# AGE OF THE CANADIAN KOOTENAY FORMATION.[1]

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ABSTRACT. The stratigraphic ranges of the species comprising the flora of the Kootenay formation in the Blairmore area of southern Alberta do not indicate a Jurassic age. Actually more genera, generally considered to be characteristic of the Jurassic, occur in the flora of the Blairmore and equivalent formations than in the flora of the older Kootenay formation. The Blairmore flora, which is correlated with a flora in the Kome beds of Greenland, and which includes practically all the known species of the Kootenay, is marked by the first appearance of dicotyledons, and is inferred to be of Aptian age. The close affinity of these two floras strongly suggests a Barremian or late Neocomian age for the plant-bearing part of the Kootenay formation in its type area.

## INTRODUCTION.

IN a recent paper by R. W. Brown (1946, pp. 240-241) it was proposed to unite a basal part of the Kootenai formation of Montana to underlying beds that were correlated with, and included in the Morrison formation. In Montana these so-called Morrison beds had provided a few freshwater invertebrates, scattered fragments of vertebrates, and fruits of *Chara*. The faunal evidence was tentatively accepted as indicative of a Jurassic age both by C. A. Fisher (1908, p. 30) and W. R. Calvert (1909, p. 24), who worked respectively in the Great Falls and Lewistown coalfields. More recently W. A. Cobban (1945, p. 1269) on the evidence of *Chara* and ostracoda stated that "the age of the beds must be Kimmeridgian and possibly younger."

The enlargement and redefinition of the Morrison formation to include a basal part of the Montana Kootenai can be regarded only as a new grouping of beds that may be more in accord with lithological sequence or more useful to the field geologist. Formations are primarily only beds or groups of beds, united on the basis of lithology for geological mapping or other purposes, in which no important time-breaks in sedimentation have been detected. Individual formations, therefore, if they represent a sufficient interval of time may contain more than one flora or fauna, and may even be in the nature of pas-

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sage beds from one geological system to another. The Ravenscrag formation in southern Saskatchewan, for example, as originally defined (Davis, N. B., 1918 p. 11; Fraser, F. J. *et al.*, 1935, p. 39; Berry, E. W., 1935, pp. 4-7) carries an Upper Cretaceous flora and fauna in its basal part and a Paleocene flora in its upper part. Similarly the Blairmore formation in southern Alberta carries one flora throughout most of its thickness, and another flora in its uppermost several hundred feet. This palaeontological factor of formations is ignored by some geologists who assume that a formation must contain only a single flora or fauna, in spite of the truism that many formations transect chronological horizons.

In a sedimentary sequence of beds comprising a formation interruptions of the nature of erosional unconformities may occur without destroying the concept of lithological unity, defined for that formation, or violating the principle of essentially continuous deposition. Local features of this kind are very common in the form of channels at the base of sandstones or coarser clastics in non-marine sediments. In the case of more widespread erosional unconformities it is ultimately the judgment of a palaeontologist that will determine whether the break is too important to be included within the limits of a single formation. Where the plane of an eroded surface of major magnitude so nearly parallels the bedding planes as to be classified as a disconformity it may commonly escape detection by the geologist, and be included within the limits of a single formation. However, once its presence has been detected, it necessarily destroys the unity of that formation, and it must become the boundary between separate formations. Such hidden disconformities are particularly likely to occur at times of recession of an inland sea when the strand lines were undoubtedly oscillatory in their movements. Environmental conditions at such times were, moreover, probably critical for many kinds of both land and sea life, with resultant meagre fossil records, so that disconformities might long escape detection. An example of a recently discovered disconformity of this kind is that recorded by W. A. Cobban (1945, p. 1291) in the Jurassic formation of Montana, formerly known as the Ellis, and lying between Cobban's Swift and Rierdon formations. Another good illustration of a hidden disconformity in what were originally regarded as "Passage Beds" from the Kimmeridgian to the Aptian is afforded by Jurassic-Cretaceous sequence that

includes the Speeton Clay of England (Spath L. F. 1924, pp. 80-81). The disconformity in this instance embraced the uppermost Kimmeridgian, the Portlandian, Purbeckian, Infra-Valanginian and lowest Valanginian beds. Palaeontology and not lithology must be the criterion for the recognition of such disconformities.

### STRATIGRAPHIC SETTING OF THE KOOTENAY.

The Kootenay formation, originally and loosely defined by J. W. Dawson (1886, p. 2 )as the "Kootanie series" for strata containing a specific flora, was first differentiated on a lithological basis as a formation by W. W. Leach (1912, pp. 194, 195). Later its stratigraphic limits were emended by B. Rose (1917, pp. 109, 110) who redefined its contact with the overlying Blairmore formation. The formation, about 750 feet thick in the Blairmore area, consists of alternating sandstones, shales, and coal seams, the sandstones being grey, commonly coarse-grained and cross-bedded, the shales, dark, commonly sandy and carbonaceous.

The overlying Blairmore formation, 2000 feet or more thick, has its base generally marked by a conglomerate, 10 to 30 feet thick, which is locally present in valleys or channels eroded into the Kootenay. The succeeding Blairmore beds according to Rose are red, green and a few grey to black, sandy shales, interbedded with grey sandstones, generally in zones from 1 to 10 feet thick, although occasionally 50 feet, together with conglomerate at irregular intervals throughout and as lenses in the sandstone.

J. S. Stewart (1919, p. 28) described the contact of the basal conglomerate of the Blairmore with the Kootenay as "conformable and in most places the conglomerate grades into sandstone upward and downward, and in the eastern part of the Blairmore area, horizontally also. The conglomerate in places is 50 feet above the uppermost coal seam of the underlying Kootenay formation, and in other places it practically forms the roof of the seam."

The Kootenay formation in the Blairmore area is underlain by the Fernie formation. W. W. Leach (1912, p. 194) placed the contact of the Kootenay and Fernie formations on York Creek at the base of greenish thin-bedded sandstone, 75 feet thick, which was stated to lie conformably upon shales of the Fernie. Elsewhere in his report (Op. cit. p. 193), Leach

stated "The line of demarcation between these shales and the overlying Kootenay formation is not very sharply drawn, but may be assumed to be at the base of the lowest heavy bed of sandstone underlying the coal seams." Commenting on the contact B. Rose (1917, p. 109) wrote "There is a gradual change from marine shales to subaerial sandstone, and the line of demarcation used is at the base of the first heavy bed of sandstone." Thus Rose cites a measured section at Blairmore, in which the base of the Kootenay is a massive grey sandstone, 100 feet thick. J. S. Stewart (1919, p. 26) also noted the uncertain character of the basal contact, for he states "the passage of the one formation (Fernie) to the other (Kootenay) is thought to be transitional in character, and the position of the dividing line between them is somewhat indefinite. The base of the Kootenay is usually placed at the horizon where the arenaceous beds and sandstones become predominant, and these strata consist of a series of thin-bedded sandstones and shales of a dark greenish colour, that are rather friable on weathering."

In considering the top beds of the Fernie formation F. H. McLearn (1916, p. 111) wrote as follows: "The uppermost thin-bedded arenaceous member is very characteristic of the Fernie . . . It consists of alternating beds of dark shale and sandstone in 1 to 2-inch layers. The writer has collected a few fish teeth and scales from this zone. The thin bedding persists almost to the thick sandstone at the base of the Kootenay. Within a few feet of it are sandstone beds, 2 feet or more thick, interbedded with thin sandstone and shale. There is thus gradation to the basal sandstone, as noted by Cairnes and others, suggesting continuous deposition." Later McLearn (1929, p. 87) referred to these top beds of the Fernie as "passage beds," assigning them a thickness of about 180 feet. From them he gathered a depauperate and poorly preserved fauna with both marine and non-marine elements. The fauna includes indeterminate pelecypods at Grassy Mountain, shark teeth and fish bones and scales north of the Rocky Mountain sanatorium, and fish fin rays, a fish-like tooth, and a caudal vertebra of an herbivorous dinosaur ? on Castle River."

### KOOTENAY AGE LIMIT SET BY FERNIE FORMATION.

The "passage beds" of McLearn at the top of the Fernie formation have not yet furnished fossil evidence indicative of

their age. They are underlain by the "green beds" of McLearn (1929, p. 87), about 50 feet thick, which carry a sparse marine fauna not diagnostic beyond indicating a probable Jurassic age. The latest zone in the Jurassic Fernie formation that could be confidently dated in the Blairmore area was Upper Bathonian or late Middle Jurassic age. (Spath, L. F., 1932, p. 145.) The Kootenay formation, therefore, insofar as its stratigraphic relations to the Fernie are concerned, in the Blairmore area, could be of Upper Jurassic age. On the other hand it is quite possible that a hidden disconformity at the present base of the Kootenay or at some lower horizon, may represent all post-Fernie Jurassic time and an unknown part of Cretaceous time.

KOOTENAY AGE LIMIT AS SET BY BLAIRMORE FORMATION.

*Blairmore Floras.* The Blairmore formation, which overlies the Kootenay with at least local erosional unconformity, is plant-bearing almost throughout. McLearn made collections of both plants and invertebrate freshwater shells, carefully recording the exact horizons of their occurrence within the formation. (See Figure.) The plants were submitted to, and reported upon, by E. W. Berry (1929, pp. 31-72). They were found to represent two distinct floras within the Blairmore formation, one extending nearly throughout the formation to about 300 feet from its top, the other confined to this latter interval.

The plant-bearing beds with the lower flora begin about 200 feet above the base of the Blairmore formation, and extend upward 1370 feet or 480 feet from the top. This lower flora was considered by Berry to be Late Aptian and Albian (Berry, E. W., 1929, p. 33). The same flora occurs farther north in Alberta in the Luscar and Gething formations. Collections from these formations have greatly enlarged our knowledge of the flora since Berry's analysis of it, and this, together with revision of Berry's identifications, has permitted a new evaluation of the evidence. In the writer's opinion the flora is wholly Aptian, while the succeeding flora, present only in the uppermost 300 feet of the formation, represents early Albian, and, not as Berry considered, Cenomanian time. Evidence for this view will now be considered.

The lower flora present in the Blairmore formation (B)

and in the equivalent Luscar (L) and Gething (G) formations, as at present known, comprises the following species:

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| L, | *Selaginellites* n. sp. |
| B, L, | *Equisetum lyelli* Mantell (including forma *burchardti* Schenk, non Dunker). |
| B, L, G | *Sphenopteris* (*Onychiopsis* ?) *latiloba* Fontaine. |
| L, | *Sphenopteris* n. sp. |
| B, L, | *Sphenopteris* (*Onychiopsis* ?) n. sp. |
| B, | *Sphenopteris* (*Coniopteris* ?) n. sp. |
| L, G | *Onychiopsis psilotoides* (Stokes and Webb). |
| B, L, G | *Ruffordia goepperti* (Dunker) Seward. |
| L, | *Acrostichopteris* n. sp. |
| L, | (very rare) *Coniopteris heterophylla* (Fontaine) n. comb. |
| B, L, G | *Coniopteris brevifolia* (Fontaine) n. comb. |
| L, | *Coniopteris* n. sp. 1. |
| B, L, G | *Coniopteris* n. sp. 2. |
| B, L, G | *Coniopteris berryi* nom. nov. for *C. pachyphylla* pars Berry (non Fontaine) Nat. Mus. Can. Bull. 58, pl. 7, figs. 3, 4 (non figs. 1, 2) (1929). |
| B, L, G | *Cladophlebis virginiensis* Fontaine emend. Berry. |
| B, L, | *Cladophlebis parva* Fontaine. |
| B, L, | *Cladophlebis oerstedi* (Heer) Seward. |
| B, L, | *Cladophlebis* (*Klukia*) *browniana* (Dunker) Seward (includes *C. dunkeri*). |
| L, | *Gleichenites gieseckiana* (Heer) emend. Seward. |
| L, | *Gleichenites nordenskioldi* (Heer) emend. Seward. |
| L, | *Gleichenites* ? n. sp. |
| B, L, | *Sagenopteris elliptica* Fontaine. |
| B, L, | *Sagenopteris mclearni* Berry. |
| B, L, G | *Sagenopteris* n. sp. |
| G | *Ptilophyllum arcticum* (Goeppert) Seward. |
| L, G | *Ptilophyllum speciosum* (Heer). |
| B, L, G | *Ptilophyllum dunkerianum* (Goeppert). |
| L, G | *Pterophyllum concinnum* Heer. |
| L, G | *Pterophyllum* n. sp. |
| B, | *Zamites* sp. |
| G | *Pseudocycas* n. sp. |
| B, L, G | *Nilssonia johnstrupi* Heer. |
| L, | (rare) *Ctenis borealis* (Dawson). |
| B, L, | *Ctenopsis insignis* Fontaine, omend. Berry. |
| G | *Ginkgoites lindleyana* (Schimper). |
| B, L, G | *Ginkgoites pluripartita* (Schimper). |
| B, | *Ginkgoites browniana* (Dunker). |
| B, L, | *Phoenicopsis arctica* (Heer). |

| | | |
|---|---|---|
| | G | *Phoenicopsis angustifolia* Heer. |
| | L, G | *Podozamites lanceolatus* (Lindley and Hutton). |
| B, | | *Nageiopsis* sp. cf. *zamioides* Fontaine. |
| B, | L, G | *Elatides curvifolia* (Dunker). |
| B, | L, G | *Elatides dicksoniana* (Heer) n. comb. |
| B, | L, G | *Athrotaxites ungeri* Halle. |
| B, | L, G | *Elatocladus* (*Sequoia* ?) *smittiana* (Heer). |
| | L, | *Elatocladus* (*Sequoia* ?) *rigida* (Heer, pars) Seward. |
| B, | L, G | *Pityophyllum nordenskioldi* (Heer) n. comb. |
| | L, | *Pityophyllum* sp. cf. *longifolium* Nathorst. |
| B, | | *Sapindopsis variabilis* Fontaine. |
| | G | *Carpolithus* (*Nyssa* ?) n. sp. |

The above list comprises 49 species, of which 12 are new, as compared with 28 species listed by Berry. The flora may be compared with other Lower Cretaceous floras e.g. (1) the Wealden of England, (2) Kome of Greenland, (3) Potomac of eastern United States.

*Wealden elements.* There are very few species in this earlier Blairmore flora that occur in the Wealden of England. They comprise only *Equisetum lyelli*, *Onychiopsis psilotoides*, *Ruffordia goepperti*, *Cladophlebis browniana*, *Ptilophyllum dunkerianum* and *Elatides curvifolia*. In addition *Ctenis borealis* may be represented in the Wealden by *Ctenis* sp. Seward (1913, p. 101), while *Pseudocycas* n. sp. is probably closely allied to *P. saportae* (Seward). Except for *Onychiopsis psilotoides* and *Equisetum lyelli* and *Ctenis borealis* this Wealden element of the Blairmore has not yet been found in the underlying flora of the Kootenay formation. Apparently an unknown part of the English Wealden may be of Lower Aptian age, for the highest beds of the Wealden shale have in places a brackish water fauna (J. F. Kirkaldy, 1939, p. 411), and the overlying marine Atherfield clay is late Lower Aptian. The described Wealden flora of England, however, came mostly from the Hastings beds or lower Wealden. These latter rest on Purbeck beds of Jurassic age although "a notable and sudden lithological change again being present" (Boswell, P. G. H., 1929, p. 383). Nevertheless the palaeontological break between the Wealden and Purbeck is generally considered to be slight (*Ibid*, p. 388). So, if the Wealden flora of England were actually earlier than Aptian, and if the age of the lower flora in the Blairmore were judged solely on the basis of its

Wealden element, it might be assigned a pre-Aptian age. In opposition to this is the presence in the lower Blairmore flora of the dicotyledon, *Sapindopsis variabilis*, and of the presence in an upper part of the formation without any signs of intervening depositional break, of a flora consisting dominantly of angiosperms. This latter flora the writer considers to indicate an Albian age, for he agrees with Berry that it is to be correlated with the flora of the Cheyenne sandstone of Kansas (Berry, E. W., 1929, pp. 56, 57). In England dicotyledons made an analogous first recorded appearance in very late Lower Aptian or in early Upper Aptian age in deposits of the Lower Greensand. A second important newcomer in the lower flora of the Blairmore is *Elatocladus* (*Sequoia* ?) *smittiana*. Although no cones of *Sequoia* have been found associated with the foliage, A. C. Seward (1927, p. 103) has noted Florin's opinion on the basis of cuticular characters that this species is more nearly related to *Sequoia* than to any other genus. It may be significant that petrified remains of *Sequoia* are present in the Lower Greensand, although the genus, or a closely allied one, apparently appeared as early as the Portlandian of France.

In summation, the testimony of the Wealden elements in the lower flora of the Blairmore is inconclusive, partly because these elements are very few, and partly because the age limits of the Wealden itself is doubtful. On the other hand the rare presence of dicotyledons, and the presence of a probable *Sequoia* allies the flora to that of known Aptian deposits of England.

*Kome elements.* Many of the more characteristic species of the lower flora of the Blairmore formation are present in the Kome beds of western Greenland. Chief of these are: *Sphenopteris psilotoides*, *Cladophlebis oerstedi*, *Gleichenites gieseckiana*, *Gleichenites nordenskioldi*, *Pterophyllum concinnum*, *Ptilophyllum arcticum*, *Ptilophyllum speciosum*, *Nilssonia johnstrupi*, *Ginkgoites pluripartita*, *Ginkgoites lindleyan*, *Phoenicopsis arctica*, *Elatocladus* (*Sequoia*?) *smittiana* and *Elatides dicksoniana*. Some of these species are considered sufficiently diagnostic unequivocally to correlate this flora with that of the Kome. Unfortunately there is no reliable information on the range of these species within the Kome deposits or on the precise age or ages represented by the Kome. Heer himself correlated the Kome series as Urgonian (Barremian), but it is

significant that a dicotyledon, "*Populus primaeva*" was associated with the typical Kome flora. At Kook (Kome) C. Schuchert and D. White (1898, p. 347) found an additional dicotyledon, viz. *Laurus* ? sp. associated with Kome species, and expressed doubt on the reference of the Kome to as low an age as Urgonian. (op. cit. pp. 347, 366). The Atane flora succeeding that of the Kome has been considered generally to be of Cenomanian age. To the writer Schuchert and White's floral list from their locality C on Pagtorfik (op. cit. p. 353), derived from beds apparently low down in the Atane series, seems rather to indicate an Albian age. At any rate the composition of the two successive floras of the Blairmore formation is closely paralleled by that of the Kome and succeeding early Atane floras. Since *Sapindopsis variabilis* makes its first appearance in the lower flora of the Blairmore, and ranges upward into the succeeding Albian flora, the age of the former like that of the Kome is believed to be younger than Urgonian (Barremian) and to be more probably Aptian.

*Potomac elements.* The revision of the lower flora of the Blairmore formation reveals that there are few species held in common with the Potomac group. These are: *Sphenopteris* (*Onychiopsis* ?) *latiloba*, *Onychiopsis psilotoides*, *Coniopteris brevifolia*, *Cladophlebis virginiensis Cladophlebis parva*, *Cladophlebis browniana*, *Sagenopteris elliptica*, *Ctenopsis insignis*, *Podozamites lanceolatus* and *Sapindopsis variabilis*. In addition, *Sphenopteris* (*Onychiopsis* ?) n. sp. is seemingly closely allied to *Thinnfeldia marylandica* Fontaine, *Acrostichopteris* n. sp. to *Baieropsis foliosa* Fontaine, and *Nageiopsis* cf. *N. zamioides* to *N. zamioides* Fontaine. On the basis of these few species alone no satisfactory correlation of the lower part of the Blairmore in terms of the Potomac may be made. Yet the flora of the upper part of the Blairmore which carries *Menispermites potomacensis*, *Celastrophyllum acutidens* ?, *Sapindopsis variabilis*, and *Araliaephyllum*, may with some confidence be correlated with that of the Patapsco formation. The appearance of dicotyledons in the earlier Blairmore flora certainly seems to link this closer to that of the Patapsco than to that of the earlier Patuxent-Arundel flora, and indicates that its chronological position may be represented by the hiatus that has been placed between the lower Potomac and Patapsco formation.

*Conclusion.* The lower flora of the Blairmore formation has closer affinities with the Kome flora than of any other described flora of Lower Cretaceous age. The flora is most probably Aptian in age because: (1) within it is the first appearance of unquestionable dicotyledons, of which one species at least, *Sapindopsis variabilis* ranges upward into the Albian flora of the upper part of the Blairmore formation; (2) there is no discernible break in sedimentation or lithology within the two hundred foot interval separating the two Blairmore floras; (3) common first appearance of *Sequoia* or of a closely allied genus in the flora; (4) the mixed flora of cycadeoids and angiosperms has an analogy in the petrified flora of the Lower Greensand (Aptian) of England. In support of an Aptian age is the affinity existing between the lower Blairmore flora and an Aptian flora from the Lago San Martin area, Patagonia, described by T. G. Halle (1913). The species common to the two floras are *Ruffordia goepperti*, *Sphenopteris psilotoides*, and *Athrotaxites ungeri*. The last mentioned is of most significance since its identification is based on fertile as well as upon sterile remains. Other elements in the Patagonian flora closely allied to some in the Blairmore flora are *Cladophlebis* cf. *browniana*, and *Sphenopteris* cf. *naktongensis* Yabe (perhaps con-specific with *Sphenopteris latiloba*). Moreover, fragments doubtfully referred to dicotyledons are present. The Aptian age of the Patagonian flora is in accord with ammonite evidence from associated beds, some of which apparently underlie the plant-bearing deposits.

Since the upper age limit of the Kootenay flora as set by the earliest Blairmore flora is probably Aptian, and since the lower age limit as set by the marine Fernie formation is early Upper Jurassic, either a late Jurassic or Neocomian-Barremian age for the Kootenay is possible. Which of these is the more probable must be decided from the evidence of the Kootenay flora itself.

## THE KOOTENAY FLORA.

A revision of the Kootenay flora present in the Blairmore area reduces the known species to fifteen. All but three of these were collected from beds lying within the upper half of the formation. The first and most notable feature of the flora is its almost entire lack of individuality, for of the 15 species present in the Kootenay only 3 are confined to that formation.

The remainder (see Figure) are all present in the younger Blairmore or equivalent Luscar and Gething formations. This range of species certainly does not suggest the presence of any time-break in sedimentation sufficient to embrace all Neocomian-Barremian time. On the contrary a late Neocomian (Infra Valenginian to Hauterivian inclusively) or early Barremian age for the upper part of the Kootenay in its type area is more probable.

The three species that are so far as known confined to the Kootenay are: *Sphenopteris* (*Adiantum* ?) *montanense*, *Nilssonia schaumburgensis* and *Czekanowskia dichotoma*. The first of these is a form-genus by no means well characterised specifically. Similar forms are represented by *Adiantum formosum* Heer (name preoccupied) from the Kome of Greenland, and by *Adiantum expansum* from Albian beds of Portugal. Hence the Kootenay species does not suggest a Jurassic age. *Nilssonia schaumburgensis* shows transitions from typical narrow forms of the species to forms approaching *Nilssonia californica* Fontaine, which are more common in Jurassic floras, but also present in formations of Alberta younger than the Kootenay. The typical forms of the species are characteristic of the Wealden and other Lower Cretaceous deposits. *Czekanowskia dichotoma* is about the only species present in the Kootenay that strongly suggests a Jurassic age. Even the genus is essentially Jurassic, and *Czekanowskia dichotoma* is apparently closely allied to, if not actually conspecific with the Jurassic *Czekanowskia rigida*. Yet the presence of *Czekanowskia dichotoma* in the Kome of Greenland, in deposits inferred by the writer to be younger than the Kootenay, was reported by Heer and confirmed by White and Schuchert. Another Jurassic "holdover," *Podozamites lanceolatus*, occurring in the Kootenay, ranges upward into the Blairmore formations and its equivalents. *Ctenis albertensis* Warren (=*Ctenis borealis* Dawson), claimed by Warren (Warren, P. S. 1927) to indicate a possible Jurassic age, occurs also, although rarely, in the Luscar formation. Indeed it is a surprising fact that the younger, presumably Aptian flora of the Blairmore, Luscar and Gething formations contains more of the characteristically Jurassic genera, e. g. *Sagenopteris*, *Zamites*, *Nilssonia* of the *orientalis* group, *Phoenicopsis*, and *Elatides*, than does the older flora of the Kootenay. This younger flora is almost as well differentiated from the Kootenay flora by the very pres-

ence of these "Jurassic elements" as by the entrance of new species. It is meaningless, therefore, to speak of "the Jurassic aspect" of the Kootenay flora in exclusion of the Blairmore flora.

In any chronological evaluation of a flora it is the entrance of new species that has significance. The flora of the Kootenay has so far provided too few species to permit dogmatic judgment as to its age, but the writer considers that the entrance within it of *Coniopteris heterophylla*, *Onychiopsis psilotoides*, *Ptilophyllum arcticum*, and *Ptilophyllum speciosum* weighs heavily in favour of a Lower Cretaceous age. The further fact that nearly all the species present in the Kootenay are likewise present in the younger flora of the Blairmore or equivalent formations, again lends strong support to a Cretaceous age. Whether the age of the Kootenay is Neocomian or Barremian or some part of both cannot as yet be satisfactorily determined by an analysis of the flora. In the Blairmore area the erosional unconformity at the base of the Blairmore formation is crossed by the ranges of a sufficient number of species to lead the writer to infer that the time-break, in that area at least, is only minor, and that the upper part of the Kootenay is there more probably Barremian or late Neocomian than Early-Neocomian (Infra Valanginian-Valanginian).

Beyond the Blairmore area little is known about the location of plant-bearing horizons within the Kootenay or in equivalent formations. A topmost part of the Nikanassin formation has supplied in places a few plants that are believed to indicate an age equivalent to an upper part of the Kootenay. Thus, from one locality in the Brule coalfield, 65 feet below the Cadomin conglomerate, a few plants were collected by B. R. McKay of the Geological Survey, Canada. They include *Equisetites lyelli* forma *burchardti*, *Onychiopsis psilotoides*, *Coniopteris* n. sp. 1, and *Czekanowskia dichotoma*. But from another locality, on North Hay River, the Nikanassin furnished *Nilssonia nigracollensis* and *Laccopteris* n. sp. Whether these two species indicate an earlier Lower Cretaceous or even an Upper Jurassic age for a lower part of the Nikanassin formation cannot be judged until more plant collections from accurately located horizons are forthcoming.

The plants from the Kootenai of Montana, to judge from published accounts, have added little to our knowledge of the flora of the Canadian Kootenay. From the time Canadian

geologists clearly differentiated the Blairmore and Kootenay formations (McLearn, F. H. 1916, 1929; Rose, B. 1917; Berry, E. W. 1929) it was evident that the Kootenai of Montana embraced parts of both the Kootenay and Blairmore formations of Alberta. Of the floral lists from five horizons in the lower Kootenai presented by Fisher (Fisher, C. A. 1908, pp. 33, 34) the two stratigraphically lowest could confidently be considered as the age of the Canadian Kootenay, while the remaining florules from 150 feet and more above the base of the formation could be assigned to the early flora of the Blairmore. The florule described by Newberry (1891, pp. 191-201) seemed to belong to the early Blairmore flora, whereas that described by Fontaine (in Ward, L. F. 1905, pp. 284-315) was apparently Kootenay. R. W. Brown (1946, pp. 241-244) has recently discussed the Kootenay species present in the basal part of the Montana Kootenai. It may be hoped that we will eventually be given the range of the species comprising the two or more floras in the Kootenai group of Montana.

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