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(Second Edition)

REVISION OF THE LOWER CRETACEOUS OF THE WESTERN INTERIOR OF CANADA

(Report and Twelve Fossil Plates)

BY

F. H. McLearn

LOWER CRETACEOUS

OTTAWA

1945

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INTRODUCTION

Since the publication of the first edition of this report in 1944, many fossil collections, made by field parties of companies searching for favourable oil structures, have been submitted to the Geological Survey for examination. The study of these collections has furnished new data on stratigraphy and correlation. This has mostly confirmed the views already set forth in the first edition, but some further revision is necessary. In addition, more detailed descriptions of stratigraphy seem advisable. Therefore, this second, enlarged edition has been prepared.

Until recently the Lower Cretaceous of the western interior[1] of Canada was known to include only one formation, the Kootenay;

[1] The western interior of Canada is here assumed to include the Rocky Mountains and Foothills Belt of eastern British Columbia and western Alberta, and the Great Plains of Alberta, Saskatchewan, and western Manitoba.

to consist only of non-marine deposits; and to occupy only a comparatively small area, namely, the southern and central foothills and mountains. Today at least thirty units of formational rank are required to define the complex and variable lithology of our Lower Cretaceous. They underlie a vast area, including parts of the Rocky Mountains and a large part of the Foothills and Plains, and they embrace beds of marine as well as non-marine origin. The increase in the number of Lower Cretaceous formations has been due to the recognition of new units in areas recently studied, and to the redemption of other units previously and erroneously assigned to the Upper Cretaceous.

Important field studies have been made by the staff of the Geological Survey, the Geological Departments of the western universities, the Research Council of Alberta, the British Columbia Department of Mines, and the geological staffs of private companies searching for oil in the Canadian west. Dr. L. F. Spath's studies of Gault ammonites, and of ammonites from the Lower Cretaceous of India have been of particular value, and his references to Canadian faunas are quoted. The present writer, however, is responsible for all correlations and for identifications of species.

STRATIGRAPHY

The Non-marine Southwest

In the western part of the Crowsnest Pass area and elsewhere within the Rocky Mountains, the Kootenay formation is very thick. In the Michel area, MacKay (1934)[1] has recorded 3,600+ feet of

[1] Dates within brackets refer to year of publication, and appear in list of references at the end of this report.

massive, coarse-grained, crossbedded, brown weathering sandstones, with some lenses of fine conglomerate, soft, sandy, grey and black shales, and coal seams. The strata carry plant remains and are of non-marine origin. The succeeding Blairmore group consists of 6,500 feet (estimated) of massive conglomerate, grey, greenish, and yellowish sandstones, light brown weathering shale, and thin coal seams; freshwater limestones are present in the upper part (MacKay, 1934).

To the east these formations are not as thick and are finer grained. Thus, in the Foothills, in the Coleman South area, the Kootenay consists of 600 to 800 feet of non-marine, grey-brown weathering sandstone, grey to black shales, and coal seams (MacKay, 1934). Plant remains are common. The overlying Blairmore strata consist of 1,800 to 1,850 feet of non-marine, greenish and reddish shales, light brown to greenish sandstones, and some conglomerate. At the base is a persistent bed of fine conglomerate, variously referred to as the basal member, basal Blairmore conglomerate (Hume, 1933), or merely the Blairmore conglomerate (Warren, 1938). It rests on the Kootenay with an erosional unconformity, and is about 25 feet thick (MacKay, 1934). Another conglomerate bed occurs near the top of the Blairmore group, and several beds of greenish limestone are present in the lower part. Plant remains and freshwater shells record a non-marine environment.

Both the Kootenay and the Blairmore persist northward along the Foothills Belt. In this direction the coal in the Kootenay becomes thinner, and finally disappears, and coal in substantial quantity appears in the Blairmore group. These and other changes produce a somewhat different succession in the central foothills, an example of which is the section exposed in the Mountain Park area (MacKay, 1930). There the basal Nikanassin formation, about 1,580 feet thick, consists of dark, carbonaceous shale, thin-bedded sandstones, and rare, thin, coaly beds. Plants occur in the upper part, which, at least, is non-marine. Above the Nikanassin is the Cadomin formation, consisting of about 25 feet of conglomerate. It is overlain by the Luscar formation, which consists of 1,600 feet of grey, thin-bedded sandstone, dark grey, carbonaceous shale, some conglomerate lenses, and commercial coal seams. Plant remains are present, but a brackish water fauna occurs near the base. It is probably mostly non-marine. The succeeding Mountain Park formation consists of about 390 feet of rusty weathering, crossbedded sandstones, rare conglomerate, and olive-green, sandy shales.

Non-marine of the North

In the northern Foothills, a considerable part, at least, of the Bullhead group is of Lower Cretaceous age, and of non-marine origin.

In Pine and Peace River Valleys this group can be divided into two formations, the Dunlevy and Gething (McLearn, 1923; Wickenden and Shaw, 1943; Beach and Spivak, 1944; McLearn and Irish, 1944). The Dunlevy formation is 3,000 to 3,200 feet thick (Beach and Spivak, 1944). The lower 2,600 to 2,800 feet consists of grey to brownish, massive, hard, well-cemented, mostly thick-bedded, partly feldspathic sandstones, crossbedded in places, some carbonaceous sandstone, and some dark shale. The lowest beds of this section carry marine shells, as at Teepee Rocks on Peace River, and are of marine origin. The highest beds, however, may be of non-marine origin. As will be noted later, there is a possibility that the basal marine beds are of Jurassic age. The uppermost 400 feet of the Dunlevy, as measured by Beach and Spivak (1944), consists of thick beds of fine conglomerate and sandstones with zones of dark shale, siltstone, and thin coal seams. Plant remains are common, and the containing strata are evidently of non-marine origin. The overlying and conformable Gething formation is approximately 1,400 feet thick (McLearn, 1923). It includes light grey to brownish, thick- to thin-bedded, massive to layered or flaggy, coarse to fine sandstones; ripple-marked, flaggy siltstones; grey to black, thick- to thin-bedded shales; clay ironstones; and commercial coal seams. Some of the sandstones and siltstones are crossbedded. Conglomerate is very rare. Well-preserved plant remains occur at various horizons, and the entire formation seems to be of non-marine origin.

Northward, in the area drained by Halfway and Sikanni Chief Rivers (Hage, 1944), important changes take place, and it does not seem possible to subdivide the Bullhead group there. Plant remains become more rare; coal seams are thinner; and no marine beds are recorded at the base. Still farther north the group thins out and is absent on the Alaska Highway, in Tetsa Valley, and on Liard River (Kindle, 1944).

In the core of the Guardian well in the Pouce Coupé district, British Columbia, 2,000 feet of sandstone and shale have been compared with the Bullhead group by Allan and Stelck (1940). The presence of some coaly layers indicates non-marine conditions in part, but the presence of glauconite suggests that some layers are marine.

In the eastern and lower part of Athabaska River the McMurray formation, or "Tar sands" consists of 110 to 180 feet of sandstone and argillaceous sandstone with rare conglomerate and shale (McLearn, 1917). In places, the sandstones are heavily saturated with asphaltum. A main feature is the large scale crossbedding, with slopes of 5 to 40 degrees. The top beds are horizontal. The formation, therefore, has a delta-like structure, with 'topset' and 'foreset' beds. Plant and wood remains and freshwater shells are present, and the formation is at least mostly of non-marine origin.

The McMurray formation has not been recognized in lower Peace River Valley, but about 275 feet of sandstone below the shales of the Loon River formation, in wells near the town of Peace River, may possibly be a western extension of this formation.

The Marine Fort St. John Group in the North

In the northern Foothills and Plains the Fort St. John is mainly a marine group, and includes many formations definitely of late Lower Cretaceous (Albian) age, as well as some only tentatively assumed to be of that age.

Along Pine River, Wickenden and Shaw (1943) recognize, in ascending order, the Moosebar, Commotion, Hasler, Goodrich, and Cruiser formations. The Moosebar consists of 800 feet of dark shale, with brown weathering concretions, and some beds of sandstone. It contains rare glauconite and sparse marine shells, and is probably largely, if not entirely, of marine origin. The Commotion includes 1,300 to 1,500 feet of fine conglomerate, sandstone, dark grey shale, and, near the top, some coal. Marine shells are present, and the formation is partly of marine, and partly of non-marine, origin. The Hasler consists of 1,100 to 1,200 feet of dark grey, probably marine shale, with some thin beds of fine sandstone and siltstone. The Goodrich contains 550 to 600 feet of marine sandstone and a little shale, marine shells being very common at some horizons. The Cruiser consists of 800 to 900 feet of dark grey shale with some layers of sandstone.

In western Peace River Valley (McLearn, 1923; Beach and Spivak, 1944) the Fort St. John group includes the Moosebar, Gates, Hasler, Goodrich, and Cruiser formations. A conglomerate, 2 feet thick in the canyon and 35 feet thick north of the canyon, immediately overlies the Gething formation of the Bullhead group. Above are 800 to 1,200 feet of dark shale of the Moosebar formation, with beds of sandstone near the top and, in places, marine shells. The overlying Gates formation is 250 to 400 feet thick, and consists of shales and sandstones with occasional plant fragments and marine shells.

The succeeding Hasler formation consists of more than 700 feet of grey to black shale and, at the top, some thin beds of sandstone. The Goodrich contains about 550 feet of buff to light grey sandstones and dark shales, with some conglomerate in places near the base. Marine shells are present, and the formation, as in Pine River Valley, appears to be entirely of marine origin. The succeeding Cruiser formation includes more than 900 feet of dark shales and some sandstones (Beach and Spivak, 1944).

Farther north, along Buckinghorse and Sikanni Chief Rivers, the Fort St. John group includes the Buckinghorse and Sikanni formations (Hage, 1944). The Buckinghorse consists of 3,000 to 3,600 feet of dark shale with marine fossils. The Sikanni comprises 980 feet of dark shale with four thick sandstone members in the lower part. Marine shells are common in the sandstones.

On the Alaska Highway, west of Muskwa and Fort Nelson, Williams (1944) records 500 feet of shale, 600 feet of cliff forming sandstones, and, at the top, 250 feet of shale. Marine shells are present in places in the sandstones.

On Liard River, Kindle (1944) includes the Garbutt, Scatter, and Lepine formations in the Fort St. John group. The Garbutt consists of about 2,000 feet of dark, friable shale with concretions. The overlying Scatter formation comprises about 750 feet of sandstone and shale, with marine shells. The succeeding Lepine is composed of about 2,000 feet of grey and black shale with concretions carrying marine fossil shells.

South of Peace and Pine River Valleys, in the Monkman Pass area (McLearn and Henderson, 1944), the Fort St. John section includes a formation of sandstone and conglomerate with some fossil leaves, lithologically resembling the Commotion formation in Pine River Valley. It is overlain by a thick section of dark shale comparable with the Shaftesbury formation of the eastern part of Peace River Valley. The section below the conglomerate has not been studied.

In the Guardian well, in the Pouce Coupé district, Allan and Stelck (1940) have referred 490 feet of shale to the Moosebar, 140 feet of sandy shale to the Gates, and about 460 feet to the 'St. John', that is to the Shaftesbury. The last formation, where exposed east of Cache Creek, contains marine fossils.

In the eastern part of Peace River Valley (McLearn, 1918) the Fort St. John group includes the Loon River, Peace River, and Shaftesbury formations. The Loon River, as observed in well borings near the town of Peace River, consists of more than 800 feet of dark grey shale, and contains marine shells in a few places. The Peace River formation consists of three members, a lower sandstone, a middle shale, and an upper sandstone or Cadotte member. The lower sandstone, about 160 feet thick near the town of Peace River, carries marine fossils and is of marine origin. The middle shale is 30 feet thick. The Cadotte member, near the town of Peace River, is 130 feet thick, consists of massive, cross-bedded sandstone with a bed of impure lignite, and is probably in part at least of non-marine origin. Northward it thins, and passes over into thin-bedded sandstone and shale containing marine fossils. The overlying Shaftesbury formation is about 600 feet thick near Judah (Rutherford, 1930) and consists of dark grey shale.

On Athabaska River, from a little below the mouth of the Pelican to Fort McMurray, the Fort St. John group includes the Clearwater, Grand Rapids, and 'Pelican shale' formations (McLearn, 1917). The marine Clearwater formation consists of approximately 275 feet of grey and green sandstones, grey and black shales, and some hard, concretionary layers. Marine shells are common in places. The Grand Rapids formation is composed of about 280 feet of sandstone and some shale. The lower part is of marine origin, as it carries marine shells. The upper part contains thin coal seams and rootlets, and is likely of non-marine origin. The succeeding marine 'Pelican shale' is approximately 90 feet thick, and consists of dark shale with rare fragments of shells of the marine pelecypod genus Inoceramus.

Formations of the Manitoba Escarpment

The Swan River formation of the Manitoba escarpment is probably in part of Lower Cretaceous age. It varies considerably from place to place, consisting of sandstone, shale, and clay, including some refractory clay. A little coal is present, and some marine fossils have been collected, so that the formation is partly of marine and partly of non-marine origin. It varies in thickness from a few to 400 feet (Wickenden, 1945).

A part of the Ashville formation may also be of Lower Cretaceous age. It consists of dark grey to black, partly carbonaceous, almost fissile shale, with a little sandstone and siltstone. It contains marine foraminifera, and is probably of marine origin. The thickness is from 100 to 200 feet (Wickenden, 1945).

Subsurface Beds of the Southern Plains

The 'varicoloured beds' of sandstone and grey, greenish, and reddish shales, with rare, very thin, coal seams, encountered in deep wells of the south Alberta plains above Jurassic strata and below beds correlated with the Alberta formation, have been referred to the Lower Cretaceous (Yarwood, 1931, 1931A). They contain sparsely distributed non-marine shells, which, with coal and plant remains, point to a mostly non-marine environment. As, however, a few marine fish remains have been found (Yarwood, 1931A), some temporary marine floods are inferred.

These 'varicoloured beds' have also been recognized in deep wells in southern Saskatchewan (Wickenden, 1932). Overlying them are marine, dark shales from which Wickenden has collected a marine microfauna.

CORRELATION[1]

Use of Lithology

In sections along the Foothills Belt, from southeast to northwest, the most persistent lithological unit is the conglomerate at the base of the Blairmore group, continuing to the northwest as the Cadomin conglomerate in the central Foothills (Warren, 1938), and as

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[1] Correlation is here used in the sense of time or age-correlation.

the upper and conglomerate-bearing part of the Dunlevy formation in Pine and Peace River Valleys. Above this persistent lithologic unit, and so occupying a similar stratigraphic position with relation to it, lie the greater part of the Blairmore group of the south, the Luscar formation of the central Foothills, and the Gething formation in the northwest, suggesting that these formations are of the same age. Underlying this persistent conglomerate, and occupying a similar stratigraphic position with relation to it, are the Kootenay and Nikanassin formations, and the lower, but greater part of the Dunlevy formation, suggesting that these are, at least partly, contemporaneous (See Warren, 1938).

It might be inferred that the coal-bearing units along the Foothills would afford an additional source of lithological correlation. At first sight their use as a criterion seems to contradict the correlation based on the persistent conglomerate unit; in the south, the coal-bearing unit, the Kootenay formation, lies below the conglomerate; in the central and northern Foothills the main coal-bearing units lie above the conglomerate. However, careful field study has shown that there is no contradiction. The coal-bearing strata of the south are not continuous with those of the central and northern Foothills. The coal seams of the Kootenay gradually disappear to the north, beneath the conglomerate. In the same direction coal gradually appears above the conglomerate, first as a single seam in the Blairmore of Turner Valley, and increasing finally to the several commercial seams of the Luscar and Gething formations of the central and northern Foothills respectively (See Warren, 1938).

The conglomerates, sandstones, and rarer shales lying in the stratigraphic position of the Bullhead group in Halfway, Sikanni Chief, and Buckinghorse Valleys have been referred to this group (Hage, 1944) on the evidence of lithological resemblance and stratigraphic position alone, as no fauna or flora have yet been collected from them.

It is very important to determine just what part of the non-marine Blairmore group of the southern Foothills is equivalent in age to the marine Fort St. John group in the north. Lithological criteria fail utterly, and other criteria will be introduced later in this report to solve the problem.

Some lithological comparisons, however, can be attempted within the Fort St. John group in the north along the Foothills Belt. In Monkman Pass a succession of massive sandstones and conglomerates bears a close resemblance to the Commotion formation of the Pine River foothills. Farther north in Peace River Valley, the sandstones of the Gates formation lie at about the same stratigraphic level as the Commotion. The lithological identity is not complete, however, as there are no conglomerates in the Gates. Other criteria are required to define the exact relation of the Gates to the Commotion. The former appears to thin out to the north, as it has not been recognized in any sections north of the Peace. In Monkman Pass a thick shale unit lies between the sandstone-conglomerate unit or 'Commotion' and Dunvegan, thus occupying the stratigraphic position of the combined Hasler, Goodrich, and Cruiser formations on Pine River. The sandstones of the Goodrich formation have been traced northward to, or almost to, the banks of Peace River, so that, presumably, this formation and the preceding and succeeding Hasler and Cruiser formations can be recognized there. Farther north in Sikanni Chief and Buckinghorse Valleys the lithology has so changed that no correlations can be made on that basis. Indeed, a new classification with new formational names has been found necessary by Hage (1944). The lithology is also different in Liard River Valley, and Kindle (1944) has of necessity proposed a new formational classification. Criteria other than those based on lithology are required to date these northern strata.

In the southern part of the western interior of Canada, lithology has been used in making correlations from west to east across mountains, foothills, and plains. A correlation of the Kootenay in the Rocky Mountains, for example, at Michel, British Columbia, with the Kootenay in the Foothills, as in the Blairmore area, can be attempted on lithological evidence alone with some degree of accuracy, although it will be shown that this correlation is not dependent solely on lithology. To the east, in deep wells under the Plains, it is not possible to identify the Kootenay on the basis of lithology or any other evidence, and it is probable that this formation does not extend very far in that direction. The correlation of beds above the Kootenay in the Rocky Mountains with the Blairmore group in the Foothills has been based entirely on lithology and relative stratigraphic position, principally on the presence in common of beds of conglomerate. The 'varicoloured beds' in the deep wells of southern Alberta and Saskatchewan are assumed to be an eastward extension of, and of the same age as, the Blairmore group of the Foothills on the basis of a similar basal conglomerate, and similar greenish and reddish shales. The presence of a few thin coal seams in the 'varicoloured beds' might suggest a comparison on a lithological basis with the Kootenay, but, as will be seen in a subsequent paragraph, the correlation with the Blairmore is confirmed by faunal evidence. It does not seem possible to compare chronologically, on lithological evidence, the marine dark shale that overlies the 'varicoloured beds' in southern Saskatchewan, with any other unit.

Some interesting age correlations from west to east across the northern Plains, can be attempted on the basis of lithology and stratigraphic position. The comparison, by Allan and Stelck (1940), of beds in the Guardian well on the Plains with the Gething formation in the Foothills is made on such a basis. Both the Gething and the Guardian well beds overlie a conglomerate, and both consist of sandstone and shale and carry coal seams. The percentage of shale at the Guardian well is, however, higher than in the Gething, the coal seams are much thinner and fewer, and glauconite, unknown in the Gething, implies a marine environment for a while at least. As these beds in the Guardian well overlie beds tentatively referred to the Jurassic Fernie group, the implication is that the Kootenay equivalent, that is some part of the Dunlevy formation below the conglomerate zone is absent and does not extend this far east under the Plains. In this well, also, a shale zone and sandstone zone are compared respectively on the basis of lithological resemblance with the Moosebar and Gates formations (Allan and Stelck, 1940). A shale unit, at a higher level, occupies the stratigraphic position of the Hasler, Goodrich, and Cruiser formations in the Foothills. This, presumably, is the shale unit that in its upper part carries the Neogastroplites fauna in the river cliffs east of Cache Creek and near the old Fort St. John trading post. The formational name "Shaftesbury" can be applied, at least tentatively, to this shale, although the type area of the formation is farther east and northeast of Dunvegan and in the vicinity of the town of Peace River.

An attempt can be made to compare chronologically the formations on lower Peace River with those on the lower Athabaska, on lithological evidence alone. It will be shown later, however, that other criteria can also be used. The sandstones underlying the shales of the Loon River formation in wells near the town of Peace River can be compared with those of the McMurray formation on the Athabaska, the shales of the Loon River formation with those of the Clearwater, the sandstones of the Peace River formation with those of the Grand Rapids, and the shales of the Shaftesbury with those of the 'Pelican shale' formation on Athabaska River.

Use of Floras

The Canadian Lower Cretaceous floras were studied long ago by Sir William Dawson, and more recently they have been studied by Professor E. W. Berry of John Hopkins University and by W. A. Bell of the Geological Survey. The work of Dawson suffered from an inadequate knowledge of the sequence of floras. The studies of both Berry and Bell, however, have been based on a succession of floras obtained in 1915 from the Blairmore and Castle River areas, Alberta. This succession consists of the Kootenay, a flora of ferns, cycads, and conifers; the Lower Blairmore or Luscar flora, with a similar composition, but having in addition extremely rare dicotyledons; and the Upper Blairmore, a flora with numerous dicotyledons (McLearn, 1916). Bell has been able to recognize these floras, and in particular the Lower Blairmore or Luscar, in collections from many localities in the western interior Plains and Foothills, and also in the interior of British Columbia (Bell, 1944).

The Kootenay flora has been collected in the Kootenay formation of the Michel, Castle River, Blairmore, and other areas in the southwest, making possible the identification of this formation both within the Rocky Mountains and the Foothills. It has also been collected in the top of the Nikanassin formation on Thornton Creek, in the Mountain Park area, Alberta, showing that a part at least of that formation is of the same age as the Kootenay. No flora has yet been found in the Dunlevy formation to the northwest, and its correlation with the Nikanassin must remain based on its stratigraphic position with relation to the persistent conglomerate already referred to. The Kootenay has been dated Neocomian or Barremian (See Figure 1) in the Curopean chronology (Berry, 1929; Bell, 1944).

The Lower Blairmore or Luscar flora occurs in the lower part of the Blairmore group of the southern Foothills, in the Luscar formation of the central Foothills, and in the Gething formation of the northern Foothills. This confirms and establishes the correlation based on similar stratigraphic position. It permits a more exact dating than does the evidence of stratigraphic position; thus, it shows that only the lower part of the Blairmore of the Blairmore area is of the same age as the Luscar and Gething formations. This flora is dated Aptian in the European chronology (Berry, 1929; Bell, 1944).

The Upper Blairmore flora has been known until recently only in the upper part of the Blairmore group in the southern Foothills. It has, however, been found recently, in very small collections, in the Commotion formation of the Pine River foothills (Wickenden and Shaw, 1943), and in beds at Monkman Pass thought to be of the same age on the basis of lithological evidence (McLearn and Henderson, 1943). As, however, the collections from the Fort St. John are small, the age-correlation based on them needs corroboration, and will be referred to later in connection with the use of marine faunas.

An Upper Blairmore flora could be anticipated in the Mountain Park beds, but no plants have yet been collected from this formation.

The Upper Blairmore flora appears to be synchronous with that of the Cheyenne sandstone of Kansas (Berry, 1929), which is of Albian age in the European chronology (See also Bell, 1944).

Use of Non-marine Faunas

The Lower Blairmore Unio[1] (Quadrula) natosini fauna

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[1] Unio is used in a broad sense in this report. It is more familiar to geologists than the names used in the recent generic revision of the fossil Unionidae by Russell (1934). In a work on systematic palaeontology for the information of palaeontologists the writer would use Elliptio and Quadrula as genera and use Unio only in its restricted sense.

(See Plate I) occurs in the lower part of the Blairmore group in the Blairmore area, where it includes Unio (Quadrula) natosini, Unio (Elliptio) hamili, Unio (Elliptio) douglassi, Sphaerium onestae, and Corbula? palliseri. This non-marine fauna is coeval with the Lower Blairmore flora. Farther north, in the Pekisko Forest Reserve, Hage has collected two species of this fauna, Sphaerium onestae and Corbula? palliseri, recording the presence there of beds comparable with the lower part of the Blairmore group. On Elbow River, yet farther north, Beach collected Unio (Elliptio) cf. hamili, recording the presence of beds of Lower Blairmore age. Yarwood (1931A) has reported the occurrence of Unio (Elliptio) hamili and Sphaerium onestae? from the 'varicoloured beds' in a deep well in southern Alberta. This supports an age correlation based on lithological evidence, but is a more exact correlation, as it shows that the part of the 'varicoloured beds' carrying the fauna are of the same age as the lower part of the Blairmore group, and not the equivalent of the entire group.

The same fauna, although with a somewhat different content, has been collected in the Luscar formation of the central Foothills by a geologist of an oil company. There it includes (See Plate II) Unio (Quadrula) natosini, 'Murraia' fabensis n.sp., and 'Unio' lacombi n.sp.

A similar fauna occurs in the Kootenai formation of Montana, and has been described by Stanton (1903). Two species are common to the lower part of the Blairmore of Alberta and the Kootenai of Montana, Unio (Quadrula) natosini and Unio (Elliptio) douglassi. It follows that the lower part of the Blairmore group is of the same age as some part of the Kootenai of Montana.

The fauna described by Russell (1932) from the McMurray formation on lower Athabaska River includes (See Plate II) Unio (Elliptio) biornatus, Murraia naiadiformis, Melania multorbis, and other freshwater gasteropods. Russell makes a provisional correlation with the Lower Blairmore, but notes that if the two faunas are not strictly of the same age, the McMurray may be the older.

Use of Marine Faunas

The marine faunas share with the floras the advantage of affording age-correlation with far distant localities, because they exhibit a wide distribution of identical or closely related genera and species. Compared with the floras and most non-marine faunas, the marine faunas undergo, on the average, a more rapid evolution, providing more faunal zones and thus a more exact age-correlation. This is particularly true of the rapidly changing ammonoids, and of the more rapidly evolving genera of pelecypods, such as Inoceramus.

The basal sandstones of the Dunlevy formation, on Tepee Rocks Spur in the Peace River foothills, have provided, among other pelecypods, a few poorly preserved specimens of what appears to be a small species of Aucella. Similar poorly preserved specimens have been obtained from the Nikanassin formation. Although indeterminate, they suggest small Jurassic species with even, concentric ornament. However, until better specimens are obtained, it seems best to leave all of both the Nikanassin and Dunlevy formations in the Cretaceous.

The 'Astarte' natosini fauna is little known as yet, and only one species 'A' natosini (See Plate II) has been described. It is a depauperate fauna consisting of some small pelecypods and rare gasteropods, and records a marine or brackish water habitat. It occurs at the base of the Luscar formation in the Mountain Park area, and at the top of the McMurray formation on Athabaska River. Its value as a criterion for correlation is as yet obscure.

Important correlations within the Fort St. John group can be made with the aid of the Lemuroceras or Beudanticeras affine fauna. The following species are illustrated (See Plates III, IV, and V): Lemuroceras cf. indicum Spath, L. belli n. sp.; L. irenense n.sp., Beudanticeras affine Whiteaves, B. cf. glabrum Whiteaves, Inoceramus dowlingi, Astarte portana n. sp., Aucellina? dowlingi n.sp., Yoldia kissoumi, Nucula athabaskensis, Protocardia alcesiana, Onestia onestae, Oxytoma camselli, Entolium irenense, Brachydontes athabaskensis, Tancredia? dowlingi, T.? dowlingi var. silentia n.var., Thracia kissoumi, Arctica limpidiana, and Arctica sp. This fauna has been collected in the Moosebar and Gates formations in Peace River Valley; in the lower part of the Buckinghorse formation, from the Sikanni Chief and adjacent rivers; in the Loon River formation and lower sandstone member of the Peace River formation on lower Peace River; and in the Clearwater formation on lower Athabaska River. Hume has collected fragments of this fauna from Mackenzie River Valley, and Warren has reported it from Great Bear Lake. Thus, the distribution of this fauna makes possible the age-correlation of some widely spread formations.

Spath has recorded Lemuroceras from the 'Ammonite bed' of the Abur group in India, and from Madagascar (Spath, 1942). He notes that the specimens from Madagascar are associated with ammonites of Albian age, that is, very late Lower Cretaceous.

The Gastroplites fauna (See Plates VI, VII, and VIII) also has played an important part in correlations within the Fort St. John group. The most important units of the fauna are species of Gastroplites, of which Gastroplites kingi, G. canadensis, and G. spiekeri are illustrated. Next in importance are the pelecypods Inoceramus cadottensis and I. cadottensis var. altifluminis. Other pelecypods illustrated are Dicranodonta dowlingi and Trigonia albertensis. Of particular interest are the starfish Lophidiaster silentiensis, L. cf. silentiensis, and Comptonia? stelcki.

This fauna affords a means of correlating the lower part of the Hasler formation in Peace River Canyon in the west with the Cadotte member of the Peace River formation in the east, the correlation being based on Gastroplites and Inoceramus. The presence of an Inoceramus diagnostic of the Gastroplites fauna in the upper part of the Commotion formation in Pine River Valley permits a correlation of the upper part of this formation with the lower part of the Hasler on Peace River. The implication is that the Hasler extends to a lower horizon in Peace Valley than in Pine Valley, and that the Gates is only a northern remnant of the lower part of the Commotion formation; that is, the sandstone and conglomerate of the upper part of the Commotion disappear to the north, and on the Peace are replaced by the shale of the lower part of the Hasler formation. The genus Gastroplites has been located in the lower part of the

Lepine formation farther north, on Liard River. Inoceramus cadottensis has been found in both the lower part of the Lepine and upper part of the Scatter formation on the same river. This provides a correlation of the upper part of the Commotion on the Pine with the lower part of the Hasler on the Peace, and with the upper part of the Scatter and lower part of the Lepine on Liard River. The equivalent beds on Sikanni Chief and Buckinghorse Rivers are probably the middle or upper parts of the Buckinghorse formation. The Gastroplites fauna, however, has not yet been located definitely in that area. The same fauna, represented by Inoceramus cadottensis, has been collected from unnamed beds far to the north, on Carcajou River, and at Sans Sault rapids on Mackenzie River.

In England, Gastroplites has been found in the cristatum zone of the Gault of Folkestone, and is of Upper meso-Albian age in the European chronology (Spath, 1937).

The Neogastroplites fauna was first collected by Selwyn (1877) in 1875 from the north bank of Peace River between Cache Creek and the old Fort St. John trading post. It occurs in the upper part of what is now known as the Shaftesbury formation. Fossils collected from this locality include Neogastroplites cornutus, N. selwyni, Nucula dowlingi, and Posidonomya nahwisi (See Plates IX and X).

The fauna of the Goodrich formation (See Plate X) includes Oxytoma pinania n.sp., Posidonomya nahwisi var. goodrichensis, P. nahwisi var. moberliensis, Entolium sp., Pleuromya wickendeni n.sp., P. kissoumi n.sp., Tancredia stelcki n.sp., and Lucina? goodrichensis n.sp. Specimens of Oxytoma are very common, and in the field this formation has been called the Oxytoma sandstone. The varieties of P. nahwisi also are common in places, and this could be called the P. nahwisi goodrichensis fauna.

The association of species in collections recently submitted by an oil company from the sandstone members of the Sikanni formation shows that the Neogastroplites and P. nahwisi goodrichensis faunas are not distinct, but are parts of one and the same fauna. The first sandstone member of the Sikanni formation contains (See Plate XI) Neogastroplites cf. cornutus, Oxytoma pinania n.sp., Posidonomya nahwisi var. goodrichensis, and Solecurtus ? (Azor?) sp. The fauna of the second sandstone (See Plate XI) includes Neogastroplites cornutus, Pteria via-media n.sp., Posidonomya nahwisi var. goodrichensis, Pecten burlingi n.sp., Corbicula? sp., and Thracia stelcki n. sp. A Pinna and a Pleuromya are very characteristic of the third sandstone, the fauna of which includes (See Plate XII) Modiolus via-alaska n.sp., M. archisikanni n.sp., Pinna hagi n.sp., Posiodonomya nahwisi var. goodrichensis, Pleuromya sikanni n.sp., and Thracia? yarwoodi n.sp. The fauna of the fourth sandstone includes (See Plate XII) Neogastroplites? sp., Oxytoma sp., Tancredia stelcki n.sp., and Pharus sp.

It follows from the above faunal records that the Goodrich formation can be correlated with that part of the Sikanni formation that contains the four sandstone members, and it can also be correlated with the upper part of the Shaftesbury formation on Peace River between Cache Creek and the site of the old Fort St. John post. Beds of this age have also been located on the Alaska Highway west of Muskwa, where Posidonomya nahwisi var. goodrichensis has been collected (Williams, 1944).

The exact dating of this Neogastroplites or P. nahwisi goodrichensis fauna is difficult. Neogastroplites is not known outside of northeastern British Columbia. It is close to the Albian genus Gastroplites and, apparently, has developed out of it. This, however, is not necessarily a criterion of Lower Cretaceous age, for the very diagnostic Cenomanian and early Upper Cretaceous genus schloenbachia is the end development of another stock of the dominantly Lower Cretaceous family, the Hoplitidae (Spath, 1942), Posidonomya nahwisi and its varieties are also not known outside of northeastern British Columbia, and there are no other pelecypods in the fauna that would support a correlation with other parts of North America or other parts of the world. Its Lower Cretaceous and late Albian dating are only tentative, and must remain so until fossils better suited to distant correlation are found.

Foraminifera have been used by Wickenden to correlate formations on the Plains. Thus Haplophragmoides gigas has been found in the 'Pelican shale' formation on Athabaska River (Wickenden, R.T.D., personal communication; Feniak, M., 1944) and in the dark grey shale that overlies the 'varicoloured beds' in southern Saskatchewan (Wickenden, 1932). This affords an interesting correlation. Wickenden has also found a microfauna that occurs both in the Shaftesbury formation of Peace River and in the Ashville formation of the Manitoba escarpment.

In leaving in abeyance the question of the Lower or Upper Cretaceous age of the Goodrich and Sikanni formations, it should be noted that we are also leaving open the question of the age of the Shaftesbury and Ashville formations, and also the age of the marine, dark shales that overlie the 'varicoloured beds' of southern Saskatchewan.

As already noted, the major problem of our Lower Cretaceous is to determine within the non-marine beds of the south the time-equivalents of the marine beds of the Fort St. John group of the north. The direct evidence based on the presence of a common flora has already been considered, but it has been noted that this evidence is incomplete and needs corroboration. Indirect evidence is, consequently, appealed to. It has already been pointed out that the Fort St. John group is of Albian age in the European chronology, and this determination is based on the similarity of the Fort St. John faunas to faunas of known age in other parts of the world. The only reservation made is that the age of the upper part of the group, the part with the Neogastroplites fauna, is somewhat doubtful; that is, there is the possibility that the upper part is of very early Upper Cretaceous age. However, for the present the entire group is assumed to be of Albian age (See Figures 1 and 2). In the southern Foothills it has been determined that the upper part of the Blairmore group, that is, the part with the Upper Blairmore flora, is also of Albian age, and this result is based on the similarity of the Upper Blairmore flora to floras elsewhere of known Albian age. So, on the basis of indirect evidence, the Fort St. John group is of the same age as the upper part of the Blairmore group. It is unlikely that any appreciable part of the overlying Alberta shale in the southern Foothills could also be equivalent in time to any part of the Fort St. John group, because the lowest Alberta zone, the "Barren zone" carries fossils of Upper Cretaceous age, and is only 110 feet thick (Webb and Herltein, 1934). Both the direct and indirect evidence are, consequently, in accord in giving a time correlation of the Fort St. John group with the upper part of the Blairmore group.

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	Europe	Blairmore Alta.	Mountain Park Alta.	Monkman Pass B·C·	Pine River Valley B·C·	West Peace River Valley B·C·	Sikanni Chief River Valley B·C·	Liard River Valley B·C·	Ammonoid Zones	Pelecypod Zones
		FOOTHILLS — SOUTHEAST TO NORTHWEST								
Lower Cretaceous ?	Albian ?	Basal Alberta shale ?	Blairmore group: Mountain Park	'Shaftesbury'	Fort St. John group: Cruiser	Fort St. John group: Cruiser	Fort St. John group: Sikanni (4th SS., 3rd SS., 2nd SS., 1st SS.)	Fort St. John group: Lépine	*Neogastroplites*	*Posidonomya nahwisi* and varieties
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group: Mountain Park	'Shaftesbury'	Fort St. John group: Goodrich	Fort St. John group: Goodrich	Fort St. John group: Sikanni (4th SS., 3rd SS., 2nd SS., 1st SS.)	Fort St. John group: Lépine	*Neogastroplites*	*Posidonomya nahwisi* and varieties
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group: Mountain Park	'Shaftesbury'	Fort St. John group: Hasler	Fort St. John group: Hasler	Fort St. John group: Buckinghorse	Fort St. John group: Lépine		
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group: Mountain Park	'Commotion'	Fort St. John group: Commotion	Fort St. John group: Hasler	Fort St. John group: Buckinghorse	Fort St. John group: Scatter	*Gastroplites*	*Inoceramus cadottensis*
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group: Mountain Park	'Commotion' ↓	Fort St. John group: Commotion	Fort St. John group: Gates	Fort St. John group: Buckinghorse	Fort St. John group: Garbutt		
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group: Mountain Park		Fort St. John group: Moosebar	Fort St. John group: Moosebar	Fort St. John group: Buckinghorse	Fort St. John group: Garbutt ↓	*Lemuroceras and Beudanticeras affine*	*Inoceramus dowlingi*
LOWER CRETACEOUS	Aptian	Blairmore group	Blairmore group: Luscar	?	Bullhead group: Gething	Bullhead group: Gething	Bullhead group			*'Astarte' natosini* *Elliptio douglassi* *Quadrula natosini*
LOWER CRETACEOUS	Aptian	Blairmore group	Blairmore group: Cadomin	?	Bullhead group: Dunlevy	Bullhead group: Dunlevy	Bullhead group			
LOWER CRETACEOUS	Neocomian: Barremian	Kootenay	Nikanassin ↓	?	Bullhead group: Dunlevy ↓	Bullhead group: Dunlevy ↓	Bullhead group ↓			
LOWER CRETACEOUS	Neocomian	Kootenay	Nikanassin ↓	?	Bullhead group: Dunlevy ↓	Bullhead group: Dunlevy ↓	Bullhead group ↓			

Figure 1

Table showing correlation of LOWER CRETACEOUS formations in the Foothills Belt, and their stratigraphic positions with relation to certain known fossil zones.

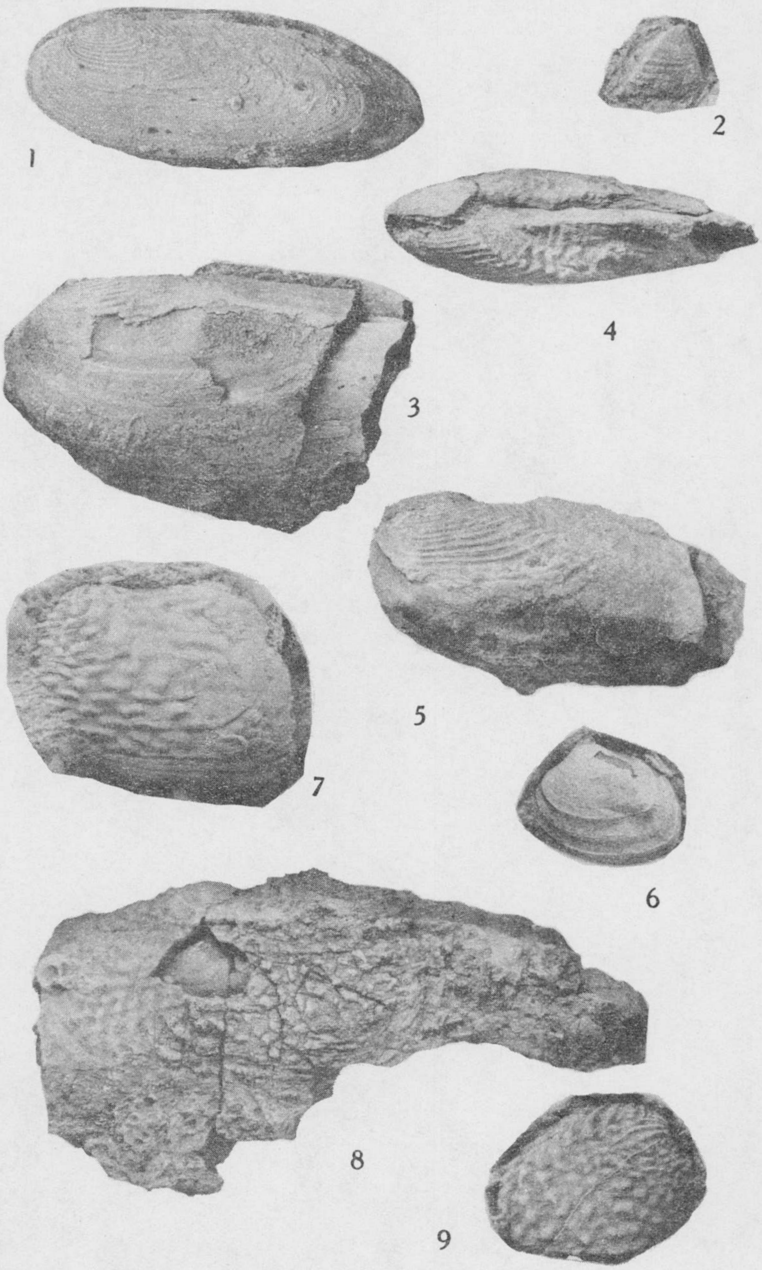
	Europe	Southern Mtns, Foothills, and Plains – West to East: Michel B.C.	Blairmore, Alta.	Southern Plains of Alberta	Southern Plains of Saskatchewan	Manitoba escarpment	Northern Foothills and Plains – West to East: West Peace River Valley B.C.	East of Cache Creek and Guardian well B.C.	East Peace River Valley Alta.	East Athabaska River Valley Alta.	Ammonoid Zones	Pelecypod Zones
Lower Cretaceous ?	Albian ?	?	Basal Alberta shale ?		Dark grey shale	Ashville ↑	Fort St. John group: Cruiser	Fort St. John group: 'Shaftesbury'	Fort St. John group: Shaftesbury	Fort St. John group: 'Pelican shale'		
Lower Cretaceous ?	Albian ?	Blairmore group	Blairmore group		Dark grey shale	Ashville	Goodrich	'Shaftesbury'	Shaftesbury	'Pelican shale'	*Neogastroplites*	*Posidonomya nahwisi* and varieties
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group	↑ 'Varicoloured beds'	'Varicoloured beds'	Swan River	Hasler	'Shaftesbury'	Shaftesbury	'Pelican shale'		
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group	'Varicoloured beds'	'Varicoloured beds'	Swan River	Hasler	↑	Peace R.: Cadotte member	Grand Rapids	*Gastroplites*	*Inoceramus cadottensis*
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group	'Varicoloured beds'	'Varicoloured beds'	Swan River	Gates	'Gates'	Peace R.: Shale; Lower Sandstone	Grand Rapids		
LOWER CRETACEOUS	Albian	Blairmore group	Blairmore group	'Varicoloured beds'	'Varicoloured beds'	Swan River	Moosebar	'Moosebar'	Loon River	Clearwater	*Lemuroceras* and *Beudanticeras affine*	*Inoceramus dowlingi*
LOWER CRETACEOUS	Aptian	Blairmore group	Blairmore group	'Varicoloured beds' ↓	'Varicoloured beds' ↓	Swan River	Bullhead group: Gething	Bullhead group: 'Gething' ↓	'McMurray'	McMurray		*'Astarte' natosini* *Elliptio hamili* *Elliptio biornatus* *Elliptio douglassi* *Quadrula natosini*
LOWER CRETACEOUS	Neocomian: Barremian	Kootenay	Kootenay			Swan River ↓	Bullhead group: Dunlevy	Bullhead group: ?				

Figure 2

Table showing correlation of LOWER CRETACEOUS formations in the Rocky Mountains, Foothills, and Plains, and their stratigraphic positions with relation to certain known fossil zones.

UNIO (QUADRULA) NATOSINI FAUNA

LOWER PART BLAIRMORE GROUP



Figures 1, *Unio (Elliptio) douglassi*

Figure 2. *Corbula ? palliseri X 2*

Figures 3, 4, 5. *Unio (Elliptio) hamili*

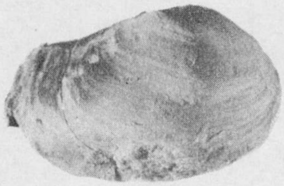
Figure 6. *Sphaerium onestae X 2*

Figures 7, 8, 9. *Unio (Quadrula) natosini*

PLATE 1

UNIO (QUADRULA) NATOSINI FAUNA

LUSCAR FORMATION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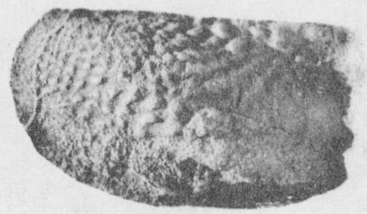
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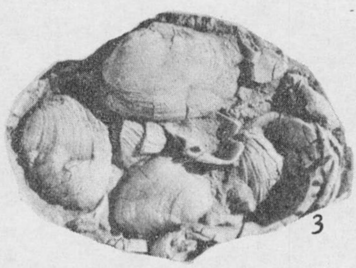

3

UNIO (ELLIPTIO) BIORNATUS FAUNA

McMURRAY FORMATION


4


5


6

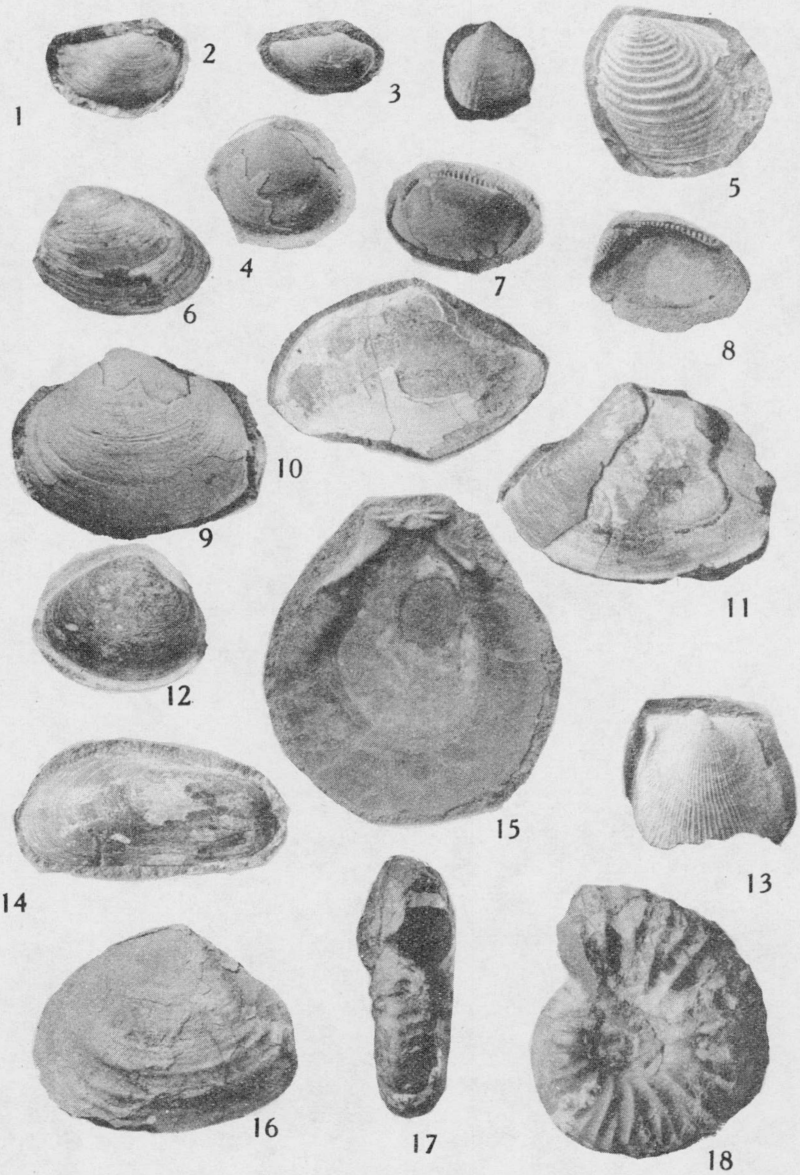

7

Figure 1. *Unio lacombi* McLearn n. sp.
Figure 2. *Unio (Quadrula) natosini*
Figure 3. *'Murraia' fabensis* McLearn n. sp.
Figure 4. *'Astarte' natosini*
Figure 5. *Melania multorbis*
Figure 6. *Unio (Elliptio) biornatus*
Figure 7. *Lioplacodes bituminis*

PLATE 11

LEMUROCERAS FAUNA

CLEARWATER FORMATION AND LOWER MEMBER PEACE RIVER FORMATION

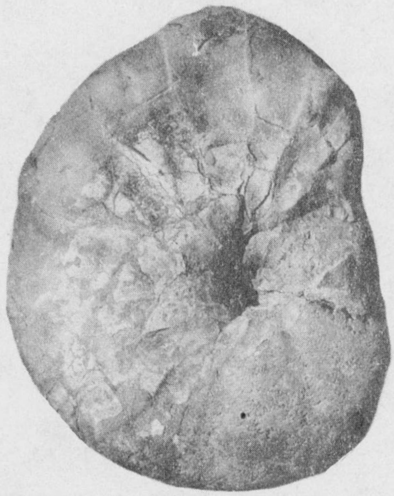


Figures 1, 2, *Yoldia kissoumi.* Figures 3, 4, *Protocardia alcesiana.*
Figure 5, *Inoceramus dowlingi.* Figures 6, 7, 8, *Nucula athabaskensis.*
Figure 9, *Onestia onestae.* Figure 10, *Tancredia ? dowlingi.*
Figure 11, *T. ? dowlingi* var. *silentia* McLearn n. var. Figure 12, *Arctica limpidiana.*
Figure 13, *Oxytoma camselli* X 2. Figure 14, *Brachydontes athabaskensis.*
Figure 15, *Entolium irenense.* Figure 16, *Thracia kissoumi.*
Figures 17, 18, *Lemuroceras belli* McLearn n. sp.

PLATE III

LEMUROCERAS FAUNA

CLEARWATER FORMATION



1

2

3

Figure 1. *Beudanticeras affine* X 1 4

Figures 2, 3. *Beudanticeras* cf. *glabrum*

PLATE IV

LEMUROCERAS FAUNA

MOOSEBAR, GATES, AND BUCKINGHORSE FORMATIONS

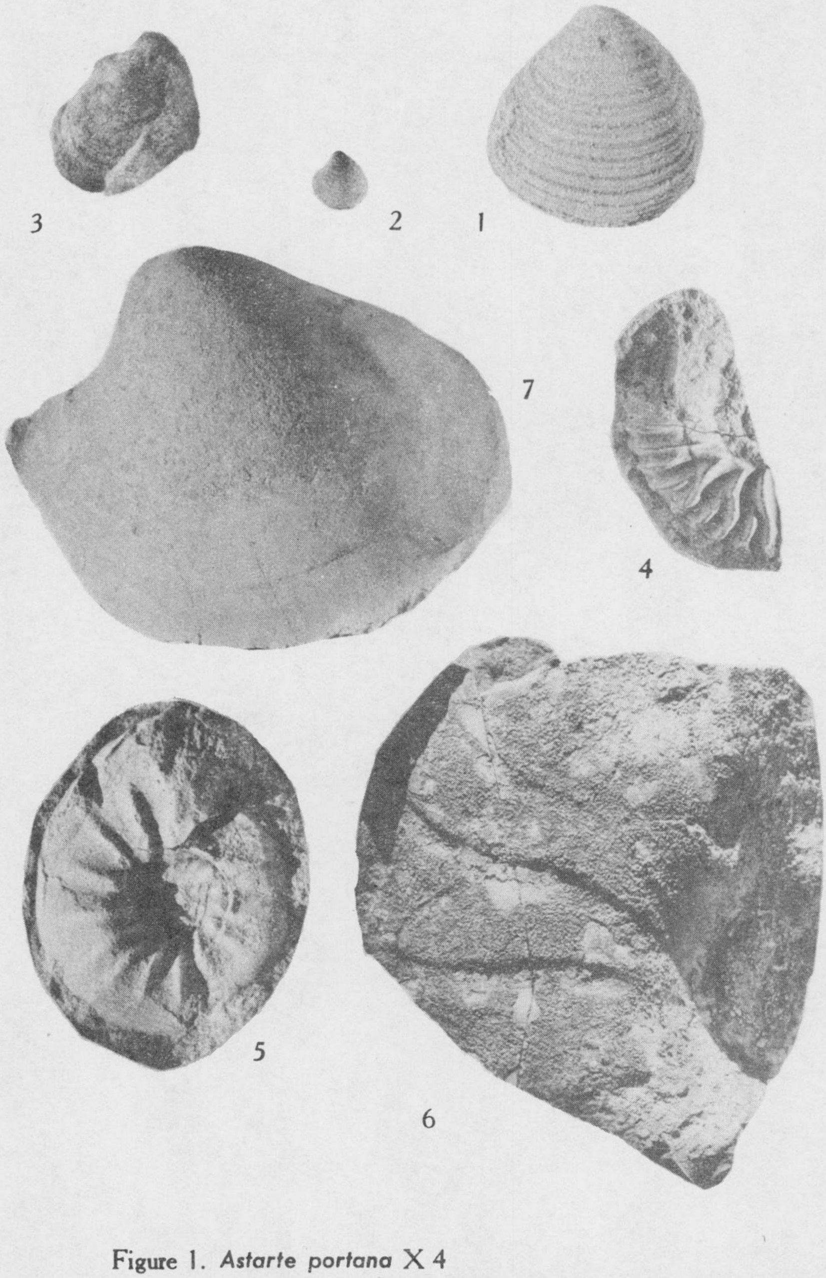


Figure 1. *Astarte portana* X 4

Figure 2. *Astarte portana* McLearn n. sp. Holotype

Figure 3. *Aucellina ? dowlingi* McLearn n. sp.

Figure 4. *Lemuroceras* cf. *indicum* Spath

Figure 5. *Lemuroceras irenense* McLearn n. sp.

Figure 6. *Beudanticeras* cf. *affine* X 2 3

Figure 7. *Arctica* sp.

PLATE V

GASTROPLITES FAUNA

LOWER PART HASLER FORMATION

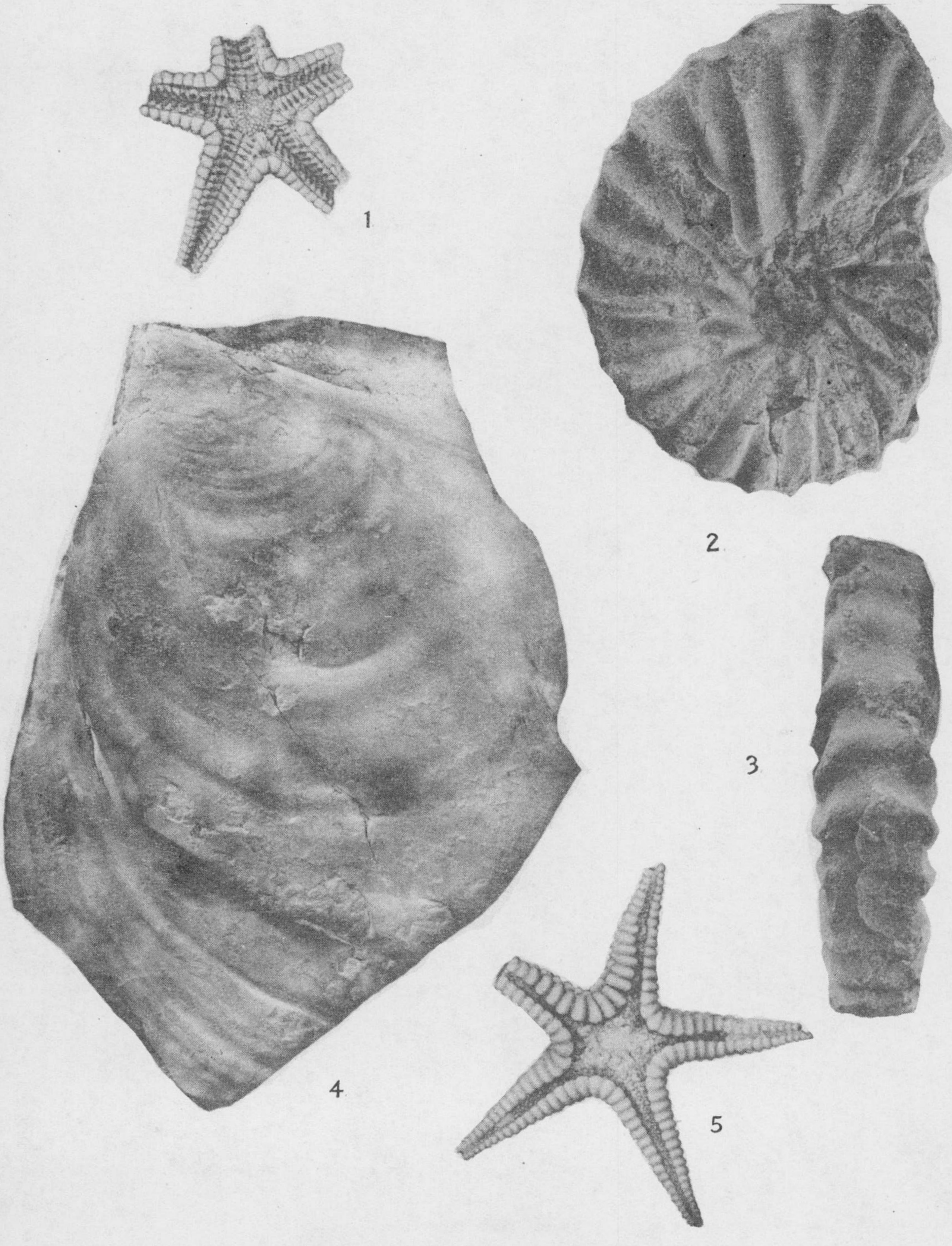


Figure 1. *Lophidiaster silentiensis*

Figures 2, 3. *Gastroplites kingi*

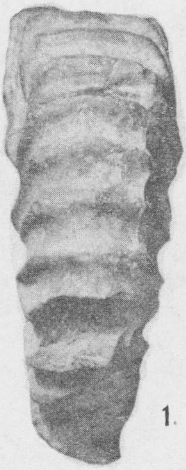
Figure 4. *Inoceramus cadottensis var. altifluminis* X ½

Figure 5. *Lophidiaster cf. silentiensis*

PLATE V1

GASTROPLITES FAUNA

CADOTTE MEMBER, PEACE RIVER FORMATION (SHEET 1)



1.

2

3.

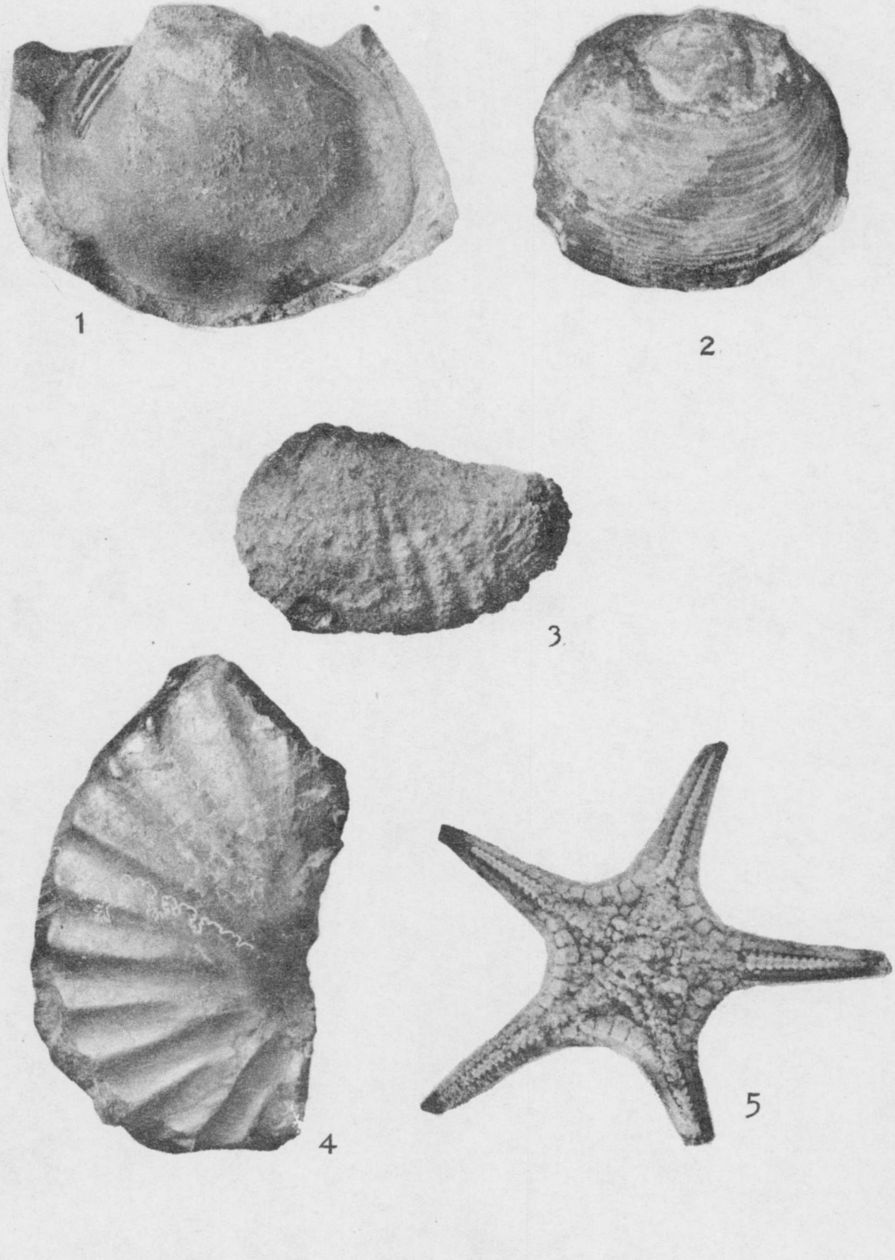
Figures 1, 2. *Gastroplites canadensis*

Figure 3. *Inoceramus cadottensis* X ½

PLATE V11

GASTROPLITES FAUNA

CADOTTE MEMBER, PEACE RIVER FORMATION (SHEET 2)



Figures 1, 2. *Dicranodonta dowlingi*

Figure 3. *Trigonia albertensis*

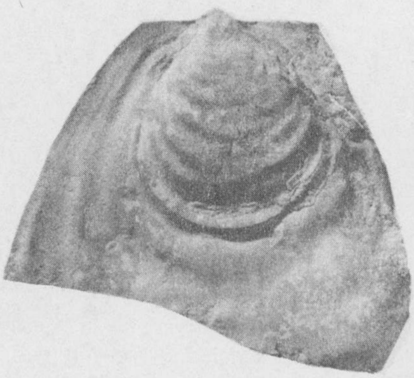
Figure 4. *Gastroplites spiekeri*

Figure 5. *Comptonia ? stelcki*

PLATE V111

NEOGASTROPLITES FAUNA

SHAFTESBURY FORMATION



2

1

3

Figure 1, *Posidonomya nahwisi*

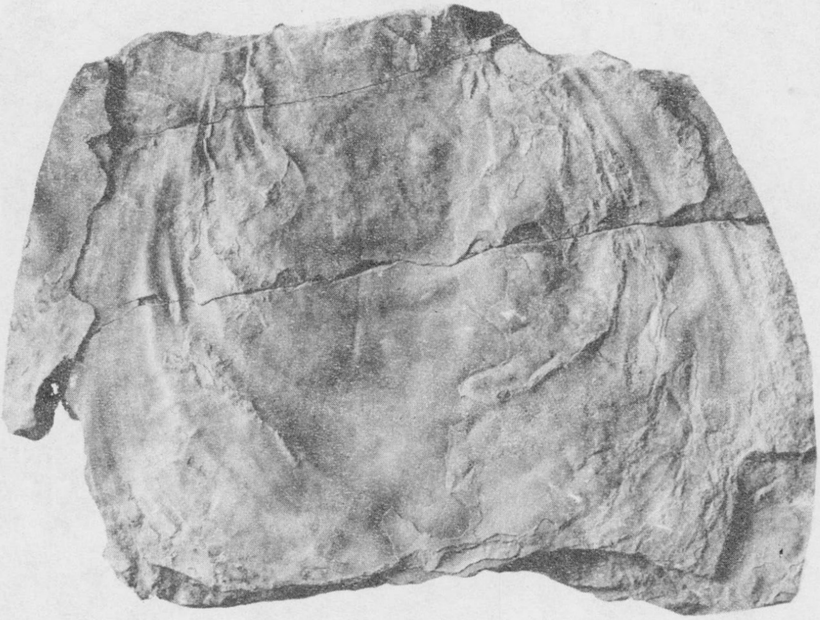
Figure 2, *Posidonomya nahwisi* (transitional to var. *goodrichensis*)

Figure 3, *Neogastroplites cornutus* X 3 4

PLATE 1X

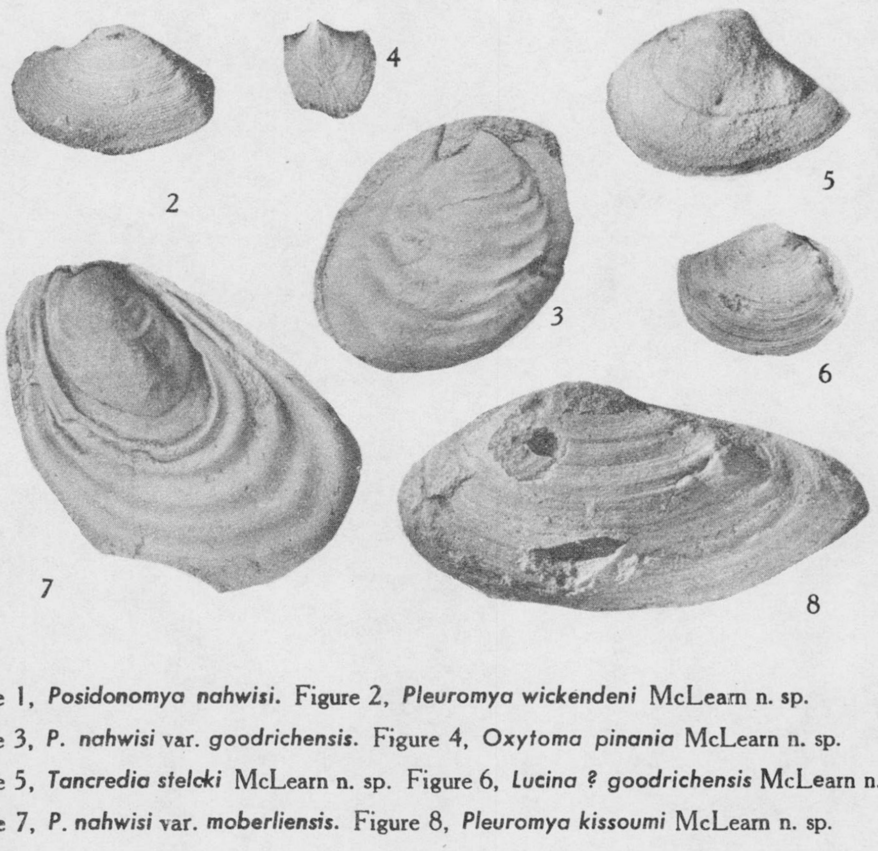
NEOGASTROPLITES FAUNA

SHAFTESBURY FORMATION



1

GOODRICH FORMATION



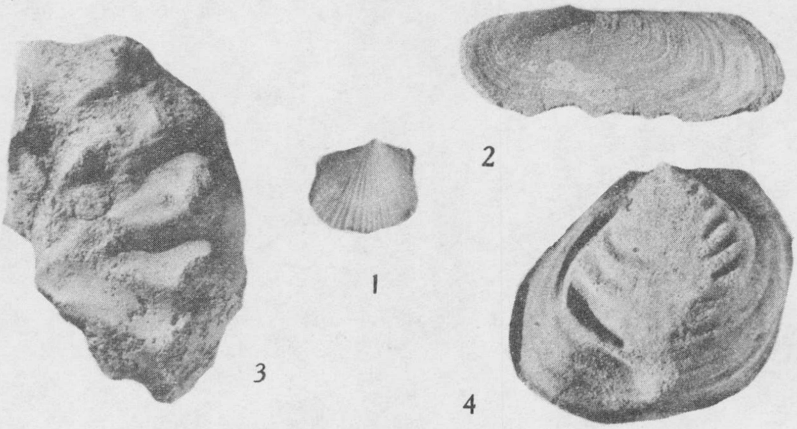
2 3 4 5 6 7 8

Figure 1, *Posidonomya nahwisi*. Figure 2, *Pleuromya wickendeni* McLearn n. sp.
Figure 3, *P. nahwisi* var. *goodrichensis*. Figure 4, *Oxytoma pinania* McLearn n. sp.
Figure 5, *Tancredia stelcki* McLearn n. sp. Figure 6, *Lucina ? goodrichensis* McLearn n. sp.
Figure 7, *P. nahwisi* var. *moberliensis*. Figure 8, *Pleuromya kissoumi* McLearn n. sp.

PLATE X

NEOGASTROPLITES FAUNA

SIKANNI FORMATION -- FIRST SANDSTONE



SIKANNI FORMATION -- SECOND SANDSTONE

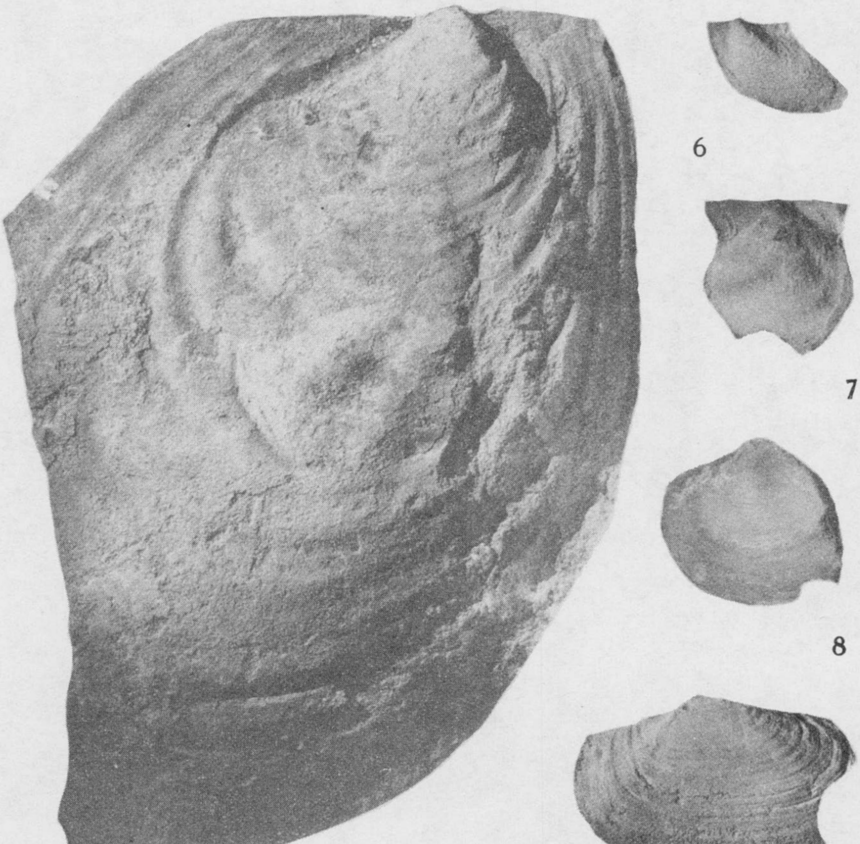
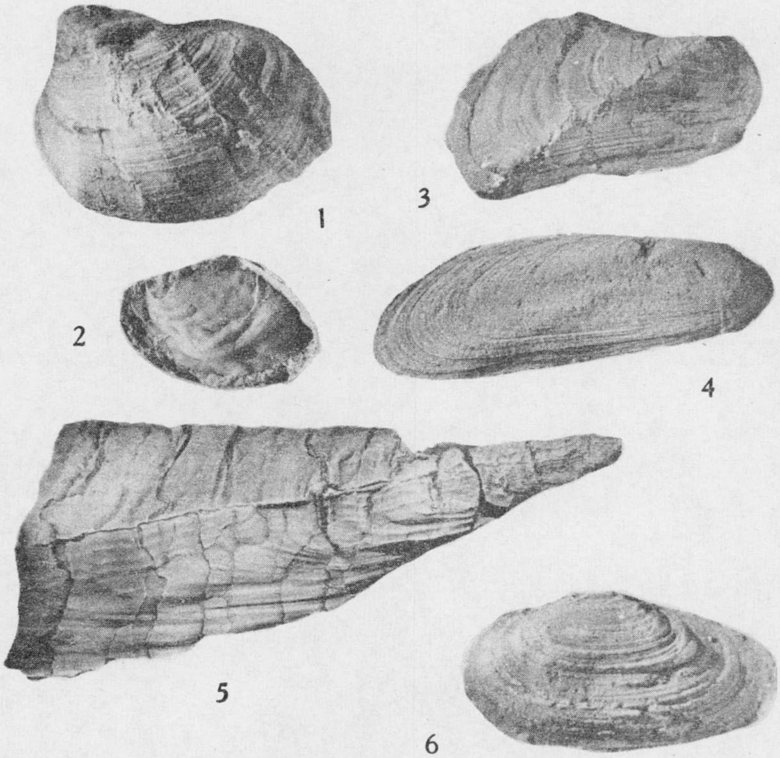


Figure 1, *Oxytoma pinania* McLearn n. sp. Holotype. Figure 2, *Solecurtus ? (Azor ?)* sp.
Figure 3, *Neogastroplites* cf. *cornutus*. Figures 4, 5, *Posidonomya nahwisi*. var. *goodrichensis*.
Figure 6, *Pteria via-media* McLearn n. sp. Figure 7, *Pecten burlingi* McLearn n. sp.
Figure 8, *Corbicula ?* sp. Figure 9, *Thracia stelcki* McLearn n. sp.

PLATE XI

NEOGASTROPLITES FAUNA

SIKANNI FORMATION -- THIRD SANDSTONE



SIKANNI FORMATION -- FOURTH SANDSTONE

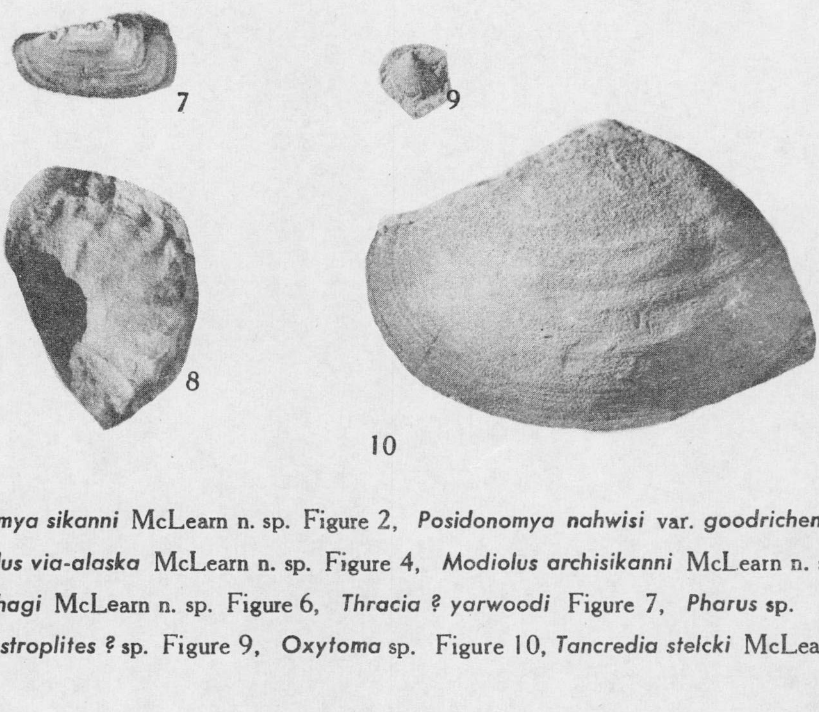


Figure 1, *Pleuromya sikanni* McLearn n. sp. Figure 2, *Posidonomya nahwisi* var. *goodrichensis*. Figure 3, *Modiolus via-alaska* McLearn n. sp. Figure 4, *Modiolus archisikanni* McLearn n. sp. Figure 5, *Pinna hagi* McLearn n. sp. Figure 6, *Thracia ? yarwoodi* Figure 7, *Pharus* sp. Figure 8, *Neogastroplites ?* sp. Figure 9, *Oxytoma* sp. Figure 10, *Tancredia stelcki* McLearn n. sp.

PLATE XII

APPENDIX. NEW LOWER CRETACEOUS SPECIES
from Alberta and Northeastern British Columbia, by F. H. McLearn.

Pinna hagi n. sp. Pl. XII, fig. 5. Moderate size. Tapering rapidly at early stages, more slowly at later stages of growth. Strong, longitudinal costae below and immediately above angle. Taper not so uniform as in *Pinna dolosoniensis* McLearn. G. S. c.: hol., 9553.

Pteria via-media n. sp. Pl. XI, fig. 6. Oblique outline; shell somewhat flattened. Irregularly spaced concentric furrows or varices of growth. More flattened shell than *Pteria linguiformis* (Evans and Shumard). G. S. c.: hol., 9554.

Oxytoma pinania n. sp. Pl. X, fig. 4, Pl. XI, fig. 1 (holotype, reversed in printing). Small, almost erect outline. Radial costae of moderate strength; some finer intercalated costae. Ornament coarser than that of *Oxytoma camselli* McLearn. G. S. c.: hol., 9555.

Aucellina ? dowlingi n. sp. Pl. 5, fig. 3. Small, ovate-oblique. Convex left valve, high unbones; almost flat right valve. Radial, closely set, very fine striations from umbo to basal margin. Ornament appears to be finer and covers greater part of surface than in very similar species *Aucellina gryphaeoides* Sowerby. G. S. c.: hol., 9556.

Unio lacombi n. sp. Pl. II, fig. 1. Highly inflated, much longer than high. Flattened umbo, small beak. More inflated, flatter umbo than in *Unio (Pleurobema) dowlingi* (McLearn). Genus subject to revision. G. S. c.: hol., 9557.

'Murraia' fabensis n. sp. Pl. II, fig. 3. Holotype is top specimen in figure. A gently convex, elongate shell with rounded anterior margin, not so pointed as in *'Murraia' naiadiformis* Russell. Posterior margin not so obliquely truncate as in that species. Concentric, fine striations and varices of growth. Genus, provisional. G. S. c.: hol., 9558.

Pecten burlingi n. sp. Pl. XI, fig. 7. Small rounded species with large triangular wings. Fine, concentric growth lines. Smaller than, and has relatively larger and more triangular wings than *Pecten silentiensis* McLearn. G. S. c.: hol., 9559.

Modiolus via-alaska n. sp. Pl. XII, fig. 3. Very convex. Outline narrows anteriorly. Curved, strong ribs from umbo to postero-dorsal angle. Shell concave anterior to this ridge. Less arcuate in outline and less curved, more angular post-umbonal ridge than *Modiolus galpiniana* Evans and Shumard. G. S. c.: hol., 9560.

Modiolus archisikanni n. sp. Pl. XII, fig. 4. Elongate, narrowing anteriorly. Moderately convex, with smoothly rounded post-umbonal slope. Fine, even concentric striation. More elongate and has more gently rounded post-umbonal slope than *Modiolus semiornata* d'Orbigny. G. S. c.: hol., 9561.

Pleuromya kissoumi n. sp. Pl, X, fig. 8. Fairly convex, elongate, narrowing posteriorly. Beaks a little anterior to middle. Irregular concentric striae and varices of growth. More elongate, more narrow posteriorly and beak nearer centre than in *Pleuromya orbigniana* (Rouillier). G. S. c.: hol., 6562.

Pleuromya sikanni n. sp. Pl. XIII, fig. 1. Inflated, ovate, nearly anterior beaks. Concentric irregular striations and varices of growth. Lacks regular, concentric ornament of *Pholadomya (Pleuromya ?) ligeriensis* d'Orbigny. G. S. c.: hol., 9563.

Pleuromya wickendeni n. sp. Pl. X, fig. 2. Moderately convex, longer than high. Nearly central beaks, abruptly rounded post-umbonal slope. Concentric, even striation. Less elongate, more central beaks, more even striation than in *Pleuromya kissoumi* McLearn. G. S. c.: hol., 9564.

Thracia stelcki n. sp. Pl. XI, fig. 9. Somewhat quadrate outline, longer than high. Somewhat flattened sides of shell with distinct 'carina'. Irregular, concentric folds or bands. Straighter carina, less convex than *Thracia sanctae-crucis* Pictet and Campiche. G. S. c.: hol., 9565.

Thracia ? yarwoodi n. sp. Pl. XII, fig. 6. Elongate; narrowed anteriorly ? Irregular concentric folds. More convex than *Thracia stelcki*, less quadrate in outline and more rounded, not carinate, post-umbonal slope. Genus, provisional. G. S. c.: hol., 9566.

Astarte portana n. sp. Pl. V, figs. 1, 2. Small, ovate below, triangular outline above. Beaks anterior to middle. Concentric, broad, flat ribs or bands separated by evenly spaced furrows. Concentric ornament broader and flatter than in *Astarte senecta* Woods. G. S. c.: hol., 9567.

Tancredia stelcki n. sp. Pl. X, fig. 5 (holotype): Pl. XII, fig. 10. Holotype is moderately convex with angular, anterior outline. Shallow radial furrow ventral to post-umbonal slope. Not so flattened as *Tancredia ? dowlingi* McLearn, has the radial furrow and antero-dorsal margin not so straight. G. S. c.: hol., 9568.

Tancredia ? pacia n. sp. Pl. III, fig. 10. More convex than *Tancredia ? dowlingi* or *Tancredia stelcki* n. sp. Anterior outline much the same, that is angular, produced and narrowly rounded. Lacks posterior radial furrow of *T. stelcki*. G. S. c.: hol., 5406a.

Lucina goodrichensis n. sp. Pl. X, fig. 6. Gently convex, ovate, a little longer than high. Fine, striate, concentric ornament. Smaller, more compressed and more even ornament than *Lucina occidentalis* Morton. G. S. c.: hol., 9569.

Lemuroceras belli n. sp. Pl. III, figs. 17, 18. Moderately involute, whorls higher than thick. Ribs bifurcate near middle of sides of whorl; also intercalated ribs; all continue across venter. More involute than *Lemuroceras aburense* Spath, does not develop stage with constrictions. G. S. c.: hol., 9570.

Lemuroceras irenense n. sp. Pl. V, fig. 5. Moderately involute, whorls a little higher than thick ? Strong ribs on inner part of sides of whorl, weak where cross venter. Ribs much stronger than in *Lemuroceras mcconnelli* Whiteaves. G. S. c.: hol., 9571.

All above descriptions are based on a preliminary study. The object is to establish species of stratigraphic value.

Ottawa, Ont.,
February, 1948.