecological field studies provide new data and suggest new interpretations, it is their first function to convey as clear and as complete a picture as possible of the situation as it has been observed. There is such a variety of methods and approaches, and these are so often poorly defined, that abundant material for comparison is not always available. I hope in this series of papers to present a faithful record of my observations in the field and to lay down my findings in a way that can be relevant to those who do not share my point of view or accept my interpretaitons. When I have brought forth and tabulated the materials I have to offer, I intend to make comparisons with other areas and to discuss the two questions stated above: the *cohesion of the association,* and the *processes of succession.*

The present studies were made from May to September 1950, when I was a member of the BAIRD Expedition to Central Baffin Island. A general preliminary account has been published (BAIRD et al. 1950, BAIRD 1951, BAIRD 1952), as well as several partial reports (GOLDTHWAIT 1951; LITTLEWOOD 1952; ORVIG 1952; WARD and BAIRD 1952; WYNNE-EDWARDS 1952). I am much indebted to Col. P. D. BAIRD for his able leadership of the expedition and for providing the necessary transportation and other facilities for work. I also thank the National Research Council of Canada for its support in engaging Mr. MASON HALE as an assistant and in contributing to our travelling expenses. Finally I owe a great deal to the Provincial Secretariat of the Province of Quebec in whose employ I was at that time as director of the Service de Biogéographie. The latter institution furnished most of the field materials and later

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Professor William C. STEERE (Stanford University) has kindly named the Bryophyta; Mr. Marcel RAYMOND (Montreal Botanical Garden) gave me much help in the identification of the vascular plants, especially the Cyperaceae; Dr. Th. SORENSEN (Copenhagen) determined some of the Gramineae; Mr. Mason E. HALE, Jr., (University of Wichita, Kansas), who was my companion in the field, identified the lichens, and Dr. Carleton BALL (Washington), the willows.

This first paper describes the vegetation of Bray Island, some 6 miles off the west coast of Baffin Island, in Foxe Basin. A brief landing was made on the eastern side, at Lat. 69° 23″ North and Long. 76° 36″ West, on August 9th and 10th, 1950, in the company of Col. P. D. BAIRD and Dr. Richard P. GOLDTHWAIT. Our Norseman plane was operated by Maurice KING, the expedition's pilot who so tragically died the following summer in Alaska and to whom we owe a real tribute for his courage, his consummate ability, as well as his patience and understanding of our objectives.

THE PHYSICAL ENVIRONMENT.

Bray Island consists of a very low-lying network of Paleozoic limestone schists and gravel which extends over 22 by 17 miles. Some of the ridges are straight, but most of them are curved (see Figure 1). They reach out to sea in tapering tongues and are shaped into somewhat steep gravelly shores or attenuated into extensive marl flats on which large boulders are stranded. A few strips of sandy beach have formed above the marl in some places.

Fig. 1. An aerial view of Bray Island showing the network of low ridges enclosing freshwater lakes and marshland.

The ridges curve and transect one another in such a way as to block the drainage outlet and many freshwater pools have formed, some of them a hundred feet and more in diameter but all quite shallow. The pools are commonly circled by marshes and indeed many of the undrained interior areas have no open water at all.

Fig. 2. A closer view of the strand where field work was done. Enclosed ponds can be seen, surrounded by marsh vegetation. I n the background salt marsh is abundantly developed in a shallow bay.

As seen from the air (Figures 1 and 2), the habitats and the plant communities that occupy them are in rather sharp contrast to one another (see generalized sketch in Figure 3). The apparently bare gravel is a pinkish gray, the sandy beaches are almost white, while the marly salt flats are quite red with goose-grass *(Puccinellia)* and the inland marshes a greenish yellow *(Carex, Dupontia* and mosses). The inextensive heaths are brown, flecked with conspicuous patches of snow lichen *(Cetraria nivalis)*. The ponds are scattered steely blue medallions.

The birds are extremely abundant in mid-August and very active: mostly Arctic terns, plovers, ducks and jaegers. A blue fox was also seen.

It would seem that the emergence of Bray Island as a whole is quite recent, in the order of about 100 years according to R. P. GOLDTHWAIT. Evidence of rather recent land movement was seen in an Eskimo stone igloo which was somewhat slumped on the edge of a terrace occupying what seemed to be the highest point (about 25 feet above sea level). A very swift current runs between the Baffin coast and Bray Island (a distance of 6 miles). Nevertheless this expanse freezes over in the winter and allows migration of animals and men, as witness the presence of the blue fox and of the Eskimo stone construction.

The tide is a fairly strong one and with the aid of the wind, salt spray can probably reach any part of the island.

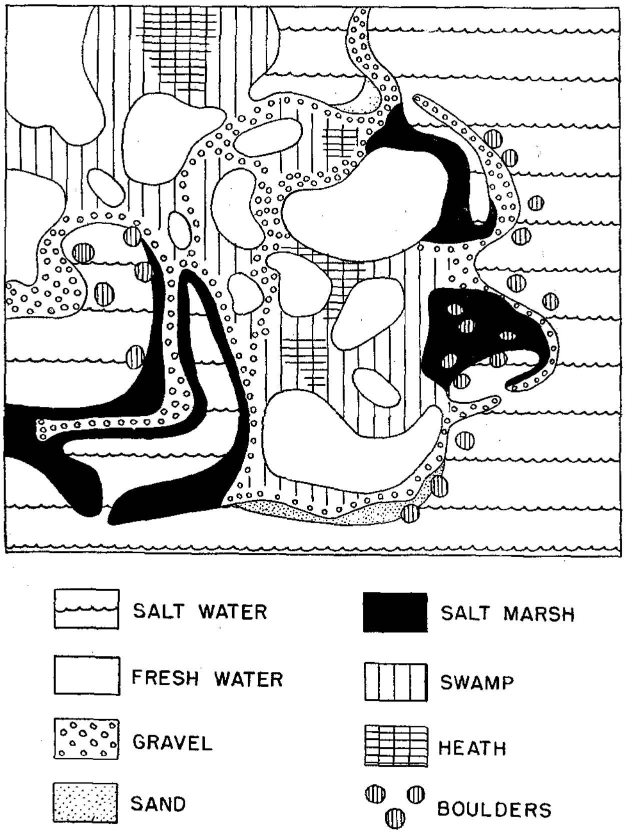

Fig. 3. A generalized sketch of habitats on Bray Island.

THE CHARACTER OF THE FLORA.

Table I gives a list of the plant species observed and collected on Bray Island. Algae and Fungi, unfortunately are not recorded and were not collected. The total number of Lichens and Bryophytes is no doubt greater than the present list. The vascular plant catalog, however, is more nearly complete. Some plants that abound and are of considerable ecological prominence on the mainland are conspicuously absent here, such as *Cassiope tetragona, Luzula confusa, Empetrum nigrum, Oxyria digyna, Vaccinium uliginosum* var. *alpinum, Salix herbacea, Hierochloe alpina, Polygonum viviparum.*

In fact the neighbouring mainland (e.g. at Lake Gillian) even harbours quite a few species that are absent from the fiordland east of the Barnes Ice Cap, such as *Oxytropis maydelliana, Astragalus alpinus, Arctostaphylos alpina.* The latter species belongs to a Low Arctic flora as do several other plants of the mainland: *Salix cordifolia, Trisetum spicatum.* The general character of the vegetation around Lake Gillian suggests rather favourable conditions, as the development of heath is fairly extensive. It would therefore appear that the poor vascular flora and undeveloped vegetation on Bray Island are not primarily due to unavailability of flora.

Most of the species present here are very widespread in both the High and the Low Arctic and also occur in alpine situations: *Equisetum variegatum, Cerastium* *alpinum, Lychnis apetala, Papaver radicatum, Saxifraga caespitosa, Saxifraga cernua, Saxifraga hirculus, Saxifraga oppositifolia, Saxifraga tricuspidata, Stellaria laeta, Alopecurus alpinus, Carex atrofusca, Eriophorum scheuchzeri, Draba alpina.*

Only three species are limited to Greenland and North America: *Dryas integrifolia, Salix anglorum* and *Saxifraga tricuspidata.*

Some of these extend into temperate areas even at low altitudes (for instance in the Gulf of St. Lawrence): *Cerastium alpinum, Dryas integrifolia, Saxifraga caespitosa, Saxifraga oppositifolia, Stellaria laeta, Eriophorum scheuchzeri.*

Another group consists of more or less strictly coastal species: *Cochlearia groenlandica, Mertensia maritima, Montia lamprosperma, Stellaria humifusa, Puccinellia phryganodes.*

A small group belongs to a well-knit High Arctic category: *Pedicularis hirsuta, Dupontia fisheri, Draba bellii, Pleuropogon sabinei, Poa abbreviata.* [1])

The ecological amplitude and the role played by the vascular species in various habitats is shown in Table II. It will be seen that 18 out of 32 species rate as common, abundant or dominant in at least one of the vegetation belts. On the other hand, 14 have been recorded in only one belt, and 13 in two belts, exhibiting very low amplitude, in contrast to one *(Eriophorum scheuchzeri)* which extends through four belts and 4 that are found in three belts.

The ecological conditions that prevail in each one of these are in sufficient contrast to provide a measure of the meaning of these amplitudes.

THE HABITATS AND COMMUNITIES.

A generalized transect is drawn in Figure 6 to show the range of habitats on Bray Island and to situate the communities that occupy them.

Salt marsh.

The intertidal strip has a depth of several feet and extensive marl flats are uncovered by the receding waters. The marl is studded with coarser schistose fragments and strewn with boulders, some of which are very large (several feet high). Much of this is sterile as the waves wash the thin sediment back and forth. It becomes enriched, however with uprooted and floating Algae.

Large expanses, especially in the sheltering coves and bays, are dominated by a goose-grass *(Puccinellia phryganodes)* which propagates vegetatively with great strength, throwing up stiff rosettes of reddish leaves from its short rhizomes. This occasionally dense, close carpet is frequently torn by the tides and scraped off by rolling boulders and no doubt most efficiently of all by rasping ice, either stranded floes or formed *in situ* (Figure 6B).

At the upper edge of the marsh, individual rosettes or colonies of *Cochlearia groenlandica* occur and also the meshes of *Stellaria humifusa,* its flowers half-hidden in the browning foliage.

Sandy beach.

There appears to be little sandy beach formation on Bray Island, as the tidal waters mostly wash up against a completely bare schistose crest or else flow thinly over the marl flats described above. However, a few shallow sand deposits do occur. Practically the only plant to be found is the oysterleaf *(Mertensia maritima),* which attains normal proportions, flowers and fruits well (Figure 6C). *Honckenya peploides,* so abundant on the East Baffin Coast, was not seen here.

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[1]) Maps showing the distribution type of *Equisetum variegatum, Alopecurus alpinus, Eriophorum scheuchzeri, Stellaria humifusa, Saxifraga hirculus, Saxifraga tricuspidata, Dryas integrifolia, Pleuropogon sabinei, Poa abbreviata, Pedicularis hirsuta,* will be found in PORSILD 1951.

Schist ridges.

On the crests that form the network of this rambling island, a somewhat unusual vegetation prevails. Figures 4, 5 and 6 show two belts.

Fig. 4. The top of a strand with scattered cushions of *Saxifraga caespitosa* and *S. tricuspidata* on the coarse limestone gravel. In the background, the Baffin mainland.

Fig. 5. In the foreground, the strand (as in Fig. 3). In the background, extensive marshland and small bodies of freshwater.

In D, of Figure 6 and in the middle ground of Figure 5, the level is lower, the surface flatter. The schists themselves consist of angular fragments, many of them needle-like and about 2—5 cm long, others rather flat. There is no sand.

These surfaces are somewhat consolidated by large flat patches of *Saxifraga oppositifolia* whose much ramified stems retain the dead growth of many past years and hold moisture at soil level. This usual pattern of High Arctic "*Saxifraga* barren"

(POLUNIN 1948) presents here an unusual variant in that *Saxifraga caespitosa* also occurs in dense patches as much as 25 cm in diameter instead of in the single rosette or disconnected rosettes which are its usual habit.

A few other species are scattered frequently throughout in isolated patches or tufts: *Stellaria humifusa, Cerastium alpinum, Poa abbreviata, Caloplaca elegans* (only on the larger stones). Others, even less conspicuous are: *Draba alpina, Draba bellii, Lychnis apetala, Cochlearia groenlandica, Polytrichum piliferum* and *Cetraria tilesii.* This latter, a bright lemon-yellow lichen, in Central Baffin appears to be a most reliable indicator of limestone (HALE 1954).

The more or less gently domed top of the ridge (as illustrated in Figure 4, in the foreground of Figure 5 and in E of Figure 6) was vegetated more densely and in such a geometrically coherent pattern as to suggest the kind of water utilization that prevails in the creosote-bush desert.

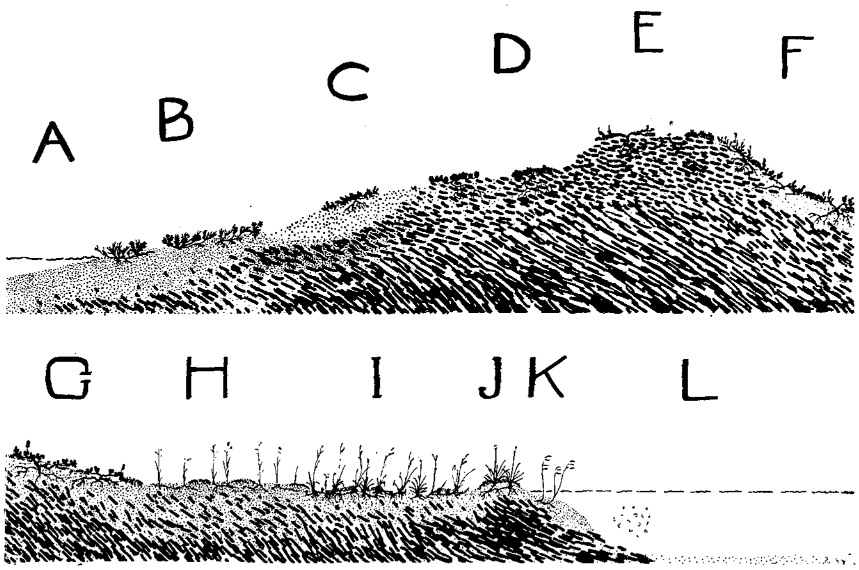

Fig. 6. A generalized transect showing the belts of vegetation on Bray Island. (A) Below low-tide. (B) Intertidal marsh with *Puccinellia.* (C) Sandy beach with *Mertensia.* (D) Schist and gravel flat with *Saxifraga caespitosa* and *S. oppositifolia.* (E) Schist and gravel dome with *Saxifraga oppositifolia* and *S. tricuspidata.* (F) *Dryas* and *Salix* heath. (G) Mossy *Salix* heath. (H) *Dupontia* wet meadow. (I) *Carex salina* mossy meadow. (J) *Eriophorum scheuchzeri* strips. (K) *Pleuropogon sabinei* border. (L) Freshwater pond.

The flat, more or less round clumps of *Saxifraga tricuspidata* and *Saxifraga oppositifolia* were more or less uniformly about 10—25 cm across and spaced about 30—50 cm apart. The soil here consisted of crude gravel but some organic material was present under the patches of vegetation.

Both saxifrages were past flower but had not yet matured their fruit. The 1950 leaves of *S. tricuspidata* were developed, whereas those of *S. oppositifolia* were not yet quite expanded.

Other species (none of them at all abundant) were: *Papaver radicatum* (in flower), *Poa* sp. (probably *arctica,* with immature seed and very few 1950 leaves), *Stellaria laeta* and *Lychnis apetala* (both past flowering). Also present but quite insignificant were: *Polytrichum* sp., *Candelariella* sp., *Stereocaulon* sp., and the yellow *Cetraria tilesii.*

Heaths.

On the lee of the ridges (positions F and G of Figure 6) two belts can be distinguished.

On the higher ground, where the soil appeared to be better drained (Figure 6F), the best-developed vegetation on the island occurred. The upper layer, some 7 cm high, had a coverage of about 40 % mostly of *Dryas integrifolia* and *Salix anglorum,* with a thin scattering of *Pedicularis hirsuta, Carex atrofusca,* a few depauperate shreds of *Saxifraga oppositifolia.* The lower layer, (1 cm and less) consisted almost entirely of mosses, mostly *Aulacomnium palustre* forming a resilient greenish carpet on top of which *Thamnolia vermicularis* threaded thinly through larger patches of *Cetraria delisei* and *Cetraria nivalis.* The latter was conspicuous enough in its ivory-white colour to be seen from the air.

It cannot be said that peat was forming on this site, although the upper 5 cm were black with organic material. This somewhat homogeneous crust rested directly, and without transition on a bed of crude schists.

In the lower-lying area, (Figure 6G), the depth of organic accumulation was greater and the drainage lesser. For this reason, apparently, *Dryas* was not present and *Salix* dominated the upper 5 cm, its trailing, leafy branches covering about 25 % of the surfaces. No other large Phanerogams were present, only the thin rosettes and frail stems of *Saxifraga cernua* and *S. hirculus* (both flowering), and the decumbent *Stellaria laeta.* The latter hardly rose above the mossy cushions that made up some 60 % of the ground cover, again mostly *Aulacomnium palustre,* with *Pohlia nutans, Brachythecium turgidum, Tomenthypnum nitens.* On top of these, again a substantial growth of *Cetraria nivalis,* some *Thanmolia vermicularis* and a number of white, powdery, crustose lichens *(Lecidea? Pertusaria?)* epiphytic on the drying edges of the moss polsters.

Marsh.

Flat, undrained tracts were quite extensive (Figure 6H), and commonly a thin film of water reached the soil surface. Mostly a discontinuous growth of flattened mosses shielded the gray marl. Some organic matter was always present near the surface. *Aulacomnium palustre* and *Tomenthypnum nitens* were by far the most abundant Bryophytes. They were penetrated by a good deal of *Mnium affine* and *Brachythecium turgidum* and minor quantities of *Myurella julacea, Ditrichum flexicaule,* and *Pohlia nutans.* The small, creeping, leptophyll *Chrysosplenium tetrandrum,* the rosettes of *Saxifraga cernua* and *S. hirculus* and *Cardamine pratensis* hardly emerged from the mosses or lay flattened on the marl itself.

The extremely open upper layer consisted entirely of graminoids that hardly attained more than 30 cm. The most robust was *Eriophorum scheuchzeri* of which only a few clumps occurred. There was also some *Alopecurus alpinus,* especially on the bare ground. But the dominant was *Dupontia fisheri.*[1]) This poorly developed, always yellowish grass sent up innumerable, thin flowering culms, regularly spaced. The slowness and poorness of its growth contributed little organic increment to the soil.

The colonizing power and soil-building capacity of *Carex salina,* on the other hand, which dominated the next belt (Figure 6 I) were much greater. There the organic deposit was deeper, the water level higher (and more constant?). *Carex aquatilis* var. *stans* and *Hierochloe pauciflora* were quite conspicuously associated with *Carex salina.* Also present were *Eriophorum scheuchzeri, Carex atrofusca* and a few colonies of *Equisetum variegatum.*

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[1]) This seems to be the high-arctic type and not var. *psilosantha.*

Again the mosses mentioned above formed a rather dense growth, somewhat more continuous than under the *Dupontia* and with a tendency to build hummocks. The saxifrages *(S. cernua* and *S. hirculus)*, were scattered throughout, and also *Montia lamprosperma* and *Chrysosplenium tetrandrum.*

These two marsh communities, the *Dupontia* association and the *Carex salina* association occupied much of the surface of the island, the former showing broad yellow flats or thin yellow strips, and the latter brownish-green patches.

Nowhere did either *Equisetum variegatum* or *Eriophorum scheuchzeri* actually dominate, although they tended to be more conspicuous on the edges of pools or ponds (Figure 6 J).

Ponds and rivulets.

Some of the ponds were fairly large (see Figure 1). They were literally teeming with populations of Copepods, and Cladocerans at least of three different species. Many ducks were seen swimming on the ponds. Blue-green and Green Algae were present, but were not collected.

In many places the *Carex salina* belt extended to the very water's edge. It did not tend to form a mat, however. In fact it was sharply abraded by the ice.

Where the shore of a pond was gravelly, and also on the few rivulets that ran out of the ponds down to marsh or sea, a thin line of *Pleuropogon sabinei* would sometimes form (Figure 6 K).

TABLE III. LIFE-FORM SPECTRUM OF VASCULAR PLANTS ON BRAY ISLAND COMPARED TO THAT OF THE WHOLE EASTERN ARCTIC AND TO THE "NORMAL".

AREA	Total Spp.	Ph	Ch	H	G	Th
World (Raunkiaer)	1000	46.0	9.0	26.0	6.0	13.0
Canadian Eastern Arctic (Desmarais)	297	—	26.3	59.9	14.8	2.0
Bray Island	32	—	18.8	71.8	9.4	—

DYNAMICS OF THE VEGETATION.

There has been little time for Bray Island to develop its present plant cover. The flora is extremely poor, the number of distinct communities quite restricted also. If Figure 6 outlines the whole picture, there are less than 10 different vegetation types. In fact J and K are hardly independant belts and almost certainly D—E, F—G and H—I are in each case an early and a late phase of the same thing.

Actually, this linear transect hardly accounts for all possible contacts between different communities. Brackish flats occur where *Puccinellia* (B) and *Dupontia* (H) come together; and no doubt further silting favours a progression from the one to the other, thence to *Carex* (I). On the other hand, there are transitions from *Carex* (I) to *Salix* (G) and to *Dryas* (F). Several trends in succession are thus indicated.

In the xeroserre, progression would involve an encroachment of the willows (G) directly upon the bare sand (C) or on the saxifrage barrens (D and E), as so commonly happens throughout Central Baffin.

A distinction can be made between the progresses in succession which are *allogenic* and those which are *autogenic* (see TANSLEY 1949). In the former case, replacement of one community by another is conditioned by a process, such as silting, not primarily involving the plants themselves, whereas in the latter (accumulation of organic materials for instance) the plants are responsible for important physicochemical changes.

It is evident that much arctic (and alpine) vegetation is so keyed to allogenic change as to be almost static, since geomorphic transformations are extremely slow. Such rapid allogenic succession as that pictured by ALLEE et al. (1949, Fig. 206) would be hard to find. For this reason DAHL (1953) chooses to consider almost all plant communities in the mountains of Scandinavia as "climax".

Whatever view one takes of this situation and however one decides to codify them in the nomenclature of communities, allogenic stages are certainly less clearly related than autogenic ones.

On Bray Island, some autogenic sequences can be traced, as indicated above. The most striking no doubt are the *Eriophorum* to *Carex* and the *Salix* to *Dryas* steps, where the accumulation of organic material, or its incorporation into the marl or schists and the raising of the level thereby are largely due to plant growth.

One last observation must be made concerning organic increment in the soils. The tides wash up impressive quantities of large marine Algae. These are stranded at the upper tide level, dry very readily and are blown inland to be deposited on the surface of all the plant communities. Although their contribution to the "improvement" of the saxifrage barrens is doubtful, their role in the soil-building of the *Dupontia, Carex, Salix* and *Dryas* communities is certainly not negligible. Therefore, the apparently autogenic changes in these associations are conceivably hastened by an allogenic factor. The marine algal contribution to the teeming animal life of the ponds is also potentially an important one.

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