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# Soil-vegetation relationships on a cobbly limestone floodplain, Anticosti Island, Quebec

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Abstract

The limestone floodplain of the Galiote River, Anticosti Island (Quebec) is occupied by 4 shrub associations: *Dryadetum drummondi* (37%), *Juniperetum horizontalis* (15%), *Dryadetum integrifoliae* (4%) and *Potentilletum fruticosae* (3%) as well as by 6 less important communities, primarily herbaceous. Four new subassociations are presented: *D. d. dryadetosum drummondii, D. d. danthonietosum spicatae, D. i. juniperetosum horizontalis* and *J. h. dryadetosum integrifoliae*. The vegetation colonizes soil representative of the Regosolic, Brunisolic and Gleysolic orders, composed of calcareous material at pH greater than 7 with a base saturation capacity of more than 100%. These soils are first colonized by pioneer plants such as *Dryas*, which stabilize the substrate thus facilitating the establishment of a less specialized vegetation and leading finally to forest development. This succession follows a topographical gradient that runs from the river to the forest; the river being the principle element determining the distribution of the described plant communities.

*Key words: calcareous soils, plant communities, Dryas, cobbly floodplain, Anticosti*

## INTRODUCTION

Situated in the Gulf of St. Lawrence (Fig. 1) Anticosti Island is 222 km long at an altitude of 313 m. Geomorphologically the island is a cuesta inclined toward the SW (Painchaud et al. 1984). The substratum is mainly composed of Silurian and mid Ordovician limestone (Petryk 1981). The vegation belongs to, the balsam fir-white spruce (*Piceo glaucae-Abietetum balsameae*) climax domain characteristic of the cold maritime climate predominant in the Gulf (Grandtner 1979).

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Botanical explorations of the island at the beginning of the 19th Century but it was the study by Marie-Victorin and Rolland-Germain (1969) which describes for the first time a characteristic allochthonous flora on the alluvial floodplains. This flora, a remnant of post-glaciation (Morisset 1974), presents interesting questions for plant geographers. As it has never been examined from the point of view of plant ecology, a study of the

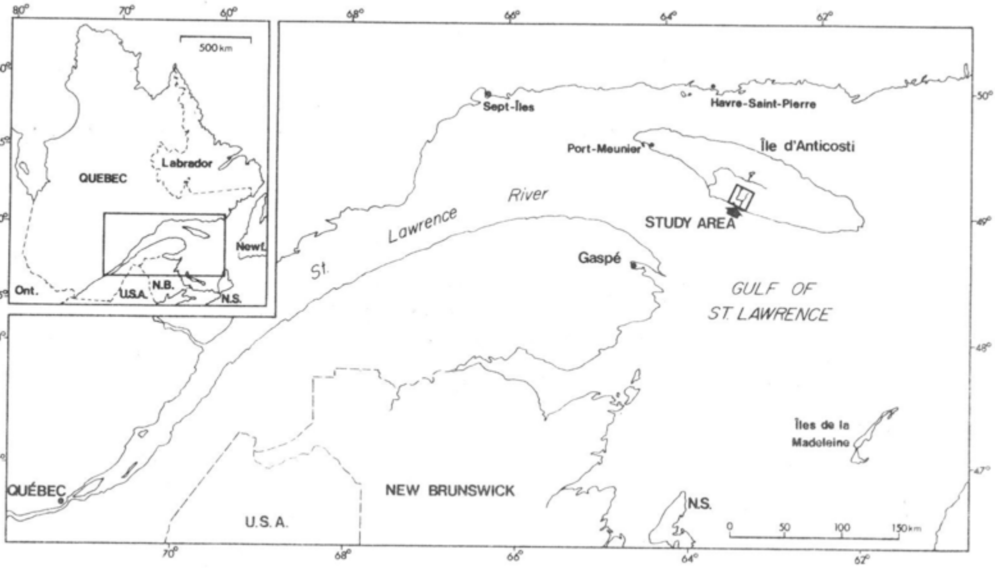


Fig. 1. Geographical location of the study area, Anticosti Island

region was undertaken during the summer of 1981. After referring to Marie-Victorin and Rolland-Germain (1969) and consulting with Guillemette (pers. comm., 1980), the alluvial plain of the Galiote River, situated on the south coast of the island was chosen as the study site. This paper reports on the vegetation and the consequent relationships with the soil.

## METHODS

### VEGETATION STUDY

Twenty transects, spaced at 1 km intervals perpendicular to the river, were sampled. Twenty-nine of the 35 total phytosociological releves were made in the zones delimited by the transects whereas the other 6 were taken from areas between the transects. In most cases the sample plots were 4m × 4m.

In each sample plot as well as each canopy layer sensu Payette and Gauthier (1972), the species abondance-dominance and sociability was determined using the Braun-Blanquet (1932) scale slightly modified by Grandtner (1974). In cases where less than 5 releves were available, the term plant community was employed.

All the vascular and non-vascular plants collected in or in the vicinity of the sample plots were deposited in the QEF Herbarium (Laboratoire d'écologie forestière de l'Université Laval in Québec).

Scientific nomenclature of the vascular plants follows Scoggan (1978--1979) with the exception of the following taxons: *Calamagrostis stricta* (Timm) Koeler, *Scirpus pumilus* Vahl. var. *rollandii* (Fern.) Beetle, *Antennaria gaspensis* Fern., *Castilleja septentrionalis* (Lindl.) Gray, *Festuca vivipara* (L.)SM., *Viola pallens* (Banks) Brainerd and *Achillea nigrescens* Rydb. In the following cases identification was made only to species level: *Senecio pauperculus* and *Solidago spathulata*. The scientific nomenclature for the mosses conforms with Ireland et al. (1980) while that for the liverworts follows Schuster (1974). Scientific names for the lichnes are from Hale and Culberson (1970) with the exception of *Polyblastia gelatinosa* Th. Fr., *Caloplaca leucoraea* (Ach.) Deichn., *Psora crenata* (Th. Tayl.) Reinke and *Catapyrenium lachneum* (Ach.) R. Sant. These latter two taxons were collected in addition to the releves.

## SOIL STUDY

A pedon was dug in nearly all the sample plots. As a consequence of the cobbly nature of the sediment and the textural uniformity of the Ck horizon the mean depth of the pedon was less than 1m. Data from each horizon was collected for each of the following categories: depth thickness colour (Munsell colour chart 1973), texture, structure stoniness and roots (Bernier and Carrier 1973). The drainage class (C.P.P. 1978) was also determined. The samples were air-dried, sifted to 2 mm and the following criteria were analyzed according to methods cited in Laflamme (1981): pH measured by potentiometer, $\%C$ and $\%N$, (Kjeldahl 1958, Walkley and Black 1934), organic matter (ash), exchangeable cations and the cation exchange capacity (Schollenberger and Simon 1945), phosphorous (Truog et al. 1930) and the granulometry (Bouyoucos 1936). In the brunisolic horizons the percentage Fe and Al was determined using atomic absorption spectrophotometry.

Analysis was carried out on 51 of the 69 collected samples. Humus classification follows Bernier (1968) while the soils were classified according to the Canadian system (C.P.P. 1978).

## SOIL

The three soil orders regosolic, brunisolic and gleysolic were recognized in the study area.

### REGOSOLIC ORDER

Regosolic soils, mainly represented by orthic regosol, cover nearly 80% of the area. The surface of orthic regosol (Fig. 2a) is covered by a thin (mean thickness 1 cm) and discontinuous calcic xeromor, reflecting the xeric conditions of the environment. This surface layer is often reduced to a single L horizon. The limits of the subjacent horizons, composed of cobbly material (mean diameter 10 cm) are not easily distinguished. This soil is typified by the thin Ahk horizon (0-10 cm) where the vegetation becomes rooted. The next horizon (Ck) is thicker with a coarser texture and has little influence on the development of the vegetation as the roots generally reach this level only when the Ahk horizon is absent. The nutrient level in the mineral horizons of this soil are relatively low except for Ca which is found in quantities greater than 25 meq per 100 g. In general, the Ahk horizon has slightly higher nutrient content values than the Ck horizon, with the exception of pH which is practically identical (7.7 vs 7.5). As both horizons have little organic matter (Ahk 2.25%, Ck 0.63%) and the quantity of N is negligible (Ahk 0.09%, Ck 0.03%), the C/N is small (Ahk 15, Ck 14). The cation exchange capacity (Ahk 6.85 meq per 100 g, Ck 3.27 meq per 100 g) and the available P (7 ppm) are relatively low.

In the cumulic regosol (Fig. 2b), there is no surface organic matter and the horizons are clearly delimited. The accumulated thickness of the Ahk horizon varies from 1 to 5 cm. The profile is distinguished by the alternation of the Ahk and Ck horizons. In the latter the thickness may vary from 2 to 20 cm and includes a considerable percentage of

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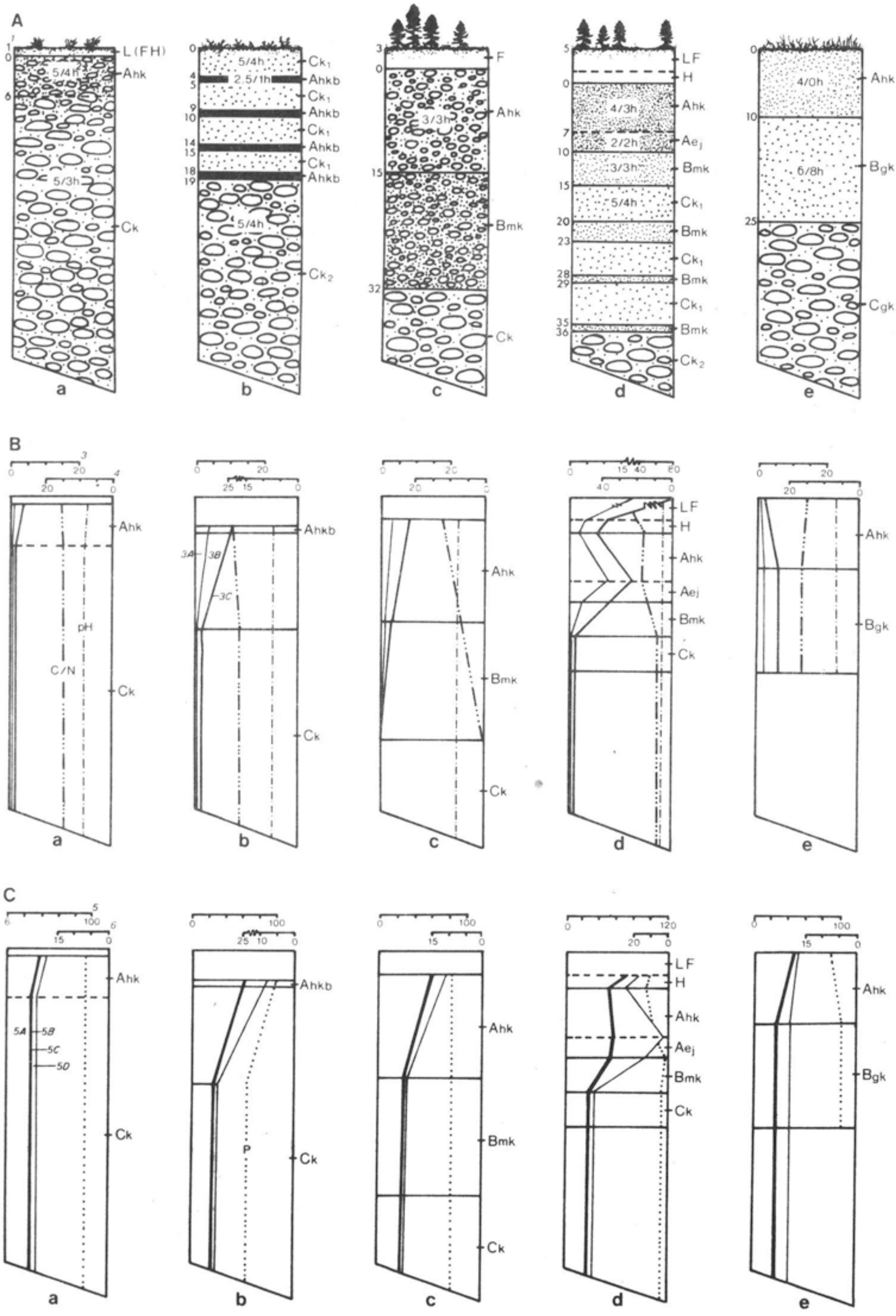
Fig. 2. Morphological (A), physical-chemical (B) and nutritional (C) characteristics of the principle soils of the alluvial plain of the Galiote River, Anticosti Island: orthic regosol (a), cumulic regosol (b), orthic melanic brunisol (c), eluviated eutric brunisol (d) and orthic humic gleysol (e). 1. Horizon depth in cm. 2. Soil colour: luminosity and humid saturation, constant shade (10 yr), except 5 yr for the Ahkb horizon (profile b) and 7.5 yr for the Ahk horizon (profile e). 3. % carbon (3A), % organic matter (3B), % nitrogen (3C). 4. pH and C/N. 5. meq per 100 g for the following ions Ca (5A), Mg (5B), K (5C) and cation exchange capacity (5D). 6. Phosphorus (ppm)


A
L(FH)
Ahk
Ck
5/4h
5/3h
Ck₁
Ahkb
Ck₂
2.5/1h
5/4h
F
Bmk
3/3h
LF
H
Ae_j
4/3h
2/2h
3/3h
5/4h
Bgk
Cgk
4/0h
6/8h
a
b
c
d
e
B
pH
C/N
3A
3B
3C
C
5A
5B
5C
5D
P

sand. In the cumulic regosol, a fine layer of sediment (Ahk and Ck) rests on a deep cobbly Ck horizon, resembling the Ck horizon in the orthic regosol. The percentage C in the Ahk horizon is higher than in the preceeding soil (3.96) while that of N is roughly the same (0.19). This, consequently, results in a higher C/N (24). With regard to nutrients, the C.E.C. in the Ahk horizon is significantly higher (23.13 meq per 100 g) as is the P in the Ck horizon (23 ppm).

Orthic humic regosol and cumulic humic regosol are the subgroups found in the humic regosol. As the results for the morphology and physical and chemical characteristics are similar to the preceeding subgroups, they are not included in Fig. 2. The humic regosol is distinguished by a thick Ahk horizon (10 to 40 cm). In contrast to the cumulic regosol, in the cumulic humic regosol there is an alternation of gravelly Ck horizons in the entire profile.

## BRUNISOLIC ORDER

The brunisols cover only 5% of the floodplain. The subgroup orthic melanic brunisol was encountered twice eutric eluviated brunisol was observed on only one occasion.

The orthic melanic brunisol (Fig. 2c) is covered by a calcareous mor type humus, thicker than that of the preceeding soil, formed of decomposing plant material. The thickness of the Ahk horizon varies from 15 to 17 cm. In these layers of fine deposits, plants are deeply rooted above a gravelly Ck horizon. The Bmk horizon (mean thickness 17 cm) is not rich in organic matter (1.23%vs5.11%in Ahk). The cation exchange capacity (3.0 meq per 100 g) is also lower than that in the Ahk horizon (17.7 meq per 100 g). There is a slight augmentation in K in the surficial mineral horizon (0.61 meq per 100 g).

The formation of the eluviated eutric brunisol (Fig. 2d) is the result of an early pedogenicprocess. The surface is characterized by the presence of three distinct organic horizons (L, F, H) with a total thickness of 5 cm, in which the vegetation is deeply rooted. The mineral horizons are clearly delimited, without gravel. The thin and discontinuous Aej horizon, slightly eluviated, develops under the Ahk horizon. Due to the large quantity of organic matter (19.39%), this latter horizon is described as young. The slight loss of carbonate at the surface is responsible for the minor increase in pH with depth (7.1 to 7.6). The increased C/N in the humic horizons (L, F 57, H 23) are the result of a weak mineralization. However, in the Aej horizons, poor in N (0.64%), the C/N is relatively low (18). The high C.E.C. of the Aej (60.6 meq per 100 g) and Bmk (43.0 meq per 100 g) indicates that humic colloids are abundant in these horizons. This latter horizons is low in Fe (0.08%) and Al (0.03%). In addition, the quantily of P in the soil is inversely proportional to that of Ca.

### GLEYSOLIC ORDER

Along the edge of the river, in the zone where the water table is shallow (30 cm), an orthic humic gleysol develops. In this soil (Fig. 2e), poor in organic matter, the vegetation is rooted in the Ahk horizon. The Bgk horizon shows traces of gleyification. In this horizon, rich in organic matter (3.48%), there is consequently an augmentation in C.E.C. (13.7 meq per 100 g). The cobbly Ck horizon is water saturated.

## VEGETATION

The cobbly terraces of the Galiote River are covered with a sparse shrub and herb vegetation, subarctic or arctic in physiognomic character. An essentially xeric environment, these terraces are colonized by pioneer species such as *Dryas drummondii* and *Dryas integrifolia*. Woody species are rare in this environment and when present are usually prostrate. Mosses and lichnes grow predominately along the edge of the forest. Closer to the river, they form small colonies.

Four plant associations and 4 subassociations were recognized. The floristic composition appears in Table 1, where the units are ordered in function of increasing floristic richness. Additional releves were carried out in 5 less important communities and are described later in the text.

### DRUMMONDS MOUNTAIN AVENS ASSOCIATION
*DRYADETUM DRUMMONDII* DANSEREAU 1959
Table 1, Col. 1, 2

*Dryas drummondii* is dominant in this association forming a discontinuous low shrub layer (52% of mean cover). *Picea glauca* f. *parva* is present in 90% of the releves, growing in proximity to the circular *Dryas* colonies. This species is solitary with a mean height not exceeding 15 cm. Approximately 20% of the soil is covered by the low herbaceous layer, characterized by the presence of species representative of Group 1 (Table 1) such as *Senecio pauperculus*, *Campanula rotundifolia* and *Solidago spathulata*. Although it is not extensive, the moss layer includes several species, *Tortella tortuosa* being the most frequent. The mean abundance-dominance coefficient for the mosses is low and their distribution is sporadic and irregular. Lichens are not present.

*D. drummondii* grows on a well drained orthic regosol. This is a pioneer association occupying recent alluvial deposits, and covers nearly 37% of the area studied. It should be noted that 25% of the soil is not covered by vegetation.

Table 1

Plant associations of the Galiote river floodplain, Anticosti Island

| Association | | (1) | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|---|---|
| Sub-association | | (1a) | (1b) | – | (3a) | (4a) | – |
| Column no. | | 1 | 2 | 3 | 4 | 5 | 6 |
| Number of relevés | | 4 | 8 | 5 | 5 | 7 | 2 |
| Vegetation | | | | | | | |
| Cover (%) | | 61 | 73 | 117 | 66 | 127 | 194 |
| Low tree (5-10 m) | Lt | . | . | . | . | . | 5 |
| Tall shrub (2.5-5 m) | Ts | . | . | . | . | . | 4 |
| Low shrub (0-2.5 m) | Ls | 56 | 49 | 62 | 47 | 72 | 65 |
| Low herb (0-0.6 m) | Lh | 4 | 24 | 54 | 18 | 35 | 65 |
| Mosses and lichens | Ml | 2 | <1 | 1 | 2 | 20 | 55 |
| Total number of species (6) | | 8 | 13 | 18 | 14 | 24 | 41 |
| Vascular plants | | 5 | 13 | 18 | 12 | 21 | 36 |
| Mosses and lichens | | 3 | <1 | <1 | 2 | 3 | 5 |
| Floristic composition (7) | | | | | | | |
| Shrub layer | | | | | | | |
| 1. *Dryas drummondii* | Lt | V.3 | V.3 | . | I.1 | . | . |
| 2. *Picea glauca parva* | Lt | V.+ | IV.1 | II.1 | IV.1 | III.+ | . |
| 3. *Potentilla fruticosa* | Lt | . | II.+ | V.4 | IV.1 | V.2 | 2.2 |
| 4. *Salix bebbiana* | Lt | . | I.+ | . | . | . | . |
| *Juniperus communis depres.* | Lt | . | . | . | I.+ | . | . |
| 5. *Dryas integrifolia* | Lt | . | II.2 | . | V.3 | IV.2 | . |
| 6. *Juniperus horizontalis* | Lt | . | . | II.2 | V.2 | V.3 | 2.2 |
| 7. *Arctostaphylos uva-ursi* | Lt | . | II.1 | II.1 | I.+ | V.2 | 2.2 |
| *Larix laricina depressa* | Lt | . | . | . | I.+ | IV.1 | 2.2 |
| 8. *Picea mariana* | Ts | . | . | . | . | . | 1.1 |
| *Picea mariana semi-prostrata* | Lt | . | I.+ | . | (I.+) | III.2 | 2.3 |
| 9. *Lonicera villosa* | Lt | . | . | I.+ | . | . | . |
| *Oxycoccus macrocarpus* | Lt | . | . | I.+ | . | . | . |
| *Andromeda glaucophylla* | Lt | . | . | I.+ | . | . | 1.2 |
| *Rhamnus alnifolia* | | . | . | . | . | I.+ | 1.+ |
| *Ledum groenlandicum* | Lt | . | . | . | . | I.+ | 1.+ |
| *Chamaedaphne calyculata* | Lt | . | . | . | . | . | 1.1 |
| *Kalmia polifolia* | Lt | . | . | . | . | . | 1.+ |
| Low herb layer | | | | | | | |
| 1. *Senecio pauperculus* | | IV.+ | V.1 | V.2 | V.1 | V.1 | 2.1 |
| *Campanula rotundifolia* | | III.+ | V.1 | III.1 | III.1 | III.1 | 2.1 |
| *Solidago spathulata* | | III.+ | V.1 | III.1 | V.1 | III.1 | 1.+ |
| *Danthonia spicata* | | . | V.2 | II.2 | II.+ | V.1 | 2.1 |
| 2. *Taraxacum* sp. | | (II.+) | . | . | . | . | . |
| *Calamagrostis inexpansa* | | III.+ | III.1 | V.1 | . | II.1 | . |
| *Solidago bicolor concolor* | | II.+ | II.+ | . | . | III.2 | . |
| *Saxifraga aizoides* | | (II.+) | IV.1 | I.+ | . | III.1 | . |
| *Lesquerella arctica purshii* | | . | III.1 | . | V.1 | III.1 | . |

Table 1 — continued 1

| Column no. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 3. *Erigeron hyssopifolius* | . | IV.1 | V.1 | . | III.2 | 2.2 |
| *Viola adunca minor* | . | II.1 | III.1 | . | II.1 | 1.+ |
| *Anemone parviflora* | . | III.+ | III.2 | I.+ | III.1 | 2.1 |
| *Carex scirpoidea* | . | I.1 | V.2 | (I.+) | V.2 | 2.1 |
| *Thalictrum alpinum* | . | . | III.1 | . | III.1 | 2.3 |
| *Prucella vulgaris* | . | . | III.1 | . | III.1 | 2.1 |
| *Tofieldia glutinosa* | . | . | III.2 | . | III.1 | 2.2 |
| *Primula mistassinica* | . | . | II.+ | . | III.1 | . |
| 4. *Trisetum melicoides* | . | I.+ | I.+ | . | . | . |
| *Trisetum spicatum* | . | II.1 | . | . | . | . |
| *Muhlenbergia racemosa* | . | I.+ | . | . | . | . |
| *Antennaria neglecta* | . | I.+ | . | . | . | . |
| *Viola pallens* | . | I.+ | . | . | . | . |
| *Carex aurea* | . | I.+ | . | . | . | 1.+ |
| *Sysirinchium montanum* | . | I.+ | II.1 | . | . | 2.+ |
| *Festuca vivipara* | . | I.1 | I.1 | . | . | . |
| *Parnassia glauca* | . | . | IV.1 | . | I.1 | . |
| *Allium schoenoprasum laurentianum* | . | . | I.1 | . | . | 1.+ |
| *Agropyron repens* | . | . | II.1 | . | . | . |
| *Pinguicula vulgaris* | . | . | II.1 | . | . | 1.+ |
| *Cirsium arvense* | . | . | I.+ | . | . | . |
| *Calamagrostis stricta* | . | . | . | I.1 | . | . |
| *Anemone multifida* | . | . | . | III.+ | . | . |
| *Festuca ovina saximontana* | . | . | . | I.+ | . | . |
| 5. *Comandra umbellata* | . | . | II.2 | I.+ | III.2 | 2.1 |
| *Muhlenbergia richardsonis* | . | . | I.3 | IV.1 | III.2 | 2.2 |
| 6. *Carex eburnea* | . | II.1 | I.1 | . | IV.1 | 2.2 |
| *Zigadenus glaucus* | . | . | II.+ | IV.1 | III.2 | 2.1 |
| 7. *Agrostis scabra* | . | II.1 | I.+ | . | III.1 | . |
| *Antennaria gaspensis* | . | II.+ | II.1 | I.+ | III.1 | 1.+ |
| *Carex crawei* | . | . | I.+ | . | I.1 | . |
| *Fragaria virginiana* | . | I.+ | I.2 | . | I.1 | 2.1 |
| *Euphrasia arctica* | . | . | . | I.+ | II.1 | . |
| *Braya humilis laurentiana* | . | . | . | (I.+) | I.+ | . |
| *Viola* sp. | . | . | I.2 | . | I.+ | . |
| 8. *Cypripedium calceolus parviflorum* | . | . | . | . | III.1 | 1.+ |
| *Smilacina stellata* | . | I.+ | . | . | II.+ | 2.1 |
| 9. *Prenanthes racemosa* | . | . | . | . | IV.+ | . |
| *Lobelia kalmii* | . | . | . | . | II.1 | . |
| *Epilobium glandulosum cardiophyllum* | . | . | I.+ | . | I.+ | . |
| *Scirpus pumilus rollandii* | . | . | . | . | I.1 | . |

Table 1 — continued 2

| Column no. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| *Tofieldia pusilla* | . | . | . | . | I. + | . |
| *Selaginella selaginoides* | . | . | . | . | I. + | . |
| 10. *Sanguisorba canadensis* | . | . | III. + | . | . | 2.1 |
| *Carex capillaris* | . | . | . | . | . | 2.1 |
| *Parnassia parviflora* | . | . | . | . | . | 1.1 |
| *Antenaria pulcherrima* | . | . | I.4 | . | . | 1.1 |
| *Habenaria hyperborea* | . | . | . | . | . | 1.1 |
| *Equisetum variegatum* | . | . | . | . | . | 1. + |
| *Hieracium florentinum* | . | . | . | . | . | 1. + |
| *Castilleja septentrionalis* | . | . | . | . | . | 1. + |
| 11. *Cornus canadensis* | . | . | . | . | . | 2.2 |
| *Linnaea borealis* | . | . | . | . | . | 1.1 |
| *Petasites palmatus* | . | . | . | . | . | 1.2 |
| *Maianthemum canadense* | . | . | . | . | . | 1. + |
| *Mitella nuda* | . | . | . | . | . | 1. + |
| Moss layer | III. + | II.1 | . | III.1 | III.2 | . |
| *Tortella tartuosa* | III.1 | . | . | . | II.1 | 1. + |
| *Ditrichum flexicaule* | III.1 | . | . | . | II.2 | . |
| *Tortella fragilis* | II. + | . | . | . | II.1 | . |
| *Hypnum imponens* | II. + | I.1 | . | . | . | . |
| *Tortella inclinata* | II. + | . | . | . | . | . |
| *Campylium chrysophyllum* | II. + | . | . | . | . | . |
| *Encalyptra* sp. | II. + | . | . | . | . | . |
| *Encalyptra procera* | . | . | I.1 | . | . | . |
| *Hypnum lindebergii* | . | . | . | I. + | II.1 | . |
| *Pleurozium schreberi* | . | . | . | . | II. + | . |
| *Campylium stellatum* | | | | | | |
| *Rhytidiadelphus triquetrus* | . | . | . | . | I. + | 1.2 |
| *Bryum* sp. | . | . | . | . | I. + | 1.2 |
| *Brachythecium salebrosum* | . | . | . | . | . | 1.3 |
| *Hylocomium splendens* | . | . | . | . | . | 1.3 |
| *Ptilium crista-castrensis* | . | . | . | . | . | 1.2 |
| *Rhacomitrium canescens ericoides* | . | . | . | . | . | 1.1 |
| *Dicranum scoparium* | . | . | . | . | . | 1. + |
| *Plagiochilla asplenioides porelloides* | . | . | . | . | . | 1. + |
| Lichen layer | | | | | | |
| *Cladonia pocillum* | . | . | . | I. + | III.2 | . |
| *Leptogium minutissimum* | . | . | . | I. + | . | . |
| *Polyblastia gelatinosa* | . | . | . | I. + | . | . |
| *Caloplaca leucoraea* | . | . | . | I. + | I.1 | . |
| Cf. *Arctomia delicatula* | . | . | . | I. + | . | . |
| Cf. *Lecidea uliginosa* | . | . | . | I. + | . | . |
| *Psora crenata* | . | . | . | (I. +) | . | . |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Catapyrenium lachneum* | . | . | . | (I.+) | . | . |
| *Cladina mitis* | . | . | . | . | I.1 | . |
| *Cladina rangiferina* | . | . | . | . | I.1 | . |

(1) *Dryadetum drummondii*
(1a) *dryadetosum drummondii*
(1b) *danthonietosum spicatae*
(2) *Potentilletum fruticosae*
(3) *Dryadetum integrifoliae*
(3a) *juniperetosum horizontalis*
(4) *Juniperetum horizontalis*
(4a) *dryadetosum integrifoliae*
(5) Black spruce and tamarack community
(6) Mean total number of plant spp. present in the relevés including vascular plants, mosses and lichens. -
(7) Floristic composition:
The Roman and Arabic numbers correspond respectively to frequency and mean abundance-dominance following Braun-Blanquet (1932). However, for less than 4 relevés, absolute presence is used. The absence of a species is indicated by a point only, while parantheses signify the presence of a species out of the sampling sites. The number for the shrub and herb in layers in the shrub and herb layers in the left margin identifies the vascular plant group cited in the text.

Similar communities of *D. drummondii* are formed on the floodplain of the Grand River, Gaspe (Lamoureux 1971), in the Peace River in Alberta and in the Liard River in British Columbia (Raup 1934). Our association differs from that described by Dansereau (1959) on Mont Alban, Gaspe by a significantly different and more abundant floristic list. We believe that two new subassociations should be recognized:

Typical Subassociation
*dryadetosum drummondii* s. ass. nova.
Table 1, Col. 1

This subassociation is recognized by the presence of few taxons (5), the absence of *Dathonia spicata* and the nearly total absence of the distinguishing plants of Group 1. The low shrub layer is composed of only *Dryas drummondii* and *Picea glauca* f. *parva*. In the low herb layer the mean total cover is less than 5% while cover by species of Group 1 is less than 1%. However, the mean cover for the low shrub layer is 56%. Areas not colonized by *Dryas* are devoid of vegetation. Each circular *Dryas drummondii* colony is reduced in size (mean diameter <60 cm.) and solitary.

The absence of the Ahk mineral horizon in half of the releves indicates that this regosol is not well developed.

This subassociation is less frequent than the next one occupying only 12% of the surface area covered by the association.

Common Wild Oat Grass Subassociation
*danthonietosum spicatae* s.ass. nova
Table 1, Col. 2

This subassociation is recognized by the greater number of vascular plants (13), the presence of *Danthonia spicata* in nearly 90% of the releves and the greater abundance of Group 1 species in the low herb layer. *Dryas integrifolia* and *Arctostaphylos uva-ursi* were present in some releves. There is greater diversity in the list of companion species which includes *Calamagrostis inexpansa* and *Saxifraga aizoides* from Group 2 and *Erigeron hyssopifolius* and *Anemone parviflora* from Group 3 and several taxons from Group 4 such as *Trisetum spicatum*. Mean cover of the low herb layer is 24%. In this subassociation, the *Dryas* colonies are closer together and have a more irregular form.

The edaphic characteristics are similar except a thicker Ahk horizon (8 cm).

SHRUBBY CINQUEFOIL ASSOCIATION
*PONTENTILLETUM FRUTICOSAE* ASS. NOVA
TABLE 1, COL. 3

The vegetation in this association tends to be more mesophilous. The dense vegetative cover (mean total cover 117%) is mainly composed of *Potentilla fruticosa, Erigeron hyssopifolius, Anemone parviflora,* and *Carex scirpoidea*, the herbaceous species of Group 3 as well as *Parnassia glauca* from Group 4. The abundance and exclusive presence of *Antennaria pulcherrima* in one of the releves could be provisionally considered to form a facies. In addition, the total number of species present in this same releve (28) indicates that this is a more advanced stage of primary development. With exception to the releve mentioned above, the moss and lichen layers are not represented. This is the same case for bare soil. *P. fruticosa* grows on cumulic regosols, the loamy texture of the soil resulting in a moderate to rapid drainage.

Slight depressions or zones bordering the river, subject to periodic flooding are colonized by this association. The topography and the fine texture of the soil provide the humidity necessary for the development of the association.

There is no literature on the existence or distribution of this association in Quebec. On the floodplain of the Galiote River, this association covers 3% of the region studied where it is confined to certain areas.

MOUNTAIN AVENS ASSOCIATION, SHRUBBY RED CEDAR SUBASSOCIATION
*DRYADETUM INTEGRIFOLIAE* DANSEREAU 1959 *JUNIPERETOSUM HORIZONTALIS* S. ASS. NOVA
TABLE 1, COL. 4

The frequency and the relatively high mean abundance-dominance coefficient of *D. integrifolia* identify this association. *Juniperus horizontalis* is the second most important shrubby species characterizing a new subassociation. The presence of *Carex eburnea* and *Zigadenus glaucus* in 80% of the releves, is distinctive of the herb layer. Lichens are also abundant. The structure of this subassociation resembles that of *Dryadetum drummondii*: a sparse herbaceous vegetation intermingled with irregularly formed *D. integrifolia* colonies.

The subassociation colonizes ancient fluvial deposits at the limit of the *Juniperetum horizontalis*. The vegetation roots in the non-decomposed litter of a rapidly drained orthic regosol. Cover (4%), is in nearly the same proportions as the preceeding association.

*Dryadetum integrifoliae* has been reported from the Gaspe on the cliffs at Perce (Dansereau 1959) and in Forillon National Park (Morisset 1974) and on cliffs on the Mingan Islands (Grondin and Melancon 1980). This association has also been documented in the Arctic (Polunin 1948) and from mountainous regions of Montana (Bamberg and Major 1968). These authors do not however recognize the shrubby red cedar subassociation.

SHRUBBY RED CEDAR ASSOCIATION. MOUNTAIN AVENS SUBASSOCIATION
*JUNIPERETUM HORIZONTALIS* DANSEREAU 1959 *DRYADETOSUM INTEGRIFOLIAE* S. ASS. NOVA
TABLE 1. COL. 5

*Juniperus horizontalis* constitutes the dominant element in this association and together with *Arctostaphylos uva-ursi* and *Dryas integrifolia* form a well

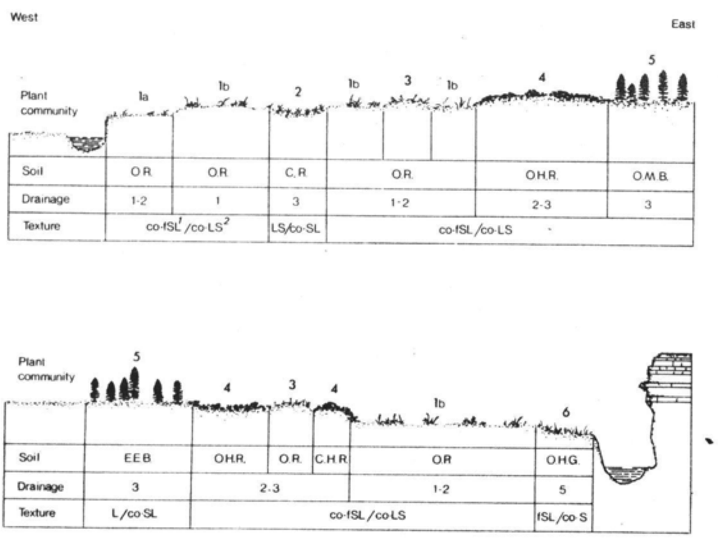



Fig. 3. Schematic topographical sequence of the Galiote River floodplain, Anticosti Island: Plant community (Table 1), soil: O.R. (orthic regosol), C.R. (cumulic regosol), O.H.R. (orthic humic regosol), C.H.R. (cumulic humic regosol), O.M.B. (orthic melanic brunisol), E.E.B. (eluviated eutric brunisol), O.H.G. (orthic humic gleysol); drainage: 1 (rapid), 2 (good), 3 (moderate), 5 (poor); texture: 1 (surface mineral horizon) and 2 (deep mineral horizon) — L (loam), SL (sandy loam), fSL (fine sandy loam), LS (loamy sand), S (sand), co (cobbly)

developed shrub layer (72% mean cover). Studented black spruce and tamarack are present. The mean total vascular plants is 21. This subassociation is distinguished by the shrub layer, especially *D. integrifolia*. The herbaceous layer is composed of the same group of species as in the preceeding phytosociological units; the only particularity being the presence of *Prenanthes racemosa* and *Lobelia kalmii* (Group 9) and *Cypripedium calceolus* var. *parviflorum* (Group 8). There is also a greater number of taxa representative of the moss and lichen layers.

This syntaxon is normally found on the floodplain, near to the forest. The soil is either a cumulic or orthic humic regosol or an orthic regosol. Drainage varies from good to rapid. Occupying 15% of the surface area of the floodplain, it is the second most important phytosociological unit.

*Juniperetum horizontalis* on the Galiote River floodplain resembles that described by Dansereau (1959). However, as *Dryas integrifolia* was very frequent, a new subassociation was delineated. Grondin and Melancon (1980) also reported a solitary *Juniperetum horizontalis* on the heathland of the Mingan Islands. *Dryas integrifolia*, however, was not present.

STUNTED BLACK SPRUCE AND TAMARACK COMMUNITY
*PICEA MARIANA* F. *SEMIPROSTRATA* AND *LARIX LARICINA* F. *DEPRESSA* COMMUNITY
TABLE 1, COL. 6

The shrub layer is primarily composed of *P. mariana* f. *semiprostrata* and *L. laricina* f. *depressa*. On one occasion black spruce was observed in the tall shrub layer. In addition to species mentionned in the preceeding association, *Sanguisorba canadensis* and *Carex capillaris* from Group 10 and the acidophilic woodland species *Cornus canadensis*, *Maianthemum canadense*, *Petasites palmatus*, *Linnaea borealis* and *Mitella nuda* are included. The presence of mosses such as *Ptilium crista-castrensis*, *Hylocomium splendens* and *Dicranum scoparium* contribute to the woodland character of this plant community. The soil is a well to moderately well drained brunisol. A thin Ae horizon in the profile of one of the releves indicates the beginning of podzolization.

This is the transitional community between the shrubby red cedar and the black spruce forest. It runs along the edge of the valley, covering 5% of the floodplain.

## OTHER COMMUNITIES

Along the edge of the river, 5 other plant communities were observed. Three of these releves are described in Dumont and Gauthier (1981).

Near the mouth of the river, at an altitude of 3 m, the *Muhlenbergia* *richardsonis* community was observed. This appears to be a successional community preceeding the stunted tamarack and black spruce community. A *Calamagrostis inexpansa* community is situated near to the river on a loamy non-gravelly deposit. covering a well drained cumulic regosol. In contrast. also in close proximity to the river, on a poorly drained orthic humic gleysol, a *Carex aquatilis* community is formed. Finally, as one preceeds into the valley where the flooplain is not very well developed, a *Juncus balticus* var. *littoralis* community is present. Also, in the upper unsampled region of the river valley, the presence of a *Carex* spp. community consisting of *Carex aurea*, *C. flava*, *C. scirpoidaea* and *Juncus alpinus* var. *rariflorus* was noted.

## DISCUSSION

Like most of the hydrographic basins of Anticosti Island, the water retention capacity of the Galiote River basin is poor and the recovery time is very short. This results in extreme water level variations and a torrential overflow. Also during the spring freshet, large chunks of ice carried downstream exert an abrasive action on the riverbanks and cliffs. This wearing away limits vegetation development, influencing the final distribution of plant communities on the floodplain. The freshet also serves to renew and rejuvenate the substrate where pedogenesis is retarded.

The instability of the soil (Bamberg and Major 1968) is a result of the action of the river. The coarse texture of the substrate along with the wind create particularly difficult conditions for plant establishment and growth. This is confirmed in examination of the physiognomy of the vegetation (low shrub, low herb sensu Payette and Gauthier 1972) and the adaptive traits of low plants as to the position of perennial buds, the type of reproduction (species with vegetative reproduction — *Antennaria*, viviparous species — *Festuca vivipara*, *Polygonum viviparum* etc.), and the growth form (stunted individuals). Further considering the slow rate of both turnover of mineral material and decomposition of organic matter, generally deficient in alluvial soils (Duchaufour 1977), it is easy to understand why only taxa such as *Dryas drummondii*, *Dryas integrifolia* and *Arctostaphylos uva-ursi* form associations of any importance. These pioneer species, capable of fixing atmospheric nitrogen are excellent colonizers of areas recently liberated of water and/or ice (Lawrence et al. 1967).

The progressive accumulation of organic matter under the dense cover provided by *Dryas* colonies creates a favourable germination bed for other less specialized species (Braun-Blanquet 1932, Bamberg and Major 1968). From a dynamic point of view then, *Dryas* spp compose the structural framework in this habitat. Moreover, the presence of certain herbaceous spp such as *Senecio pauperculus*, *Campanula rotundifolia*, *Solidago spathulata* and *Danthonia spicata* (Table 1, Group 1) in several associations, independent of topography and edaphic conditions, suggests the existence of a primary evolutionary line between the different plant communities. These plants always attain optimum development in the Drummond's mountain avens--common wild oat grass subassociation.

The pioneer low shrub species prepare and stablize the substrate for the establishment of the shrubby red cedar followed by the stunted black spruce and tamarack community on the sheltered alluvial terraces. This chronological sequence is also expressed as a topographical sequence (Fig. 3) along which a tendency for increase in the number of vascular plants, a gradual appearance of acidophiles, a development of high shrub, moss and lichen layers and an advanced pedogenesis is observed. All of the preceeding result as direct consequences of the increased stability of the substrate. On the other hand, white spruce, because of its stricter nutrient requirements (Lafond 1966), disappears with the development of a vegetative cover, preferring the barren calcareous soil colonized by *Dryas drummondii*. More specialized associations, such as the shrubby cinquefoil and the sedges become established in particular local edaphic conditions on the floodplain.

Along the edge of the river, each of the associations finds the physical space for expansion. However, the gradual decrease in the upriver portion of the valley, and consequently in the river and the floodplain, results in a reduction in space, which thus influences the development of plant communities. In several areas an overlapping of characteristic species of several of the phytosociological units was observed. This was due to the effect of crowding (Dansereau 1956).

The floodplain vegetation is a reflection of the ecological conditions prevalent in the Galiote River valley. These conditions are similar to those in arctic and alpine regions (Given and Soper 1981). In fact, the Labrador Current lowers the mean summer temperature below 15°C, considered by Damman (1965, 1976) as the limiting temperature for the survival of arctic-alpine plants. In addition, as the fluvial dynamics of the river limits forest expansion, the arctic and boreal Cordilleran elements that are also heliophiles and calcicolous can establish in the open habitats along the cobbly calcareous riverbanks.

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## *Zależność roślinności od warunków glebowych na wapiennych terasach aluwialnych na wyspie Anticosti (Quebec)*

### Streszczenie

Na wapiennych terasach aluwialnych rzeki Galiote na wyspie Anticosti (Quebec) występują 4 zespoły krzewów: *Dryadetum drummondii* (37%), *Juniperetum horizontalis* (15%), *Dryadetum integrifoliae* (4%), *Potentilletum fruticosae* (3%) i 6 zespołów składających się głównie z roślin zielnych o mniejszym znaczeniu. Zbiorowska, tu występujące, są reprezentowane przez 4 nowe podzespoły: *D. d. dryadetosum drummondii*, *D. d. danthonietosum spicatae*, *D. i. juniperetosum horizontalis* i *J. h. dryadetosum integrifoliae*. Roślinność kolonizuje 3 rodzaje gleb: inicjalne, brunatne i oglejone. Gleby te wykształcone z materiału wapiennego, mają pH przekraczające 7 oraz stopień nasycenia ponad 100%. Są one najpierw opanowywane przez rośliny pionierskie, zwłaszcza *Dryas*, które stabilizują teren i umożliwiają wkroczenie roślin bardziej wymagających a w końcowej fazie — lasu. Ta pierwsza sukcesja, postępująca obecnie, ma swój kierunek topograficzny, tj. od rzeki do lasu, gdzie rzeka pozostaje głównym czynnikiem decydującym o rozmieszczeniu opisanych zbiorowisk roślinnych.