The fossils at Driftwood Canyon Provincial Park:

A management plan for BC Parks

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1. Executive summary

Gordon Harvey's donation of 14 hectares of land along Driftwood Creek made possible the establishment of Driftwood Canyon Provincial Park in January, 1967. In accordance with Harvey's wish, the public has been allowed to collect fossils in the Park – a traditional recreational activity among Bulkley Valley residents, but one that may be problematic for BC Parks because it contravenes Section 9(1) of the Park Act and because it may have damaged this finite natural resource with heritage, educational and scientific significance..

The fossils in the Park are the remains of plants and animals that lived in and near a montane lake flanked by active volcanoes 50 million years ago. The fossils are well-preserved and flattened on thin slabs of laminated shale. They include 29 genera of plants, 21 families of insects, three genera of fishes, and unique bird and rodent skeletons. Of these, only the fishes have been scientifically documented in detail -- including *Eosalmo driftwoodensis*, the first salmon. The significance of these fossils extends to national and international levels.

Different groups have collected these fossils in the Park with markedly different effects. Amateur and professional paleontologists have collected suites of fossils that are now reposited in known institutions. Commercial fossil collectors have removed unknown numbers of fossils from the Park, some of which have been offered for sale. Many school groups have visited the Park over the years, taking with them an unknown number of

fossils. Recreational or casual fossil collectors have been the most assiduous of any group in removing fossils from the Park. Possibly as many as 300,000 pieces of fossil-bearing shale could have been taken by this group over the past 35 years. The present locations of these fossils (undoubtedly some highly important) are unknown. So many fossils have been removed over the years that visitors cannot now appreciate this most special feature of Driftwood Canyon Provincial Park.

Thirteen recommendations about the fossils at Driftwood Canyon comprise a management plan for BC Parks . Recreational fossil collecting is an anomalous activity within the provincial park system and is not permitted in any other comparable jurisdiction in Canada. The consequences for the heritage, educational and scientific aspects of this resource in the Park have been considerable. It should stop. **Recommendation 1: That recreational fossil collecting no longer be permitted in the Park.** Public fossil collecting could continue in the Park, but only as a part of a staffed educational program that emphasizes paleontology, natural history and stewardship of the fossils. **Recommendation 2: That managed fossil collecting be permitted as part of a staffed educational program delivered in the Park.** Because BC Parks cannot effectively manage a resource it does not understand, staff members should enhance their knowledge about paleontology so that they can deliver public educational programs on these fossils to Park visitors.
Recommendation 3: That BC Parks staff members participate in an intense 3-5 day training session on paleontology and geology. Because BC Parks are stewards of the most important fossil resource in the region, it should also take a leadership role in

educating all Bulkley Valley residents and students about local paleontology.

Recommendation 4: That BC Parks develop educational programs on Driftwood Canyon fossils for residents and students. Paleontology is a visual scientific discipline whose appreciation can benefit from relatively simple displays of fossils and photographs. **Recommendation 5: That BC Parks assemble a permanent display of Driftwood Canyon fossils for a central location in Smithers. Recommendation 6: That BC Parks assemble a smaller travelling display of Driftwood Canyon fossils for school visits.** Many Bulkley Valley residents have collections of unidentified Driftwood Canyon fossils, including scientifically significant specimens. **Recommendation 7: That BC Parks sponsor a public "Fossil Identification Day" with a paleontologist in Smithers.** Publications on Driftwood Canyon fossils are not generally accessible. They have appeared in rather obscure journals and as chapters in specialist books. **Recommendation 8: That BC Parks deposit a bound volume of all published papers on Driftwood Canyon fossils in the Smithers Library.** The need to apply fossil collecting policies in the Park should be explained to the public as necessary to ensure that the generous bequest of Gordon Harvey is not frittered away. **Recommendation 9: That BC Parks emphasize that fossil collecting policies are needed to protect the legacy of Gordon Harvey.** The signage in the Park should emphasize stewardship of fossil resources and that recreational fossil collecting is not permitted. **Recommendation 10: That the signage in the Park be improved to emphasize why fossil collecting is not permitted.** The fossil collecting activity of paleontologists, both amateur and professional, should be encouraged. **Recommendation 11: Park Use Permits should readily be issued to paleontologists**

who need to collect fossils in the Park for specific projects. The public is interested in paleontologic techniques, how fossil collecting occurs and about the meaning of specific fossils. **Recommendation 12: Every paleontologist who collect fossils in the Park should also be involved in some aspect of public education about fossils.** All fossils collected in the Park remain the property of the Crown and, in most cases, should be returned to British Columbia for permanent repository. **Recommendation 13: That BC Parks urge the Royal B.C. Museum to become the formal repository of provincial fossils.**

2. Driftwood Canyon Provincial Park: its establishment and unique features

A small attractive provincial park is now located at Driftwood Creek east of Smithers through the generosity of Gordon Harvey (1913-1976). Harvey, a long-time resident of Driftwood Canyon, donated 14 hectares of land along the creek to the Province of British Columbia which, with the addition of 9 hectares of Crown Land, became Driftwood Canyon Provincial Park in January 1967. The Park was established as a Class A park and classified as Category 6 with "Outstanding features considered to be of provincial to international significance". The outstanding features are 50 million year old fossils preserved in the pale brown shales that are seen as outcrops of steep cliffs and as extensive talus piles. The fossils have been known since the early years of the 20th century and they continue to be collected by paleontologists.

When he donated the land, Harvey requested that the public be allowed to collect fossils in the Park; a recreational activity that was traditional among the residents of the Bulkley Valley, but one that may be problematic for BC Parks because it is in direct contravention of Section 9(1) of the Park Act which states, in part:

> "A natural resource ... in a Class A park ... must not be granted, sold, removed, destroyed, damaged, disturbed or exploited."

Fossil collecting at Driftwood Canyon was widely promoted as a tourist attraction by the

Smithers Chamber of Commerce before the Park was established. A brochure published by the Chamber in the early 1970s advises tourists to turn off Highway 16 and follow the signs "FOSSILS" to the Park. The impact on the land from such fossil collecting might have been considerable because the same brochure suggested that, "the prospective fossil hunter will need a wrecking bar to extract the shale from the bank". Since 1967, thousands of visitors to Driftwood Canyon Provincial Park must have carried off thousands of fossil specimens -- possibly to the detriment of the scientific, heritage and educational potentials of this resource. However, the attitude towards fossils in the Park is now changing. Attendants at the Tourist Centre in Smithers still direct visitors to the Park, but they also mention that fossils should not be removed. Similarly, in the most recent brochure on Driftwood Canyon produced by BC Parks (May, 2000), conservation and protection of the fossil resource are emphasized along with a request that visitors refrain from removing any fossils.

Fossils occur in many provincial parks in British Columbia, but they are never sufficiently abundant, accessible and distinctive to warrant more than passing mention in management plans. That is, with the outstanding exception of Driftwood Canyon Provincial Park which is unique in possessing this resource in abundance. The fossils in the Park provide both an opportunity and a challenge to BC Parks. That is, to balance scientific collection of the fossils and access of visitors to the fossil beds with the need for conservation and protection as mandated by the Park Act, and still honour the memory and the request of Gordon Harvey.

3. Eocene geology and environments in the Cordillera

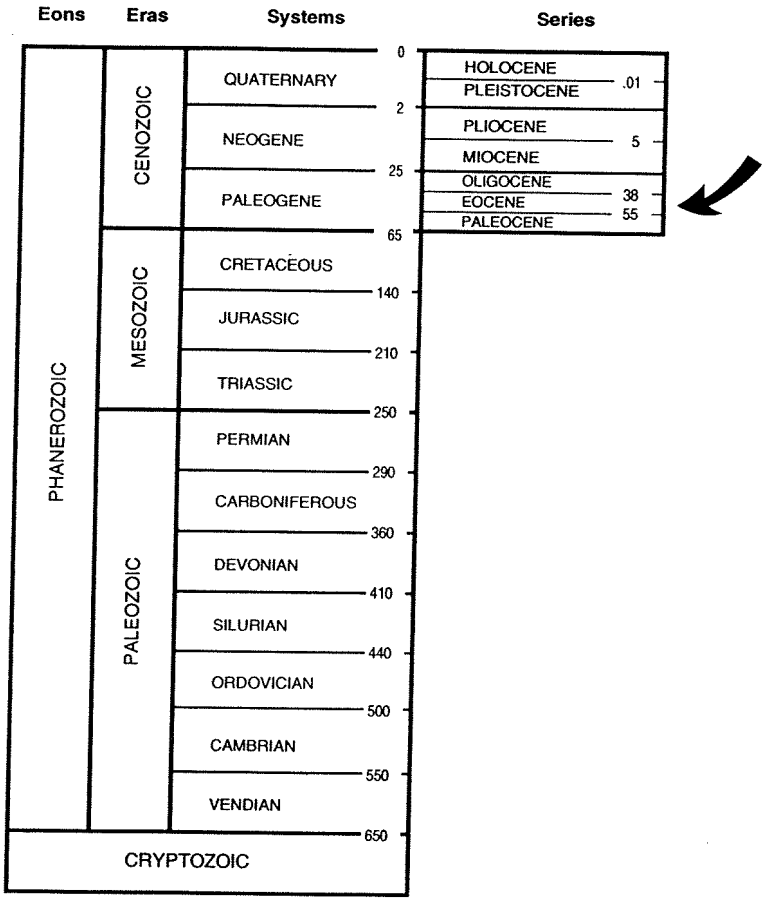
The thick belt of mountains along the western edge of North America -- the Cordillera -- was nearly fully formed when the Eocene began about 55 million years ago. Out in the ocean, however, northward movement of the Pacific Plate caused tensional forces that resulted in the formation of a series of fault-bounded basins in the central Cordillera. Volcanism was extensive and these basins were initially inundated by ash and lava flows; later they received fluvial (river) and lacustrine (lake) sediments. These Eocene lake basins form a belt 160 km wide that extends 800 km northwest from Republic, Washington, through the Princeton, Cache Creek and Horsefly areas to Driftwood Creek in the Babine Range. The lacustrine sedimentary rocks exposed at Driftwood Canyon were deposited in the northernmost Eocene lake in the Cordillera.

Radiometric dating of the ashes that are common in the sediments indicates that these lakes formed in the middle Eocene between 46 and 52 million years ago. In this report an age of 50 million years is used throughout. Some of the lake basins are associated with extensive coal swamps and all contain well-preserved fossils encased in fine-grained ash-rich sediment.

The sedimentary rocks exposed at Driftwood Canyon are mainly flat-lying pale brown and tan shales with thin dark brown laminations. These lake sediments were deposited in quiet waters, close to the shore. They are a small part of the Ootsa Lake Group of Eocene age

which, in the Smithers and Kitimat area, consists largely of volcanic flows, ash beds and volcanic breccias as thick as 1800 metres.

The Eocene coincided with a global warming episode. At that time even Ellesmere Island in the high Arctic supported rich forests of deciduous hardwoods and conifers -- vegetation that resembles that of modern Georgia and the Carolinas. The Eocene lakes in British Columbia and Washington, however, formed at moderate altitudes and, therefore, the fossils preserved in the sediment constitute a unique record of montane forests -- environments that were unknown in older rocks. This cooler climate promoted the appearance of the oldest conifer-dominated forests in the world along with the diversification of many new flowering plants. The aggregate diversity of these environments is remarkable -- 450 species of plants and 75 families of insects have been documented from the Eocene lakes between Republic and Driftwood Canyon -- of course, the diversity at any single locality is much lower.



The geologic time scale of eons, eras, systems, and series calibrated in millions of years. The Eocene Series forms the middle part of the Paleogene System in the lower Cenozoic Era.

4. Eocene fossils of Driftwood Canyon

The time is the Eocene, 50 million years ago. The middle age of the Earth (otherwise known as the Mesozoic) had come to an end fifteen million years previously with the extinction of dinosaurs. And now the animals and plants that inherited the Earth at the dawn of the modern age (Cenozoic) would, in appearance, be rather familiar to naturalists. A botanist standing in an Eocene forest could, with some confidence, identify the conifers and broad-leaved trees and nod in recognition of the insect-attracting flowers. A trap set by an entomologist in the same forest would capture insects belonging to living families -- mosquitos, dance flies, crane flies, fungus gnats, among many others. An angler on the shore of an Eocene lake would have no problem recognizing the fish on his line as a salmon. An ornithologist by the same lake would readily recognize a variety of shore birds as members of the duck and goose clan.

And yet, this similiarity can be deceptive. Eocene leaves so confidently identified as belonging to a modern tree are, in some cases, associated with entirely different reproductive structures. Virtually none of the fossil insects has been identified to a level higher than family, so whether they belong to extant genera is just not known. The few that have been identified to the genus level differs in seemingly trivial ways from living insects. And, yes, the fish is a salmon, but because it lacks the characteristic long lower jaw of modern salmon, it is a salmon with an important difference.

The plants

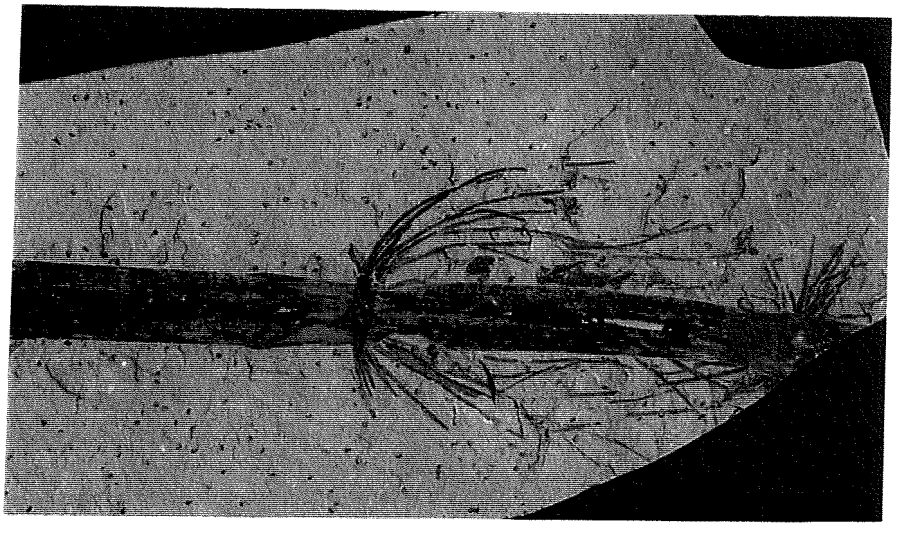
Plants are the most conspicuous fossil at Driftwood Canyon and they are often the only fossil that visitors are able to see and collect. The most common fossil plant in the Park is a small attractive frond that is frequently mistaken for a fern. This, however, is the dawn redwood *Metasequoia* (Plate 1), a member of the redwood and cypress family (Taxodiaceae). This plant is a deciduous conifer that sheds its foliage every year as small branchlets. It is easily identified by the opposite, paired arrangement of the double row of needles on each branch. Until 1948, when it was found growing in an isolated valley in central China, *Metasequoia* was known only from fossils that occur abundantly in Eocene rocks of North America, Greenland and Siberia. This tree was later re-introduced to North America where it is now favoured by horticulturalists for its hardiness and attractive shape.

Fossils of other Taxodiaceae are much more difficult to identify. Redwood (*Sequoia*), giant redwood (*Sequoiadendron*), swamp cypress (*Glyptostrobus*) and Japanese cedar (*Cryptomeria*) have been reported at Driftwood Canyon. These bear variable foliage that cannot be distinguished in the absence of cones. Some paleobotanists advocate use of the general name *Elatocladus* for such foliage. The same problem applies to distinguishing the cedars *Thuja* and *Chamaecyparis*. Yew (*Taxus*) bears small seeds that are rarely preserved as fossils, but without the seeds, yew foliage is difficult to separate from that of Taxodiaceae.

Fossil leaves of the maidenhair tree *Ginkgo* are known from a few specimens in the Park.

Plate 1

A *Metasequoia* branch from Driftwood Canyon Park. Note the opposite paired arrangement of needles (DC--11-02). Photo by Ken Pugh, BC Parks Collections.



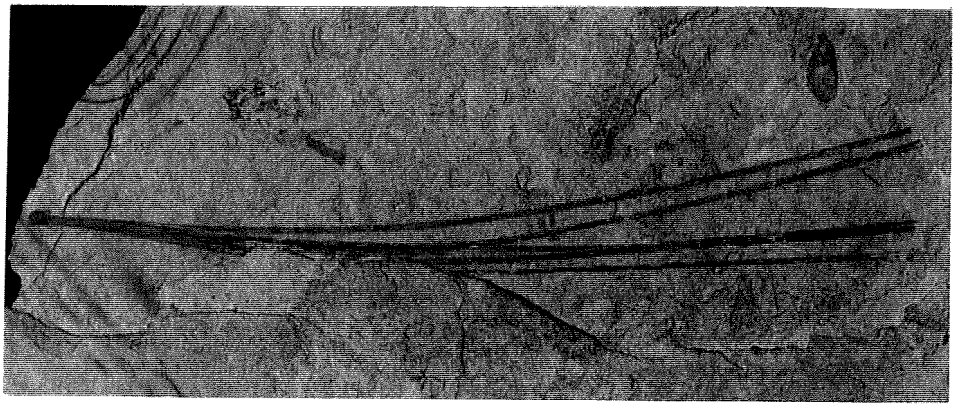
The horsetail *Equisetum* from Driftwood Canyon Park (DC-11-01). Photo by Ken Pugh. , BC Parks Collections.

This ancient and widely distributed group of plants is represented today by a single living species, *G. biloba,* which grows wild only in a small area in western China. Because of its hardiness and its attractive pale green foliage borne on graceful limbs, *Ginkgo* has become a common ornamental tree that grows well in temperate regions, even in the polluted centres of European and North America cities. The term "living fossil" was coined by Charles Darwin for *Ginkgo,* a plant that has changed very little since it first appeared in the Triassic.

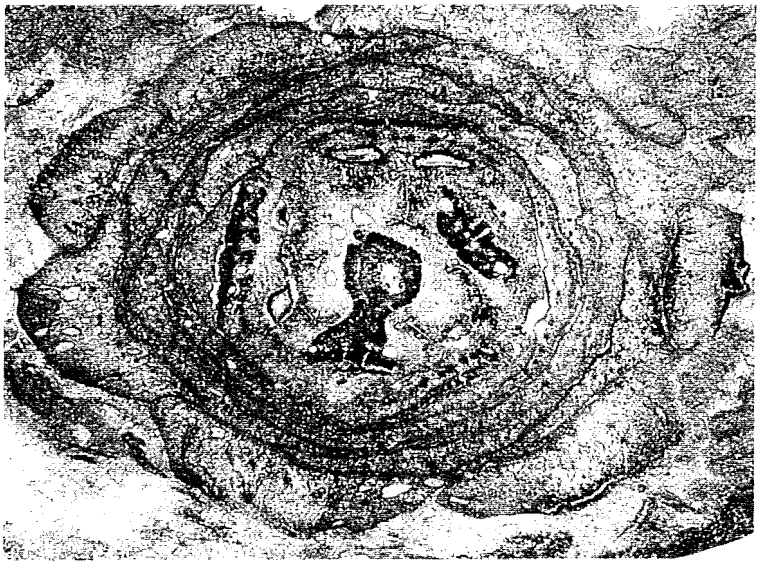
Fossil seeds, needles and cones of true fir (*Abies*), spruce (*Picea*), larch (*Larix*), golden larch (*Pseudolarix*) and pine (*Pinus*) have also been reported in the Park. A distinctive five-needle pine, commonly called *Pinus latahensis* (Plate 2), a relative of the living white pines, also occurs as a fossil in the Park.

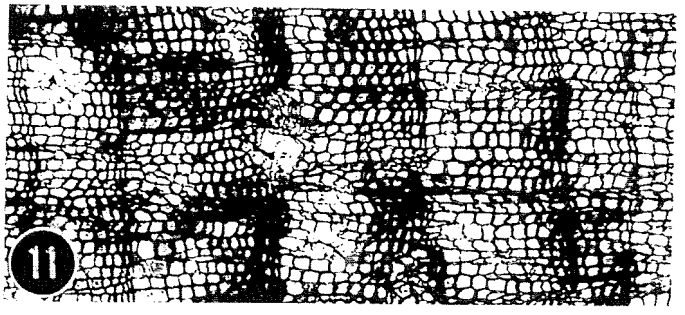
In 1983 Ruth Stockey, Professor of Botany at University of Alberta, devoted an entire paper in the scientific journal *Botanical Gazette* to a detailed description of three-dimensionally preserved material of a single species she named *Pinus driftwoodensis* (Plate 2). This material is preserved in a block of chert that was collected from a small lens of coal at Driftwood Creek. Chert is essentially solid silica gel. The preservation is extraordinary because all plant cells have been entirely replaced by fine silica. The detailed tissue morphology becomes evident only after the block is cut and polished and etched with hydrofluoric acid. Stockey was able to describe the ovulate cone, the scales, the seeds, the needles, the twigs, even the pollen cone. This quality of preservation makes *P.*

Plate 2



Pinus latahensis from Driftwood Canyon Park (DC-11-09). Photo by Ken Pugh. BC Parks Collections.



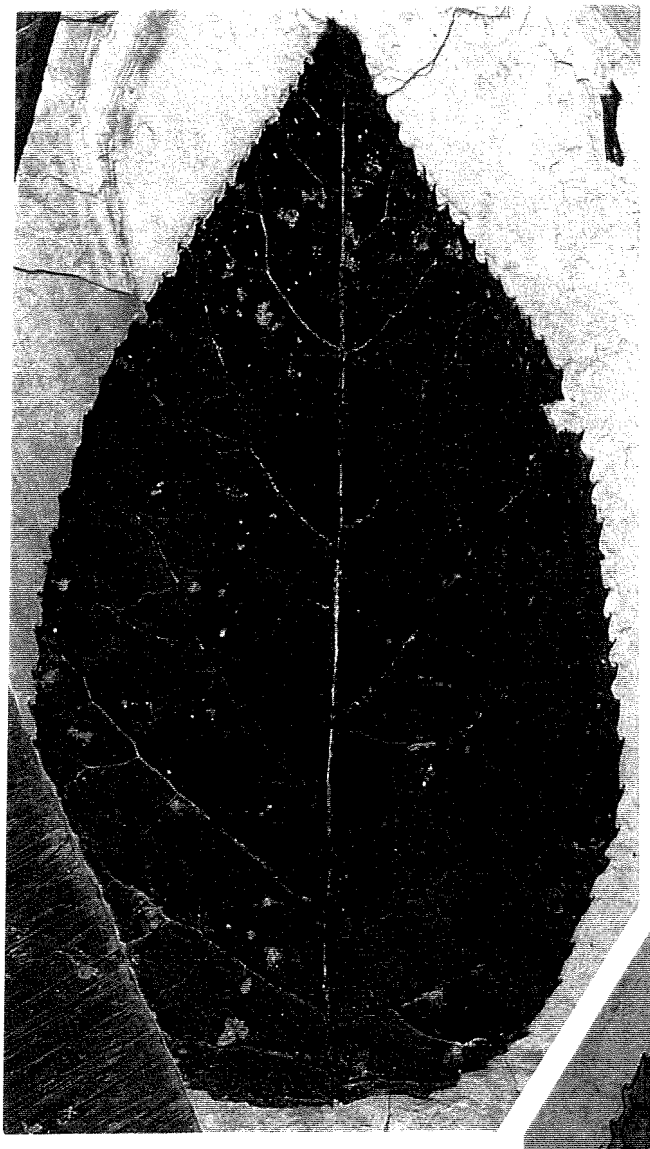


Pinus driftwoodensis Stockey from a chert block collected at Driftwood Creek (Holotype, UAPC S5446). Cross-section of permineralized seed-bearing cone (magnification X 5) and detail of the wood (X 75). Figures from Stockey (1983).

driftwoodensis one of the oldest and and one of the best known species of *Pinus* and one that differs from other fossil species of *Pinus* that occur in Eocene deposits in the Princeton area. It has similarities to modern species, but also possesses features not seen in modern pines. This study by Stockey is the only comprehensive study of any fossil plant species based on material collected from Driftwood Canyon.

The Eocene shales outcropping at Driftwood Canyon Provincial Park also preserve a variety of leaves of angiosperms (flowering plants) along with ferns and other plants. Many of the fossil angiosperm leaves are astonishingly well preserved -- disclosing fine details of the shape, margins and venation (Plate 3) -- nonetheless, it is difficult to identify plant species from fossil foliage alone because different plants can bear essentially identical leaves. A rather extensive list is included as Appendix 1. This list, primarily from Pugh (1999), shows that various trees and understory bushes are represented as fossils in the Park. Some plants, such as the water fern *Azolla* and the cattail *Typha*, are indicative of a quiet freshwater lake. *Azolla* has received a lot of attention lately because it contains a basal cavity occupied by a nitrogen-fixing blue-green alga and is used as a nitrogen-rich fertilizer for rice crops.

Plate 3



An unidentified angiosperm leaf from Driftwood Canyon Park (DC-11-06). Photo by Ken Pugh, BC Parks Collections.

The Insects

Because of their size, plant fossils are readily observable in talus and in outcrop at Driftwood Canyon Park, but only the most observant of collectors will be able to identify a minute jumble of body, wings and thin legs on a shale surface as a fossil insect. And only a paleontologist or entomologist with detailed knowledge of fossil and living insects and access to a good dissecting microscope, will be able to carry an identification to the family level.

Fossil insects from Eocene lake beds in central British Columbia were first studied by Samuel Scudder in the late 19th century and by Anton Handlirsch in the early 20th century. In the '30s and '40s, Tony Rice began collecting fossil insects as a part of his mapping work for the Geological Survey of Canada in the Princeton area. He collected these fossils widely, including the Driftwood Canyon area. In 1959 he published a descriptive account on the fossil March flies (Bibionidae) of British Columbia in which he recognized an unprecedented twenty species of the genus *Plecia*, including fully nine species at Driftwood Canyon. The next major research effort on Eocene insects of central B.C. was initiated by Mark Wilson of the University of Alberta who, in 1977, documented the presence of 14 different families in the strata at Driftwood Canyon. Later, he focussed on insect fossils as indicators of local environment. In the last few years, various members of the Vancouver Paleontological Society have been documenting the insect fossils at different localities in central British Columbia. An atlas of Eocene insects has been published by VPS

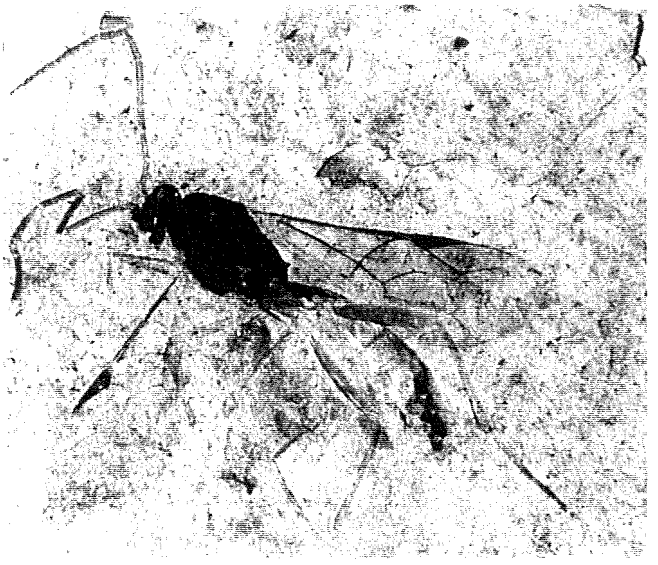
(Archibald, 1995), including some from Driftwood Canyon. Bruce Archibald is continuing his work on these fossil insects as part of his thesis at Harvard University.

With more than twenty families, the Eocene insect fauna from Driftwood Canyon is a little less diverse than that of the Princeton area in the southern part of the province. But that difference is probably more apparent than real because the single locality at Driftwood Canyon has not been collected as intensely as the localities in the Princeton area. The order Diptera (true flies) is well represented at Driftwood Canyon by March flies (Bibionidae), crane flies (Tipulidae [Plate 4], Ptychopteridae, Trichoceridae), fungus gnats (Mycetophilidae, Sciaridae), dance flies (Empididae [Plate 4]), mosquitos (Culicidae) and hover flies (Empididae). The order Hemiptera (bugs) includes leaf hoppers (Cicadellidae), spittlebugs (Cercopidae), plant lice (Aphididae), water striders (Gerridae [Plate 5]) and ripple bugs (Veliidae). The order Coleoptera (beetles) is rare at Driftwood Canyon; it is represented only by the weevils (Curculionidae). The order Hymenoptera includes the parasitic wasps (Ichneumonoidea [Plate 4] and Braconidae), the Megaloptera the caddisflies (Trichoptera), the Dermaptera the earwigs, and the Isoptera the termites.

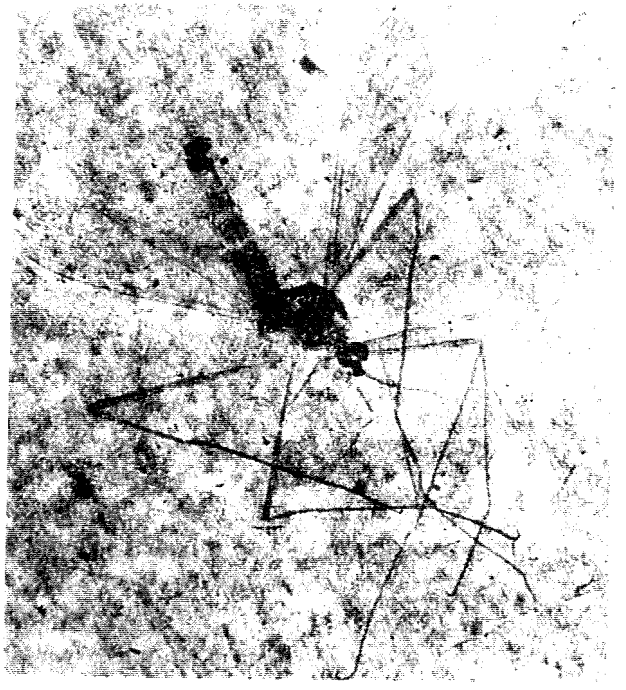
A simple list of families obscures some intriguing patterns in the Eocene fossil insect assemblage from Driftwood Canyon. Because beetles are diverse, common and easily fossilized, they are generally abundant fossils elsewhere, but they are surprisingly rare at this and other Eocene sites in the province. Water striders are rare at other localities in the province, but common at Driftwood Canyon. March flies, by contrast, are rare at Driftwood

Plate 4

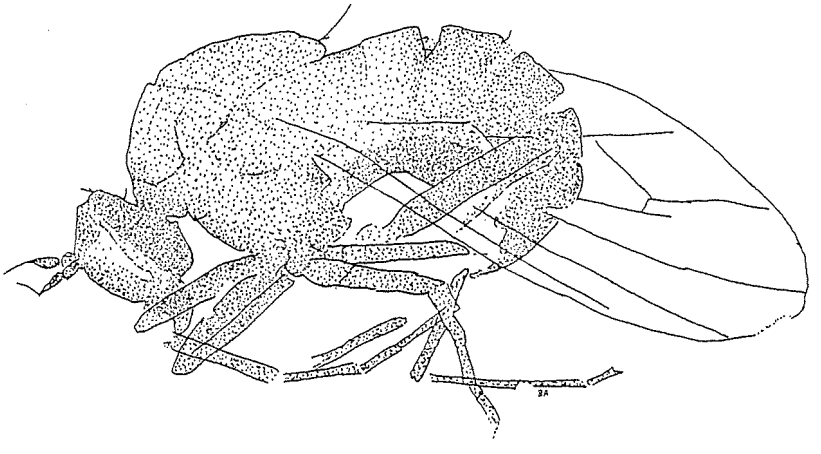
Plecia sp.



An ichneumon wasp (Ichneumonidae) from Driftwood Canyon Park (ROM 31033). Figure from Wilson (1988).



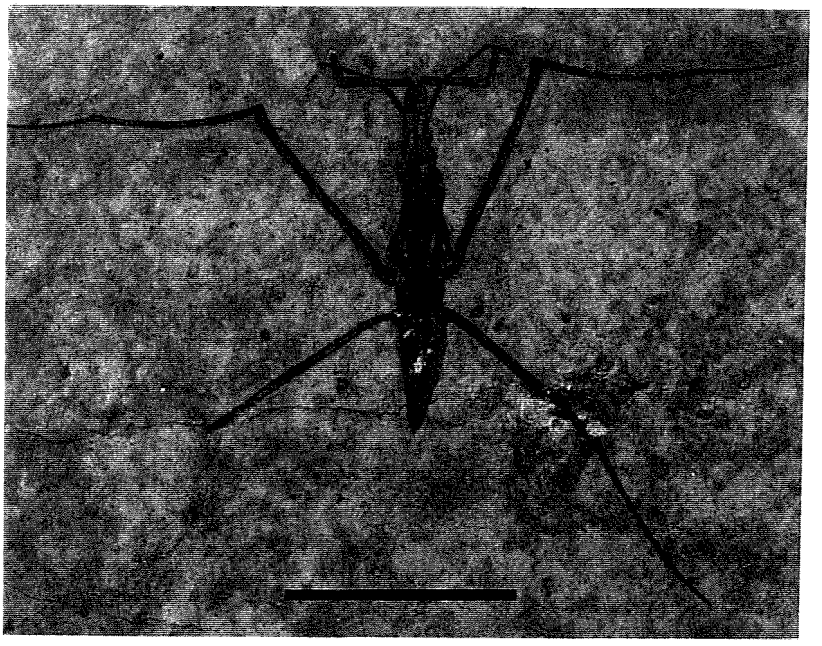
A crane fly (Tipulidae) from Driftwood Canyon Park (ROM 31034). Figure from Wilson (1988).



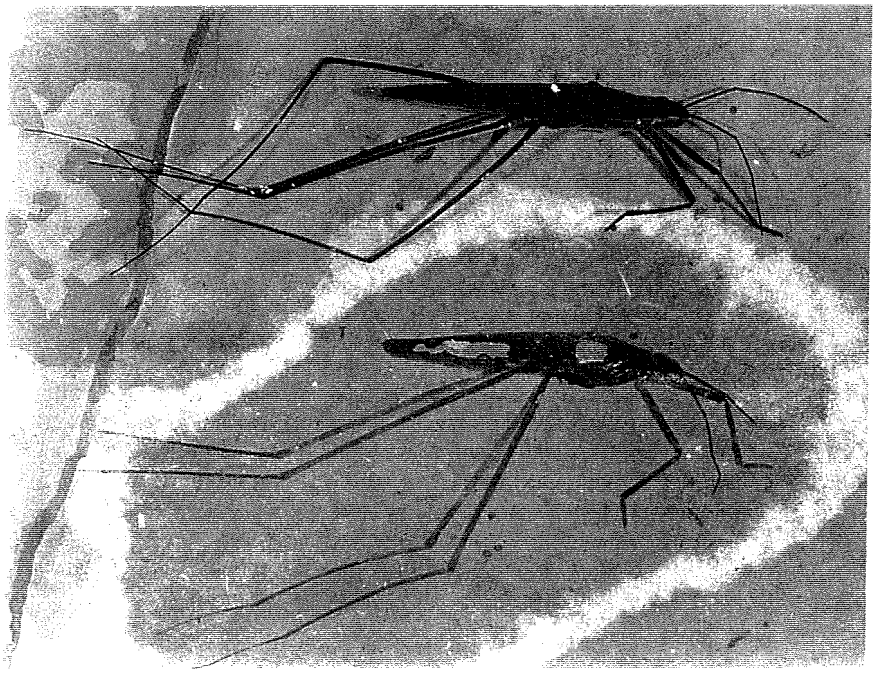
A dance fly (Empididae) from Driftwood Canyon Park. Body about 3 mm long. Figure from Archibald (1998).

Canyon, but the they are most common insect fossil found at most other Eocene localities in the province. Such patterns in relative abundance of fossil insects must be controlled by proximity to particular local environments or by selective preservation, but these factors are poorly understood.

The class Insecta includes more living species than all other animals and plants combined. Such massive diversity has been accepted by many biologists to be good evidence that insects evolved very quickly to produce many new species. However, a fascinating study by Anderson *et al.* (1993) on fossil and living water striders from the Smithers area has shown that some insect species were long-lived, lasting many millions of years. They compared a fossil male water strider from Driftwood Canyon Park to a living male water strider collected from a lake near Smithers (Plate 5). The living water strider, which belongs to *Limnoporus notabilis*, is identical in all features to the fossil, but it has a longer terminal segment on the antennae. If that seemingly trivial difference is ignored, then the fossil from Driftwood Canyon also belongs to *L. notabilis* and this species has lasted fully 50 million years.



Limnoporus, a water strider (Gerridae) from Driftwood Canyon Park (UAFIC). Bar is 10 mm long. Figure from Wilson (1996).

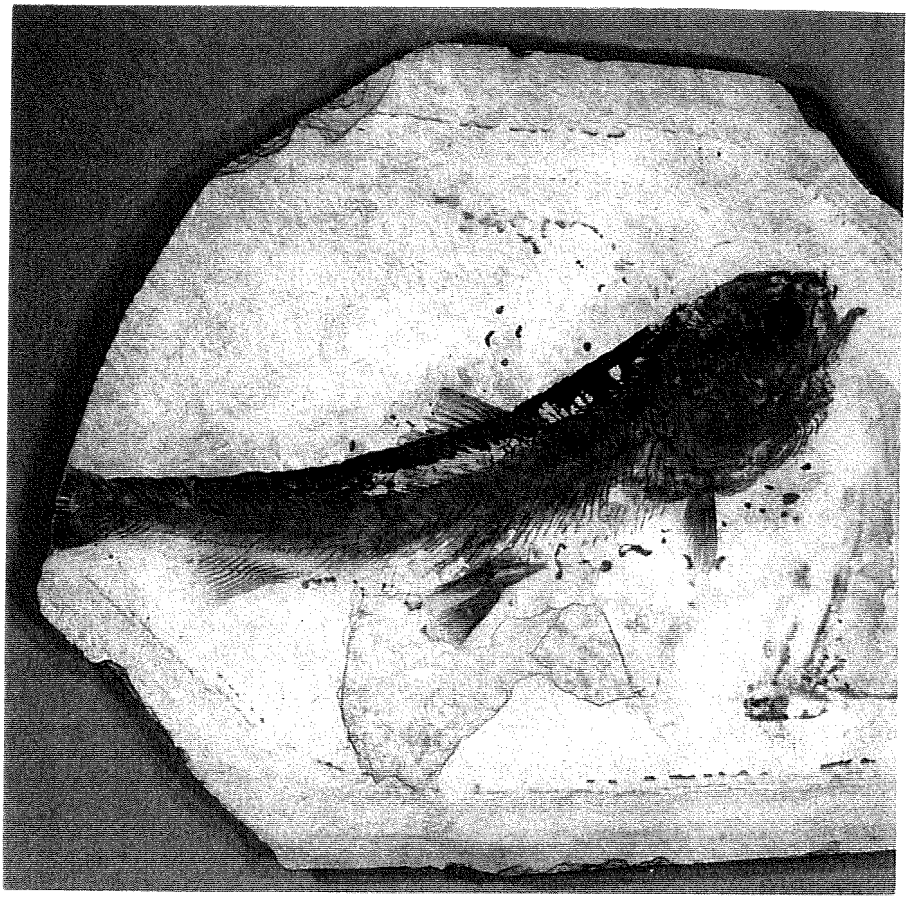


Adult males of the water strider *Limnoporus,* both collected near Smithers. Upper specimen is the recent *L. notabilis.* Lower specimen is the fossil *Limnoporus* from Driftwood Canyon Park. The body length of the fossil is 2 cm. Figure from Andersen et al. (1993).

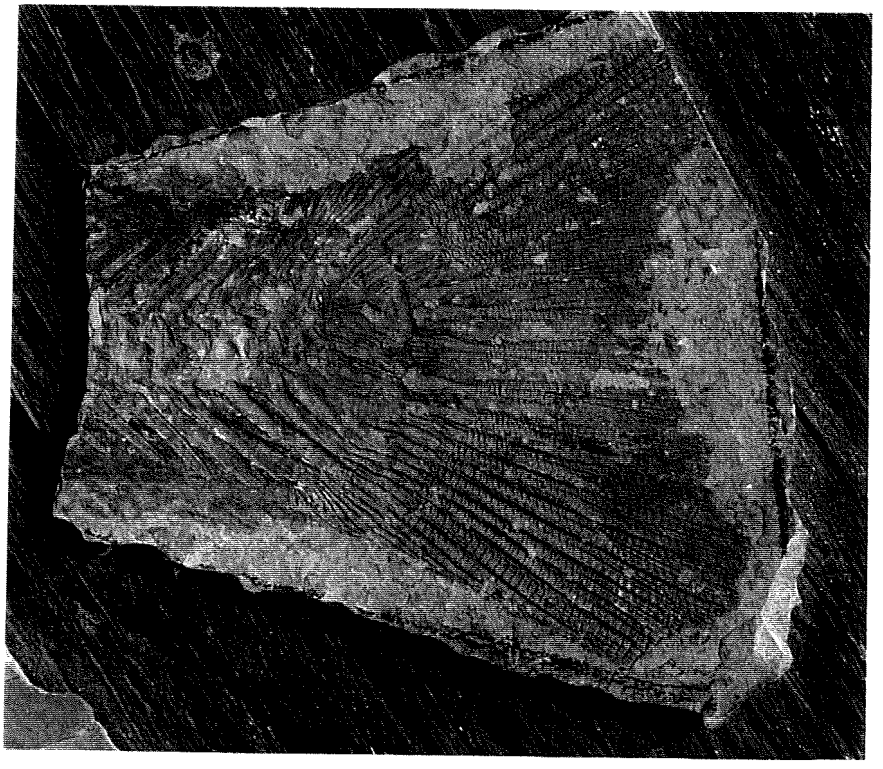
The Fishes

Of all the fossils documented from the Eocene shales exposed at Driftwood Canyon Provincial Park, the freshwater fishes are the most completely known and perhaps the most significant. This is due almost entirely to the research efforts of Mark Wilson of the University of Alberta that started some 25 years ago. In a number of publications, Wilson has documented the presence of the sucker *Amyzon* (Plate 7), the bowfin *Amia,* and the trout-perch *Libotonius* at Driftwood Canyon, but it was his erection of the oldest salmon, a new genus and species, *Eosalmo driftwoodensis* Wilson, 1977 (Plate 6), that established the Park as a highly important fossil fish locality. This species has subsequently been discovered in other Eocene localities in British Columbia and Washington, but *E. driftwoodensis* (by name and by type locality) remains tied to Driftwood Canyon. *Eosalmo* is also monotypic; meaning that *E. driftwoodensis* is the only species assigned to that genus -- so this important fish genus is, at present, entirely based on *E. driftwoodensis.*

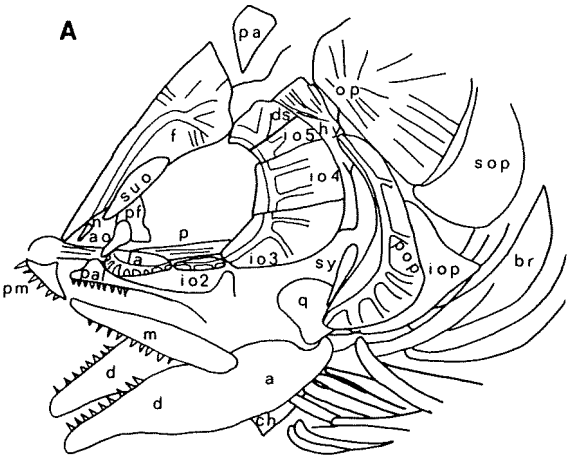
In two ground-breaking publications, Wilson (1992) and Wilson and Williams (1993) established the importance of *Eosalmo driftwoodensis* as a source of data to test critical hypotheses about on the evolution, biogeography and ecology of freshwater fishes. They focussed on four contributions of this species: First -- that the fossil *Eosalmo* is a near-perfect intermediate form between the living subfamily Salmoninae (salmon, trout and charr) and the living subfamily Thymallinae (grayling). Second -- that *Eosalmo* possesses only some of the features characteristic of Salmoninae. The remaining salmon features, notably the elongated jaw, were acquired after the Eocene. Third -- that *Eosalmo* shows



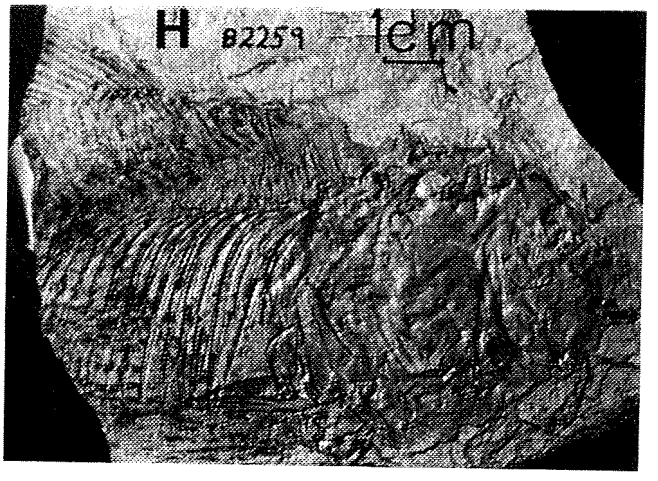
Eosalmo driftwoodensis Wilson from Driftwood Canyon Park (UALVP 12326. With a length of 15 cm this is the smallest specimen of this species found so far. Figure from Wilson (1996).



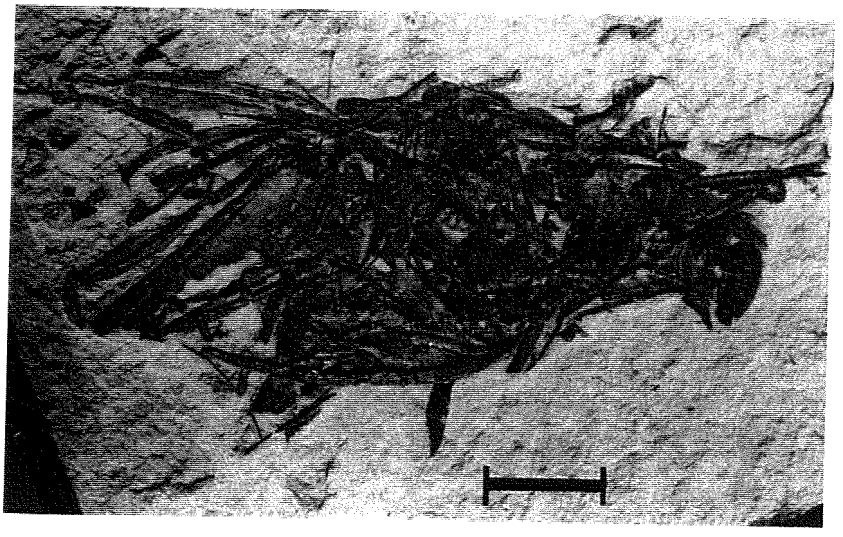
Eosalmo driftwoodensis Wilson from Driftwood Canyon Park. Well-preserved tail. (DC-11-202). Photo by Ken Pugh. BC Parks Collections



Eosalmo driftwoodensis **Wilson from Driftwood Canyon Park. Outline drawing of well-preserved skull. Uncatalogued specimen in Smithers Tourist Bureau.**



The sucker *Amyzon* sp. from Driftwood Canyon Park (ROM 19400). Figure from Wilson (1977).



A fish coprolite composed of densely packed and aligned fish bones (UALVP 12312) from Driftwood Canyon Park. Bar is 5 mm long. Figure from Wilson (1987).

that ancestral salmon lived in the Pacific drainage that is occupied by specialized salmon such as *Oncorhynchus* today. Fourth -- that the presence of a range of sizes of *Eosalmo* specimens at Driftwood Canyon shows that that the ancestral salmon *Eosalmo* was predominantly a freshwater fish that did not migrate to the sea; unlike the Atlantic salmon *Salmo* and the Pacific salmon *Onchorhynchus* which today are largely marine.

The smallest specimen of *Eosalmo driftwoodensis* is a complete fish 15 cm long. It was collected at Driftwood Canyon many years ago by a recreational fossil collector and became known to paleontologists only when the owner responded to an advertisement placed by Mark Wilson in the *Interior News*. This specimen was critical to the idea that *Eosalmo* remained in the lake for their entire life.

In view of the great importance of salmon runs on the Skeena and Bulkley rivers to First Nations people and others, the occurrence of the first salmon in the world as fossils in 50-million year old shales in the Driftwood Canyon Provincial Park should be of considerable interest to all inhabitants of this part of the province.

Evidence about the diet of fishes in the Eocene lakes is provided by unusual fossils -- coprolites; that is, fossil feces (Plate 7). The coprolites at Driftwood Canyon consist mainly of densely packed and rearranged bundles of fish bones that are easily distinguished from remains of fish carcasses. It is possible that some of these coprolites are not feces, but instead gastric residues of piscivorous birds. In addition to being fish-eaters, some fishes

were predaceous on small mammals -- evidenced from the unique fish coprolite from Driftwood Canyon containing rodent bones discovered by Ken Pugh in the collections of the Royal British Columbia Museum.

The Birds

A bird is an unlikely animal to be fossilized in its entirety, and yet, Eocene lake deposits of central British Columbia have yielded up two skeletons of quite different birds.

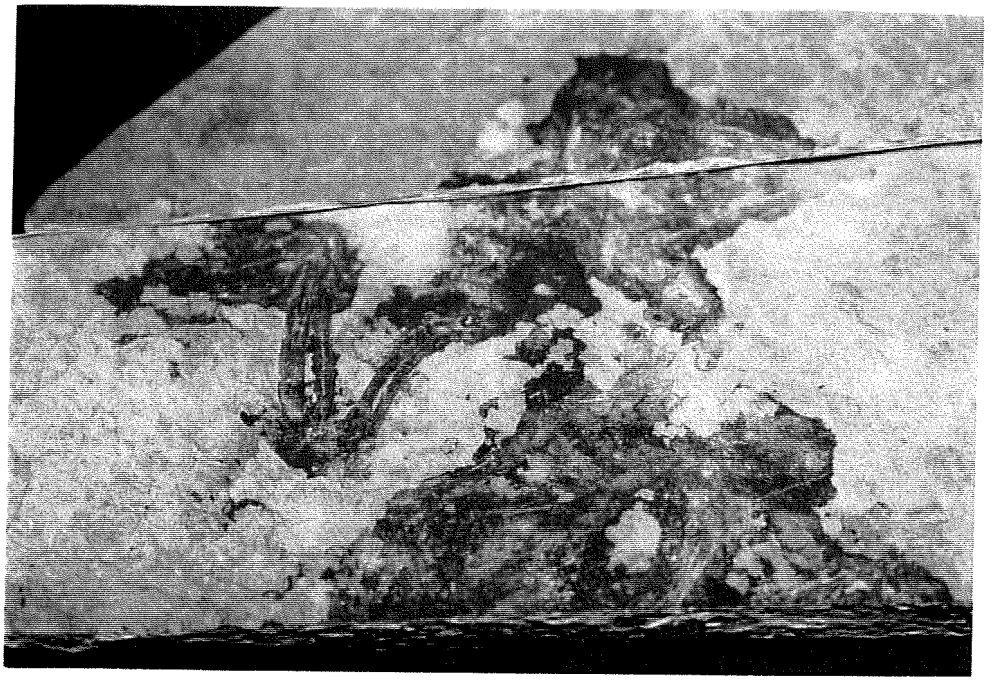
In the 1960s and '70s infrequent discoveries of feathers and hollow limb bones served as pointed reminders to paleontologists that fishes were not the only vertebrates to be collected from the Eocene lake beds of central British Columbia. But such feathers and bones cannot be identified further than Aves.

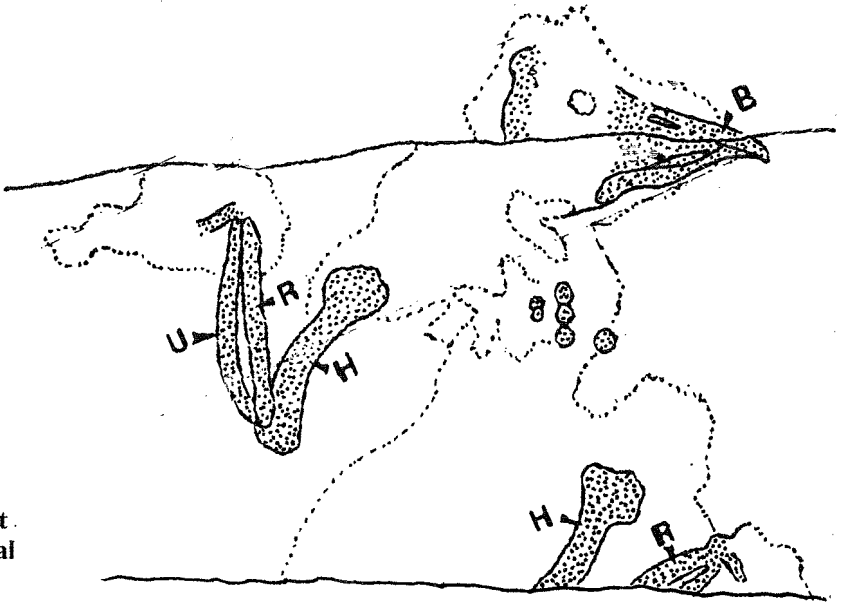
The bird fossil from Driftwood Canyon has had a rather checkered history -- and it's not over yet! In 1968 Patricia Pedley and three of her friends celebrated their graduation from University of British Columbia by driving up to Alaska. On their way north they stopped at Driftwood Canyon for a picnic lunch. Because Pedley had an interst in fossils she began searching through the shale talus. She split a large slab and the part and counterpart pieces displayed an odd-shaped brownish stain surrounding what appeared to be thin bones. Pedley suspected that this was an important fossil – after all she had graduated with a double science and education major – and when she got back to UBC she showed the fossil to paleobotanist Glen Rouse who, in turn, sent it on to the Royal Ontario Museum where Howard Savage of the Department of Ornithology identified it as a bird skeleton lacking only the feet. He thought it belonged to the Tinamidae, a family of partridge-like birds that are endemic to South America. But Savage was not a paleontologist, so he arranged to have the specimen sent to the University of Florida where, Pierce Brodkorb, at that time probably

the foremost living authority on fossil birds in North America, identified it as a fossil puffbird of the genus *Primobucco*? Puffbirds are members of the family Bucconidae and relatives of woodpeckers, toucans and jacamars in the order Piciformes. These birds are characterized by their zygodactylous foot structure (that is, they have two toes in front and two back), an adaptation for foraging on tree trunks. This specimen of *Primobucco*? extends the geologic range of Bucconidae back into the Eocene. But the greatest surprise relates to biogeography. Living puffbirds are endemic to South America and their range extend no further north than central America. The presence of a puffbird in Eocene rocks at Driftwood Canyon Provicial Park remains an unexplained conundrum. Pedley's bird specimen was returned to her in 1995, three years after the death of Dr. Brodkorb. This important specimen has yet to be described and published. Patricia Pedley later donated this fossil to the University College of the Cariboo in Kamloops.

The other avian discovery from Eocene lake deposits was made by Dave Langevin at the McAbee site east of Cache Creek in the early '90s. This specimen has been assigned to a new order of perching birds, Sandcoleiformes, by Storrs Olson, the Curator of Birds at the National Musem of Natural History in Washington. Like *Primobucco*? from Driftwood Canyon, the sandcoleiform bird from McAbee has yet to be described and published. It is now kept at the Kelowna Museum.

Plate 8





***Primobucco*?, a fossil bird lacking its feet. Collected in 1968 by Patricia Pedley at Driftwood Canyon Provincial Park. The specimen is now at the University College of the Cariboo in Kamloops. Outline drawing shows bones preserved (stipple) and stained area. H - humerus, U - ulna, R - radius, B - beak. Drawing and photo courtesy of Ken Klein.**

The Mammals

The mass extinction at the end of the Mesozoic Era 65 million years ago saw the demise of dinosaurs, among many other animal groups. No longer marginalized to the interstices of a dinosaur-dominated world, over the next ten million years the mammals rapidly diversified into virtually all of the orders now living. By the Eocene, rabbits, rodents, bats, primates, insectivores, carnivores, horses, antelopes and some extinct groups populated the forests and grasslands of western North America. Although the fossil evidence is extremely sparse, some of these mammals must have lived in and around the around the lake basins that now stretch from the Republic area of northern Washington State to Smithers in the centre of British Columbia.

The first Eocene mammal fossils from British Columbia were described from the Pleasant Valley coal mine near Princeton. These fossils consist of two teeth of a peculiar and extinct bear-like animal of unknown affinities called a tillodont and named *Trogosus*. Judging from the extensive wear on these teeth, *Trogosus* must have fed on abrasive vegetable matter. A lower jaw of a hedgehog-like insectivore named *Entomolestes* has also been found at the same general location. Finally, massive teeth of an extinct group of rhinoceros called titanotheres have been collected from Eocene rocks of the Quesnel area.

Mammal fossils were not known from Eocene strata at Driftwood Canyon Provincial Park until last year when Ken Pugh made an exciting discovery in a fish coprolite from the collections of the Royal British Columbia Museum. This coprolite contains a semi-

articulated skeleton of a small rodent. Pugh reports the following skeletal material, "nineteen articulated vertebrae and what appears to be a pelvis, femur, and two long bones". This unique fossil is important in two regards -- first, it establishes that large fish in Eocene lakes ate rodents and, second, it demonstrates that intensive searches at Driftwood Canyon might result in the recovery of additional mammal bones.

5. Significance of the Driftwood Canyon fossil site

The Driftwood Canyon fossil site is one of many exposures of fossil-bearing lacustrine shales of Eocene age that also crop out in the Princeton, Merritt, Cache Creek, Kamloops and Horsefly areas of central British Columbia and in the Republic area of northern Washington State. The fossils at these sites comprise similar or identical plants, insects and fresh-water fishes. So, whereas the Driftwood Canyon site is paleontologically special, it is by no means unique. The significance of the shales and the fossils from Driftwood Canyon differs according to the scale.

Local

The importance of the Driftwood Canyon site to Bulkley Valley inhabitants and visitors lies in it being a local window to the deep past and to life forms that existed in the region 50 million years ago. School groups take field trips to the site because it is one of the few exposures of rock with fossils in the Smithers area. The shales and fossils enhance classroom teaching of general science, biology, environmental science and earth science classes. The Driftwood Canyon site is important to the Bulkley Valley Museum because it preserves an aspect of local natural history interest. The fossils and the ancient lake deposits also have a direct connection to local coal mines whose heritage is featured prominently in the Museum. In the past the Smithers Tourist Bureau and local businesses have promoted the Driftwood Canyon site as an interesting destination where visitors and tourists can collect fossils. Local recreational fossil collectors regularly visit the site to

seach for new fossils to add to their collection. The fossil site is part of the traditional territory of the Wet'suwet'en First Nations.

Provincial

The mandate of the Royal British Columbia Museum includes fossils from sites throughout the province. It might be assumed that the Museum serves as a focus for the collection of inventory data and as a repository of specimens, not only of living animals and plants, but also of fossils. However, until the last few years, little has been done to enhance the modest provincial collection of fossils. The British Columbia Paleontological Alliance and its six regional societies "strives to enhance knowledge about paleontology in the Cordillera and to promote responsible collecting of fossils". The Driftwood Canyon fossil site has been visited by amateur paleontologists who collected fossil insects under the general auspices of the BCPA. To the British Columbia Geological Survey, the Driftwood Canyon fossil site is important because it dates as Eocene the thick volcanics of the Ootsa Lake Group which shows mineralization in several areas.

National

The localities where professional paleontologists at Canadian universities choose to do fieldwork is influenced largely by the presence of well-preserved fossils of a given age. Provincial boundaries are rarely a factor, but restrictive provincial regulations governing the collection of fossils, such as those enacted in Alberta in the 1970s, certainly serve as a disincentive. Virtually all the reseach on Eocene fossils from Driftwood Canyon has been

published by University of Alberta researchers, primarily by Dr. Mark Wilson and consequently the largest collection of Driftwood Canyon fossils now resides at the University of Alberta in Edmonton. To the Geological Survey of Canada, the Royal Ontario Museum and the Canadian Museum of Nature the significance of the Driftwood Canyon site lies in it being the source for well-preserved Eocene fossils in their collections. Eocene fossils are uncommon from Canadian sites east of British Columbia.

International

The modern science of paleobiology deals with global patterns and with processes, principles and models that address and explain the distribution and change of fossil assemblages of animals and plants, regardless of political boundaries. The Driftwood Canyon site is higly important because it preserves the fossil biota of the northernmost Eocene lake deposit in the Cordillera. Paleobiologists would certainly rate the contributions of Driftwood Canyon fossils such as the salmon *Eosalmo* and the water strider *Limnoporus* to biogeography, paleoecology, taxonomy and evolution as highly signifcant. Exceptionally preserved fossil specimens such as the ovulate *Pinus driftwoodensis* cone and the bird *Primobucco*? often encourage new and provocative ideas about extinct plants and animals.

6. Fossil Collectors at Driftwood Canyon

Fossils have been collected at (that is, removed from) Driftwood Canyon since 1967 when it was established as a Class A provincial park and for many years before that. Such removal of a natural resource from the provincial park system remains as an acknowledged anomaly.

Different groups have been involved in fossil collecting at Driftwood Canyon. These have different backgrounds, different expectations and different impacts on the resource. Fossil collecting at the Park has been considered traditional in many local communities in the Bulkley Valley and the activity has been promoted in tourist guides. Changes have recently been made. In information brochures, BC Parks has now begun to emphasize protection of the fossil beds by encouraging visitors to refrain from removing any fossils. Similarly, the Smithers Chamber of Commerce still considers the Park a popular destination, but they also ask visitors not to collect fossils.

Before we focus on the different groups that have been collecting fossils at Driftwood Canyon, we need a definition of "responsible fossil collecting".

The British Columbia Paleontological Alliance, a union of professional and amateur paleontologists established in 1993, has framed some useful guidelines. The Alliance assert that "fossils comprise a critical record of past life forms and, therefore, they have important

scientific, heritage and educational values. Any collecting of fossils must be madewith due consideration of these values". Responsible fossil collecting is characterized by the BCPA as follows:

> "Collectors must record and maintain documentation of all relevant geographic and stratigraphic information for each fossil collected. Every effort should be made to ensure that this information is accessible to interested professional researchers. Fossil specimens must be properly curated. Each specimen should be identified and normally have a unique idenfying number related to a documented fossil locality. Specimens should be stored in a manner consistent with their long-term preservation. Important specimens should be housed in a recognized paleontological repository".

The implications of these guidelines are clear. If a collector removes a fossil from its enclosed rock matrix without recording locality and geological data, all of its scientific value and most of its educational and heritage value is lost. Similarly, if the proper documentation is recorded, but the whereabouts of the fossil is not known, its value again is effectively nil.

Recreational fossil collectors

Recreational or casual fossil collectors have been the most assidious of any group in removing fossils from Driftwood Canyon. Every vehicle of the thousands that stop at the

parking lot each year potentially carries a couple of casual fossil collectors. They have heard of the special feature of the Park and, naturally, want to check it out. Typically, members of this group know little about geology and paleontology but, like most people, are fascinated about fossils and their great antiquity.

The location of the vast majority of the fossils removed from Driftwood Canyon Park over the years by casual or recreational fossil collectors is presently unknown and effectively lost to paleontologists. It goes without saying that the standards of these collector are a long ways from "responsible fossil collecting" as defined by the BCPA. Given the country of origin of some of the Park visitors, Driftwood Canyon Eocene fossils are probably sitting on windowsills, book shelves and in collections in the United States, Japan and Germany.

Have casual collectors removed important fossil specimens from the Park? I have knowledge of two highly important fossil specimens that were found by casual collectors at Driftwood Canyon and later were made known to paleontologists -- the unusual fosssil bird *Primobucco*? found by Patricia Petley now at University College of the Cariboo and the smallest known specimen of *Eosalmo driftwoodensis* found by a recreational fossil collector and later acquired by University of Alberta. One would be naive not to believe there have been many more.

Many casual collectors would be able to recognize an articulated bird or fish and perhaps suspect that these were important fossils. Most of such fossils would probably disappear

into private collections. A few (such as *Primobucco*? and *Eosalmo*, above) might be brought to the attention of paleontologists. But not all important fossils are large impressive vertebrates. Some significant fossils at Driftwood Canyon are minute insects that can only be identified with a quality dissecting microscope and considerable entomological insight. Others comprise small bird or mammal bones that require special osteological knowledge to be identified. If small fossils, significant or otherwise, are taken by casual collectors, they probably reside, unacknowledged and unappreciated, in private collections, at best, or shoeboxes and garages, at worst.

School groups

Groups of students and teachers from schools in the Bulkley Valley have regularly taken field trips to examine, and in many cases, collect from the fossiliferous shales at Driftwood Canyon Provincial Park. Elementary, high school and college students have been involved over the past few years. Students would probably have the same impact on the fossil resources of the Park as recreational fossil collectors. The quality of this learning experience depends largely on the geologic knowledge of the teacher or the field trip leader. None of the teachers involved has had special earth science training, but the leader of a field trip of elementary students is a geologist.

Paleontologists

Only a few of the fossil collectors in the Driftwood Canyon Provincial Park have been amateur or professional paleontologists or geologists, but because all information available

about the fossils in the Park comes from this group, their collecting activity should be encouraged.

Serious fossil collecting for scientific purposes in the Park began in the 1940s when Tony Rice of the Geological Survey of Canada collected insects, particularly March flies (Rice, 1959). Len Hills of the University of Calgary collected fossil plants in the Park in the 1960s (Hills and Gopal, 1967). While a graduate student at the University of Toronto in the early 1970s, Mark Wilson collected fishes in the Park, notably the important *Eosalmo driftwoodensis* (Wilson, 1977a, 1992, 1996a, Wilson and Williams, 1993). Later, at the University of Alberta, Wilson expanded his collecting in the Park to fossil insects because of their usefulness as indicators of environments in the Eocene lakes (Wilson, 1977b, 1980, 1988, 1996b, Anderson et al., 1993). He also collected the exceptionally well-preserved ovulate *Pinus driftwoodensis* cone described by Ruth Stockey of the University of Alberta (Stockey, 1883). As a part of her thesis on Eocene flower form and pollinator diversity, Sheila Douglas of University of Alberta studied a variety of insects from the Park in the 1980s (Douglas and Stockey, 1996). Rod Bartlett of the Vancouver Paleontological Society collected fossil insects from the Park in the early 1990s (Archibald, 1995). Bruce Archibald as a part of his thesis at Harvard University collected Eocene insects from the Park in the late 1990s (Archibald, 1998). In order to document the fossils occurring at different localities and to determine diversity, Ken Pugh collected plants, insects and fishes from the Park (Pugh, 1999, 2000)

The collections made by paleontologists from Driftwood Canyon Provincial Park are now reposited at universities, museums or research institutions in Canada (see Appendix 2). Locality data attached to these specimens is adequate, if minimal (that is, almost always "Driftwood Canyon" or "Driftwood Creek"). Only Pugh (1999, 2000) has provided detailed locality information. He has shown that the "Driftwood Canyon" locality of previous workers consists of two major and four minor fossil localities within and just outside the Park.

Commercial fossil collectors

Both lay people and paleontologists were divided on the question of whether recreational fossil collecting should continue at Driftwood Canyon Provincial Park. But they were unanimous and emphatic that commercial fossil collecting must be prohibited. The notion that someone would receive a financial reward from selling a fossil that has been stolen from a provincial park struck everyone as particularly egregious. However, the commercial fossil collector contravenes section 9(1) of the Park Act no more than does the recreational fossil collector. According to this section, a natural resource in a Class A park must not be removed or disturbed (regularly done by recreational fossil collectors), and it must not be exploited or sold (occasionally done by commercial fossil collectors). Moreover, it might be difficult to distinguish a casual fossil collector from a commercial fossil collector because their activities in the Park are virtually identical -- perhaps differing only by degree.

Fossils from Driftwood Canyon have certainly been sold. I have knowledge of only a single transaction, but undoubtedly there have been others. In 1991, at the Denver Rock and Fossil Show, a dealer offered for sale a large complete specimen of *Eosalmo driftwoodensis* that had been collected by persons unknown at Driftwood Canyon. The specimen had been exported illegally; that is, without a Canada Cultural Property Export and Import Permit. The owner, an American and not necessarily the collector, received US $5,000 for the specimen which has now been repatriated to Canada. It is reposited in the museum at Parc de Miguasha, Quebec.

Mark Wilson of the University of Alberta, who started collecting fossils Driftwood Canyon in the 1970s, has heard rumours of complete fossil fishes and even fossil birds from the Park that have been offered for sale, but he emphasizes that these are unconfirmed.

As long as recreational fossil collecting is allowed at Driftwood Canyon Provincial Park, it constitutes tacit approval for the continuation of commercial fossil collecting.

7. A legacy of 35 years of recreational fossil collecting at Driftwood Canyon

According to visitor data collected by BC Parks, a total of 29,000 vehicles stopped at the parking lot at Driftwood Canyon Provincial Park over the summer months (May to September) from 1990 to 2000. Applying a factor of 3.1 persons per vehicle, this means that about 90,000 people visited the park over this eleven year period. Similar data are not available for the previous two decades, but if the number of visitors were comparable then more than a quarter of a million people have visited this small park since its establishment in 1967.

Not all of the visitors would be interested in collecting fossils, but if as few as a half or a third each kept a couple of fossil specimens out of general interest or as a souvenir of their visit, then between 100,000 and 300,000 pieces of fossil-bearing shale would have left the park over the past 35 years. The collecting activity of most of the visitors would be focussed at the accessible talus slopes of shale that spread out beneath the two vertical cliffs. The preferential removal of shale pieces with conspicuous and impressive fossils from two relatively small areas would inevitably result in the concentration of non-fossiliferous shale pieces or shale pieces with small, fragmented or unimpressive fossils.

Among the hundreds of thousands of fossils that have been taken from the Park are undoubtedly many new to paleontology, or well-preserved specimens that could have increased knowledge about known species.

The depletion of fossils on the scree slopes would be compensated if the rate of new shale chunks sloughing off the cliffs was sufficiently high.. Has this rate kept up with the rate of removal of fossil-bearing shale? This is a difficult question to answer because it deals with the non-quantifiable impression of people who have visited the Park over many years. My discussions with people in the Smithers area often led to the statement that it is now much more difficult to see and appreciate fossils at Driftwood Canyon Park than it was years ago. Richard Hebda, the Curator at the Royal B.C. Museum responsible for Earth Science, has substantiated this impression. He has visited the Park a number of times over nearly 20 years and is now convinced that fossils have been removed to the extent that visitors cannot now appreciate the most special feature of Driftwood Canyon Provincial Park.

The same view is comunicated by Lillian Weedmark, the Curator of the Bulkley Valley Museum. She reguarly directs museum visitors to Driftwood Canyon, but in the last few years she has noted that some return to the museum disappointed because they were not able to see any kind of fossil in the shales at the Park.

It appears that thirty-five years of intense fossil collecting at Driftwood Canyon Provincial Park has taken its toll in the numbers of fossils to be seen and their quality. Important fossils have undoubtedly disappeared, but the most regretable outcome is that visitors to the Park now can only see the pitiful remnants of a once-impressive natural resource.

8. Views of different stakeholders and interest groups

Some of the paleontologists who were asked their views about casual fossil collecting at Driftwood Canyon Provincial Park suggested that it should continue because personal fossil collecting might serve as an incentive for individuals to become informed about paleontology and geology. Thus, Bob Campbell, the Chair of the newly formed Northern British Columbia Paleontological Society in Prince George, wrote that his members believe that fossil collecting is a unique opportunity for public education and discovery that should be continued at Driftwood Canyon. Similarly, James Haggart, the Chair of the British Columbia Paleontological Alliance (the umbrella group of the six regional paleontological societies in the province) wrote that "the collective opinion of the directors is that recreational fossil collecting is a valuable educational tool for the general public, and should be allowed to continue at Driftwood Canyon Provincial Park".

There is, however, little evidence that unmanaged casual fossil collecting at Driftwood Canyon (without any educational component) has resulted in anything more than the accumulation of curios in window sills. Certainly, the survey of Smithers high school students (see below) suggests that their collecting of Driftwood Canyon fossils led to little enlightenment about fossils.

Mark Wilson of the University of Alberta, the paleontologist who has contributed more scientific publications on the fossils of Driftwood Canyon than anyone else, recommends

that casual fossil collecting here should be limited to shale pieces on the scree slopes. He also supports the "Stonerose Model" by indicating that before any fossil is taken away from the Park, it should be reviewed by a "paleontologically literate attendant". Any fossil plant or insect that is scientifically important should be retained; as should all vertebrate fossils.

Wilson, Haggart and a few other paleontologists suggested that the consequences of casual fossil collecting at Driftwood Canyon could be mitigated if the activity was restricted to the scree slope or to a portion of that slope. However, because virtually all of casual collecting is already done on the scree slope, this suggestion endorses the status quo. Moreover, it is unlikely that a policy of allowing collecting in only a single area, but not in others, can be effective in a park as small as Driftwood Canyon,

Some prominent paleontologists in British Columbia declare that recreational fossil collecting should not be permitted in Driftwood Canyon because it is a provincial park – essentially as a point of principle. The only fossil collecting to be allowed in Driftwood Canyon and other a provincial parks should be done, under permit, by paleontologists and the fossils collected should remain property of the Crown. This is the view of Chris Barnes, the Director of the School of Earth and Ocean Sciences, University of Victoria, Randle Robertson, the Executive Director of the Yoho-Burgess Shale Foundation in Field, and Richard Hebda, the Curator of Botany and Earth History at the Royal B.C. Museum.

Allen Gottesfeld, who taught geology at Northwest Community College in Kitimat in the

1980s, was much more emphatic about casual fossil collecting at Driftwood Canyon. In his book, *Geology of the Northwest Mainland* (Gottesfeld, 1985, p. 35), he stated:

> "The Driftwood Creek fossils are excellent specimens from a time period which is not well represented in North America. The insect preservation is of outstanding quality. This locality is not adequately represented in museums, consequently the exploitation of this locality for casual collection is deplorable"

In the past, the Chamber of Commerce and the Tourist Bureau in Smithers have promoted Driftwood Canyon Provincial Park as a place to picnic and to collect fossils. According to Susan Randrup, the Park is still promoted as an attractive destination and a place where interesting fossils can be seen, but visitors are now advised that they should not collect fossils. This information is consistent with that in the latest brochure on the Park issued by BC Parks (May, 2000) which states, "BC Parks is committed to conserving this valuable resource at Driftwood Canyon, please do not remove fossils from the park."

Views of Smithers high school students.

A questionnaire to students in grade 9 and 10 science classes at Smithers Secondary about fossils and Driftwood Canyon provides interesting data about casual fossil collecting and general knowledge about fossils. The questionnaire was drafted by Ray Chipenius and administered by Stephen Lockwood in late January, 2001. Of a sample of 60 students, 34 (57%) had collected fossils at Driftwood Canyon and 31 (52%) have fossils at home that

they had collected themselves. Of those who had collected fossils at Driftwood Canyon and had some at home, not a single student could identify these fossils or had any concept of their age. In response to the question of whether Driftwood Canyon Park should remain open to fossil collecting, 66% of the teenage students said yes, 34% said no. But whether they thought fossil collecting should continue or not, many students clearly recognized that the Driftwood Canyon fossils are a fragile resource that needs some protection. The qualifying comments include the following:

- "keep is limited to one fossil per person, so it doesn't get out of control"
- "should be closed to the public, but schools should have permission to collect"
- "ban anyone from chipping at the stuff still embedded in rock"
- "everyone don't need to collect too many fossils"
- "if left open, all the fossils may be collected"

9. Management strategies and collecting protocols at comparable fossil sites

Fossiliferous beds are found in many national parks, provincial parks, ecological reserves or other publicly protected lands in Canada. The public is often fascinated by fossils and paleontologists have an obvious scientific interest in such fossil sites. Consequently, different jurisdictions have developed management strategies that address aspects of collection, research, and repositories of fossils, and protection, access and education about fossil sites. Some management plans treat fossils as natural resources, like wildlife and plants, but because fossils are a record of the evolution of life on earth, they are probably best treated as heritage resources similar to archeological and historical artifacts and sites.

The Trilobite Beds and Walcott's Quarry

Middle Cambrian trilobites in Yoho National Park of eastern British Columbia were the first fossils to become a tourist attraction in the province. Visitors to the Trilobite Beds on Mount Stephen above the village of Field were startled by the realization that virtually every slab on the mountainside features large and complete trilobites. The sheer abundance of large fossils attracted so many visitors that they inadvertently damaged the site by walking on and breaking slabs of shale. This damage, compounded by on-going pilfering of fossils, prompted Parks Canada to close off all access to the Trilobite Beds. This site remains out-of-bounds to all visitors (park visitors as well as paleontologists), but popular guided hikes to the lower edge of the Beds, conducted by naturalist/geologists and run by the non-profit Yoho-Burgess Shale Foundation, provide visitors with an opportunity

to learn about the geology and paleontology of Mount Stephen. Little paleontological research is presently carried out on the fossils of the Trilobite Beds, but the other major Middle Cambrian site in Yoho National Park, Walcott's Quarry, is the focus for both intensive research and popular interest, especially since 1989 when Stephen Jay Gould published his book "Wonderful Life" which concerns the fossils of this quarry and their significance. Located high above Emerald Lake, Walcott's Quarry is also out-of-bounds to all park visitors. But in summer the Yoho-Burgess Shale Foundation conducts daily hikes to the quarry where visitors can see a crew from the Royal Ontario Museum excavating the shale and collecting soft-bodied fossils. These fossils from Walcott's Quarry have led some paleontologists to declare that, for what it tells us about the Cambrian evolutionary explosion of animals, this quarry is the most important fossil locality in the world. Because both Cambrian sites are located in a national park (and in a UNESCO World Heritage Site) no removal of fossils is tolerated. Park rangers have been known to search backpacks for fossils illegally collected. Yoho National Park allows a single team to excavate in and near Walcott's Quarry. Since 1983 this has been a party from the Royal Ontario Museum under the direction of Des Collins. As part of the Reseach Agreement between Parks Canada and the ROM, Dr. Collins is expected to be an active participant in educational programs by interacting with visitors. The fossils collected by Collins are curated with two sets of catalogue numbers -- Parks Canada and Royal Ontario Museum.

Dinosaur Provincial Park

The Royal Tyrrell Museum of Palaeontology at Drumheller organizes a series of hikes and

digs in Dinosaur Provincial Park and Horseshoe Canyon. Lasting from a couple of hours to a week, these are revenue-producers for the museum and are extremely popular among visitors. Through a "pay to dig" program, the Tyrrell's fieldwork in Dinosaur Provincial Park has become self-supporting. Some hikes are self-guided, but most are closely supervised by museum staff. Alberta has stringent regulations about fossil collecting and the participants in the hikes and digs are pointedly reminded of the repercussions of taking away even a small fragment of dinosaur bone. In the early part of the 20th century, many Canadian and U.S. museums and universities were involved in excavation of dinosaurs from the Red Deer River Valley. Now, the Tyrrell Museum is the only institution actively digging dinosaurs in Alberta -- to the extent that the museum has become virtually synonymous with dinosaurs in Canada.

Manuels River

Manuels River flows through a gorge into Conception Bay about 25 km west of St. John's, Newfoundland. The gorge exposes a sequence of Cambrian rocks, some beds containing magnificent trilobites that have been intensely quarried since the 1960s. Collectors have come from as far away as central United States. So many specimens of trilobites have been removed over the years that the Government of Newfoundland and Labrador has now designated the gorge as a Provincial Wilderness Site where fossil collecting or hammering is strictly prohibited. No personnel is based at the gorge and none regularly patrols it, so the collecting ban is enforced voluntarily and through the watchfulness of the sparse local residents.

Joggins

The extensive cliffs below the village of Joggins on Chignecto Bay off the Bay of Fundy in Nova Scotia expose a thick section of Carboniferous strata that contains impressive metre-high lycopsid tree stumps, sometimes containing the bones of some of the earliest reptiles. These fossil-bearing rocks were among the first studied in Canada and the site is one of the most celebrated geological sites in the world. Joggins is a protected site under the Special Places Act of the Province of Nova Scotia and excavation of fossil material from the cliffs is prohibited without a permit from the Nova Scotia Museum. The collection of loose fossils fallen onto the beach is, however, still permitted. This is clearly a defective regulation because virtually all of the important paleontological discoveries over the years have been made from material fallen from these cliffs -- including complete skeletons of fossil reptiles. The privately run Joggins Fossil Centre in the village displays many of these fossils that have fallen from the cliffs.

Le Parc de Miguasha

The cliffs at Baie de Chaleur on the south coast of Gaspe Peninsula are part of Le Parc de Miguasha, a tiny Quebec provincial park established in 1985 to protect a fossil site containing the most diverse assemblage of Devonian fossil fishes in the world. A first-class interpretation centre and museum directs the educational programs for visitors and organizes tours along the fossil cliffs. Many fragments of fossils are evident in the shales and siltstones, but the no collecting policy is strictly observed. In the early part of the 20th century, Miguasha fossil fishes were collected by the thousands by paleontologists and

private collectors and are now found in museums in Europe, United States and Canada. Now, all excavation and collecting from the fossil cliffs are managed by the director of Le Parc de Miguasha and all fossil material is assigned MHNM (Musee d'Histoire naturelle de Miguasha) numbers.

Top-of-the-World Provincial Park

Top-of-the-World is a small wilderness park located high in the Rocky Mountains north of Cranbrook. The park features outcrops of Ordovician limestones with large dramatic fossils -- stromatoporoids, corals, cephalopods, and brachiopods. Because they have been replaced by resistant silica, these fossils are conspicuous by protruding from the limestones. The relatively few visitors to this park are advised that the fossils must not be damaged or removed. In any case, being incorporated in large blocks of limestone, the fossils are not easily transportable. In the early 1990s the Royal Tyrrell Museum of Palaeontology collected fossils from the Park including more than a hundred tree trunk-like stromatoporoids, some as long as 2 metres, that were to be the basis for a new display at the museum in Drumheller. The material collected was catalogued jointly with RTMP and RBCM numbers. At the present time all Top-of-the-World fossils are kept at the Tyrrell Museum in Drumheller, Alberta.

Stonerose Interpretive Center

Unlike those above, this fossil locality is not located within publicly protected lands, but it is included here because it may have implications for a management strategy at the

Driftwood Canyon fossil beds. The Stonerose Interpretive Center is located on eight city lots in downtown Republic, Washington. The fossil beds consist of Eocene lacustrine shales with the same package of fossils as at Driftwood Canyon -- that is, plants, insects, fishes. The Center is privately owned by a nonprofit group, the "Friends of Stonerose Fossils", which is dedicated to enhancing general knowledge about Eocene fossils and environments, to promoting responsible fossil collecting of modest numbers of specimens, and to preserving the fossils for public enjoyment. Visitors can view the fossil displays in the Center and, if interested, can obtain a permit to hunt for fossils. Each person is allowed to keep only three fossils a day. All specimens must be shown to the curator who has the right to retain any fossil that is significant to the Stonerose collection or is of potential scientific value to paleontologists at the Burke Museum at the University of Washington. In this way, the collections have been enriched by thousands of amateur fossil collectors. The collective scrutiny of numerous shale chips resulted in the discovery of many complete fishes and insects along with rare leaves, flowers, fruits and seeds; even a couple of feathers.

This selective survey of the fossil management strategies and collecting protocols presently in place at Canadian publicly protected lands leads to an unequivocal conclusion -- no jurisdiction permits collection or removal of fossils from the protected lands . Some that had allowed fossil collecting in the past, changed their policies when it became clear that the resource was being damaged (Trilobite Beds, Walcott's Quarry, Miguasha, Manuels River). Others restrict access to the fossil sites to guided hikes (Trilobite Beds, Walcott's

Quarry, Dinosaur Provincial Park). Still others make a point of informing the public about the significance of the fossils and trust them not to collect and not to damage the resource (Manuels River, Joggins, Top-of-the-World).

10. Managing public information about the fossils at Driftwood Canyon

Most of the public interest in the fossils at Driftwood Canyon has focussed on the fact that these records of ancient life can be collected. BC Parks need to change this view. The emphasis should be shifted from *collecting fossils* to *learning about and conserving fossils*. With responsibility for Driftwood Canyon Provincial Park, BC Parks are the stewards of the most significant fossil resource in the region and, therefore, they should take a leadership role in providing accurate information about local paleontology, not just to park visitors, but also to the public and students of the Bulkley Valley. If they are to assume this role, it is essential that some staff of BC Parks in Smithers develop or enhance their knowledge about paleontology and geology. This could be done in several ways.

Self-directed learning can be both efficient and effective. Many excellent text-books on introductory geology, stratigraphy and paleontology are available. In the rather narrow field of Eocene paleontology, four papers in Ludvigsen, R. (ed.) *Life in Stone: A Natural History of British Columbia's Fossils* published by UBC Press in 1996 provide excellent coverage of Eocene fossils in the B.C. Interior, some from Driftwood Canyon (Wilson on the insects and fishes, Stockey and Wehr on the flowering plants, and Basinger, McIver and Wehr on the conifers).

However, the best way for BC Parks staff to become sufficiently knowledgeable would be through an intense 3-5 day training session in earth history, historical geology and

paleontology conducted by a paleontologist in Smithers. This session would allow local geology and paleontology of Driftwood Canyon to be examined in larger contexts including geologic time, ancient environments, preservation of fossils, taphonomy (science of burial), paleoecology, co-evolution, taxonomy as well as the geologic history of the Cordillera. This session should be conducted both in the classroom and in the field in Driftwood Canyon.

With such a background, BC Parks staff would be in a position to provide educational programs on Driftwood Canyon fossils to elementary, middle and secondary school students. Even though Earth History is part of the curriculum in all grades, it is rarely taught because few teachers in the school system have an adequate background in geology and paleontology. In the context of larger responsiblity, BC Parks might promote the inclusion of an Earth History session in the Bulkley Valley School District professsional days for science teachers.

Important fossils are not all attractive, but many Driftwood Canyon fossils are. The colour contrast between the cream-coloured shale matrix and the brown fossils results in quite dramatic displays (see Plate 3). BC Parks should augment its fossil collection to include well-preserved specimens of plants, insects and fishes. This collection can then become the basis for compelling displays -- a permanent display of Driftwood Canyon fossils for a central location in Smithers (possibly the Library) as well as a travelling display for school visits. The Bulkley Valley Museum is an obvious ally in assembling displays of Driftwood

Canyon fossils.

The way to change a fossil from a curio to an item of scientific significance is often no more than an identification. If a jumble of fish bones and scales can be identified as a specimen of *Eosalmo,* then immediately that fossil assumes importance and it becomes worthy of care and preservation. Many people in the Bulkley Valley have collections of unidentified Driftwood Canyon fossils, possibly including some scientifically significant specimens. BC Parks and the Bulkley Valley Museum might sponsor a "Fossil Identification Day" with a paleontologist and encourage locals to bring in their fossils for identification. This would also be an opportunity to identify important fossil specimens -- complete fishes, another bird, and possibly a mammal. Staff could then encourage the owners to donate significant fossil specimens to BC Parks or to the Museum.

Science operates through peer-reviewed publications. Laypeople rarely get the opportunity to peruse such publications, but (once the jargon is eliminated or defined) these papers are quite understandable. The scientific literature on Driftwood Canyon fossils is fairly limited -- not many more than 20 have been published, but these have come out in rather obscure scientific journals or as chapters in specialist books. To provide a resource for local naturalists, amateur paleontologists and students, BC Parks should assemble these papers, bind them in a single volume, and deposit this volume at the Smithers Library.

The greatest challenge to BC Parks is to explain the necessity to apply fossil collecting

policies to the Park. This should not be seen as curtailing the activities of Park visitors. Rather, it is necessary to ensure that the generous bequest of Gordon Harvey in 1967 is not frittered away today by inept and thoughtless collectors or by overcollecting. The ability to appreciate fossils should not be denied any visitor to the Park. And, if any fossil collecting is allowed it must meet the basic criteria of proper stewardship of the resource.

11. Recommendations for a comprehensive fossil management plan for Driftwood Canyon Provincial Park

Managing public fossil collecting at Driftwood Canyon

Recreational fossil collecting has been a featured activity at Driftwood Canyon Provincial Park for close to 35 years. This activity has been allowed to continue without management, without criteria, without rules and without evaluation. Possibly hundreds of thousands of fossil specimens have been removed from the Park without a record. The consequences for the natural history, heritage and scientific aspects of the fossil resource have been considerable.

Over the years, unmanaged recreational fossil collecting has preferentially removed large and conspicuous fossils from the most accessible portions of the fossil beds -- to the extent that it is now difficult for visitors to appreciate this unique feature of Driftwood Canyon Provincial Park. The hundreds of thousands of fossils that left the park over the years undoubtedly included an unknown number of scientifically significant specimens. Few of these can ever be recovered. Moreover, thirty-five years of recreational fossil collecting in the Park has not resulted in demonstrable increase in local knowledge about fossils or paleontology.

Recreational fossil collecting is an anomalous activity within the provincial park system in British Columbia and, furthermore, it is in contravention of Section 9(1) of the Park Act.

Comparable fossil beds are found in many national parks, provincial parks, and ecological reserves across Canada. Not a single one of these jurisdictions permits casual collection or removal of fossils.

The public and paleontologists are unanimous in condemming commercial collecting in the Park. However, it is difficult to distinguish a recreational fossil collector from a commercial fossil collector because their activities are virtually identical, differing only by degree. The most effective means of stopping commercial collecting in the Park is to stop recreational collecting.

Recreational collecting also involves safety issues. Unmanaged fossil collecting on the steep unstable scree slope and beneath the cliffs is a dangerous activity, especially for children.

Recommendation 1: That recreational and commercial fossil collecting no longer be permitted in Driftwood Canyon Provincial Park.

Visitors to the Park continue to have considerable interest in viewing, learning about and collecting the fossils. Moreover, many people in the Bulkley Valley feel that BC Parks has an obligation (moral, if not legal) to allow some kind of public fossil collecting in the Park on account of Gordon Harvey's request when he donated the land to the Province of British Columbia.

Public fossil collecting should continue to be permitted at Driftwood Canyon Provincial Park, but only as a part of a staffed educational program that emphasizes paleontology, natural history and stewardship of Eocene fossils. This program is to be delivered in the Park by BC Parks staff or by university or college students. The fossil collecting should follow the "Stonerose Model" where each individual is allowed to keep a few fossil specimens. Before they leave the site, these specimens must be shown to BC Parks staff who have the right to retain any fossil that is significant for the BC Parks Collection or might be of potential scientific value to paleontologists. In designing and delivering this program BC Parks might seek corporate sponsorship (with BC Hydro, Telus, Weldwood, for example). The students could be funded through the HRDC Student Summer Employment Program.

Recommendation 2: That managed fossil collecting according to the "Stonerose Model" be permitted as part of a staffed educational program delivered in the Park.

Professional development for BC Parks personnel

Because BC Parks cannot effectively manage a resource it does not understand, it is essential that some staff members of BC Parks in Smithers develop or enhance their knowledge about paleontology and geology to the extent that that they can deliver public educational programs on Eocene fossils in the Park. This professional development could be accomplished by an intense 3-5 day session in Smithers that would include classroom

and on site instruction. A professional paleontologist should deliver the training.

Recommendation 3: That BC Parks staff members participate in an intense 3-5 day training session on paleontology and geology conducted by a paleontologist.

Managing public information about the fossils at Driftwood Canyon

Because they are stewards of the most significant fossil resource in the region, BC Parks should take a leadership role, not just in promoting a conservation ethic of the fossil resources of Driftwood Canyon to park visitors, but also in educating all Bulkley Valley residents about local paleontology. This means that BC Parks need to become involved with schools and with students and teachers in classrooms. Earth History is part of the curriculum in all grades, but it is rarely taught because few teachers in the school system have a background in geology or paleontology. BC Parks could greatly enhance appreciation of local geology and paleontology by talking to classrooms about rocks and fossils before they lead school field trips to Driftwood Canyon. BC Parks should also promote the inclusion of an Earth History session in the Bulkley Valley School District professional development days for science teachers.

Recommendation 4: That BC Parks develop educational programs on Driftwood Canyon fossils that can be delivered to elementary, middle and secondary school students.

Paleontology is very much a visual discipline whose understanding can benefit from relatively simple displays of actual fossils and quality photographs of small fossils. The BC Parks Collection already constitute the basis for quality displays of Driftwood Canyon fosssils. With the aid of paleontogists and fossil collectors, that collection can readily be augmented to include well-preserved representatives of plants, insects and fish fossils.

Recommendation 5: That BC Parks assemble a quality permanent display of Driftwood Canyon fossils for a central location in Smithers (Library?).

Recommendation 6: That BC Parks assemble a smaller travelling display of Driftwood Canyon fossils for school visits.

Many people in the Bulkley Valley have collections of unidentified Driftwood Canyon fossils, possibly including some scientifically significant specimens. BC Parks should sponsor a "Fossil Identification Day" with a paleontologist in Smithers and encourage locals to bring in Driftwood Canyon fossils for identification. Staff could encourage people to donate important fossil specimens to BC Parks or museum.

Recommendation 7: That BC Parks sponsor a "Fossil Identification Day" with a paleontologist in Smithers and encourage locals to bring in

Driftwood Canyon fossils for identification.

The scientific literature on Driftwood Canyon fossils is fairly limited -- no more than about 20 papers have been published -- identified by (*) in the References section. The papers have been published in rather obscure scientific journals or as chapters in specialist books, but most of these contributions could be understood and appreciated by the interested layperson. To provide a resource for local naturalists, amateur paleontologists and students, BC Parks should assemble these papers, bind them in a single volume, and deposit the volume at the Smithers Library.

Recommendation 8: That BC Parks deposit a bound volume of all published papers on Driftwood Canyon fossils in the Smithers Library to serve as a resource for naturalists, amateur paleontologists and students.

The need to apply fossil collecting policies in the Park should be explained to the general public in Smithers and the Bulkley Valley as necessary to ensure that the generous bequest of Gordon Harvey is not frittered away by inept and thoughtless collectors. The ability to collect fossils is not denied any visitor to the Park, but fossil collecting must meet the criteria of proper stewardship of the resource.

Recommendation 9: That BC Parks use local media and public meetings

to emphasize that fossil collecting policies in the Park are needed to protect the generous legacy of Gordon Harvey.

The signage in the Park should be upgraded to emphasize stewardship of the fossil resources and to underscore that recreational fossil collecting is not permitted and why. The new displays would be clearer if they would focus, for example, on fossil fishes and not on reconstructed living fishes.

Recommendation 10: That the signage in the Park be improved and upgraded to emphasize that recreational fossil collecting is not permitted and why.

Managing scientific fossil collecting at Driftwood Canyon

All information available about the fossils at Driftwood Canyon has come from the work of only a few paleontologists. Their collecting activity in the Park should be encouraged, even facilitated. Because the quality of their collecting and curating is the same and the security of repositories comparable, no distinction should be made between professional paleontologists and amateur paleontologists in issuing Park Use Permits. Paleontologic research on inventory of fossil leaves and insect diversity is particularly needed at Driftwood Canyon. All paleontologists who work in the Park should also be involved in public education. The public is interested in paleontologic techniques, how paleontologic collecting occurs and about the meaning of specific fossils.

Recommendation 11: Park Use Permits should readily to be issued to professional and amateur paleontologists who need to collect fossils in the Park for a specific purpose.

Recommendation 12: Every paleontologist who collects fossils in the Park should also be involved in some aspects of public education about Eocene paleontology or how fossils are collected – either in the Park or in Smithers.

All fossils collected from a provincial park remain the property of the Crown. After their study has been completed at different institutions in B.C. or elsewhere, these fossils should be returned to British Columbia for permanent repository. BC Parks should strongly urge the Royal British Columbia Museum to assume their responsibility as the formal repository of provincial fossils, even though they have not been proactive in doing so in the past.

Recommendation 13: That BC Parks urge the RBCM to become the formal repository of provincial fossils

12. Acknowledgements

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Many paleontologists offered their views on fossil collecting at Driftwood Canyon Provincial Park. In particular, I want to thank Chris Barnes of the School of Earth and Ocean Sciences at University of Victoria, Richard Hebda of the Royal British Columbia Museum, Ken Klein of the University College of the Cariboo in Kamloops, Randle Robertson of the Yoho-Burgess Shale Foundation in Field, Ken Naumann of Langara College in Vancouver, Bob Campbell of the Northern British Columbia Paleontological Society in Prince George, Bruce Archibald of the Museum of Comparative Zoology at

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Finally, I want to recognize the contributions of two paleontologists in furthering our knowledge of fossils at Driftwood Canyon Provincial Park. Ken Pugh of the Fraser Centre for Eocene Research in Chilliwack has assembled a complete data file of occurrences of specific fossils in and around the Park. Mark Wilson of the Laboratory of Vertebrate Paleontology at the University of Alberta in Edmonton has been involved in all published academic research on Driftwood Canyon fossils over the past 25 years; either as an author or as a facilitator. Both shared their views of how best to manage this fragile resource.

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14. Appendix 1

An inventory of Eocene fossils from Driftwood Canyon Provincial Park (recorded at the genus or family level) and their repositories

PLANTS

Ferns and other plants

Azolla (water fern)	FCER BVM LOrsa RTMP RBCM
Equisetum (horsetail)	BCParks KCM

Conifers

Chamaecyparis (false cypress)	FCER
Metasequoia (dawn redwood)	FCER BCParks BVM LOrsa KCM RTMP RBCM
Picea (spruce)	FCER BCParks
Pinus (pine)	FCER BCParks BVM UAPC KCM RBCM
Abies (fir)	RBCM UWBM
Larix (larch)	FCER
Pseudolarix (golden larch)	FCER LOrsa RBCM UWBM
Sequoia (redwood)	FCER BCParks BVM LOrsa
Sequoiadendron (giant redwood)	FCER BVM Lorsa

Cryptomeria (Japanese cedar)	FCER
Glyptostrobus (water pine)	KCM
Thuja (arbovitae)	FCER
Taxus (yew)	FCER
Ginkgo (maidenhair tree)	BVM LOrsa

Flowering plants

Amelanchier (serviceberry)	LOrsa
Alnus (alder)	FCER
Betula (birch)	LOrsa KCM
Salix (willow)	FCER
Cercidiphyllum (katsura)	LOrsa KCM RBCM
Juglans (walnut)	LOrsa
Typha (cattail)	FCER BCParks LOrsa
Florissantia (cocoa tree family)	FCER
Quercus (oak)	KCM LOrsa
Rhus (sumac)	BVM
Sassafras	BVM
Sorbus (mountain-ash)	FCER
Ulmus (elm)	UWBM

INSECTS

Dermaptera (earwigs)	FCER RBCM
Isoptera (termites)	UAFIC
Cicadellidae (leafhoppers)	ROM Archibald FCER
Cercopidae (spittlebugs)	UAFIC ROM RBCM
Aphididae (plant lice)	VPS UAFIC Archibald
Gerridae (water striders)	ROM UAFIC VPS LOrsa
	BCParks BVM KCM
	FCER Archibald RBCM
Veliidae (ripple bugs)	ROM
Trichoptera (caddis flies)	ROM FCER
Chrysopidae (green lacewings)	Archibald VPS
Trichoceridae (winter crane flies)	ROM
Ptychopteridae (primitive crane flies)	ROM
Tipulidae (crane flies)	ROM UAFIC VPS Archibald
Culicidae (mosquitos)	FCER UAFIC
Bibionidae (march flies)	GSC LOrsa BCParks ROM
	UAFIC FCER Archibald RBCM
Mycetophilidae (fungus gnats)	ROM Archibald
Sciaridae (dark-winged fungus gnats)	UAFIC ROM
Empididae (dance flies)	ROM UAFIC Archibal

Syrphidae (hover flies)	Archibald
Curculionidae (snout beetles)	FCER
Ichneumonoidea (ichneumon wasps)	ROM UAFIC VPS Archibald
Braconidae (braconid wasps)	ROM RBCM

FISHES

Amia (bowfins)	ROM CMN
Eosalmo (salmon)	BVM UALVP ROM CMN LOrsa BCParks FCER RTMP Miguasha
Amyzon (suckers)	ROM
coprolites (excrement)	FCER UALVP

BIRDS

Primobucco?	UCC
bones	ROM UALVP
feathers	UALVP BCParks FCER

MAMMALS

rodent bones in fish coprolite	RBCM

15. Appendix 2

Repositories of Eocene fossils from Driftwood Canyon Provincial Park

Archibald Bruce Archibald's research collection, Harvard University Museum of Comparative Zoology, 26 Oxford St. Cambridge MA 02138

BCParks BC Parks, Skeena District 3790 Alfred Ave., Smithers, B.C. V0J 2N0

UWBM Burke Museum, University of Washington University of Washington, Seattle, WA 98195

BVM Bulkley Valley Museum Smithers, B.C.

CMN Canadian Museum of Nature PO Box 3443, Station D, Ottawa, Ontario K1P 6P4

FCER Fraser Centre for Eocene Research Ken Pugh, 45964 Ivy Ave., Chilliwack, B.C. V2P 2C5

GSC Geological Survey of Canada

601 Booth Street, Ottawa, Ontario K1A 0E8

KCM Kitimat Centennial Museum

293 City Centre, Kitimat, B.C. V8C 1T6

LOrsa Private collection of Tony L'Orsa

Smithers, B.C.

Miguasha Parc de Miguasha

C.P. 183, Nouvelle, Quebec G0C 2E0

RBCM Royal British Columbia Museum

675 Belleville St., Victoria, B.C. V8V 1X4

ROM Royal Ontario Museum

100 Queen's Park, Toronto, Ontario M5S 2C6

RTMP Royal Tyrrell Museum of Palaeontology

Box 7500, Drumheller, Alberta T0J 0Y0

VPS Vancouver Paleontological Society

Centrepoint PO Box 19653, Vancouver, B.C. V8T 4E7

UALVP University of Alberta, Laboratory of Vertebrate Paleontology

Department of Biological Sciences, Edmonton, Alberta T6G 2E9

UAFIC University of Alberta, Fossil Insect Collection

Department of Biological Sciences, Edmonton, Alberta T6G 2E9

UAPC University of Alberta, Paleobotanical Collection

Department of Botany, Edmonton, Alberta T6G 2E9

UCC University College of the Cariboo

Department of Physical Sciences and Engineering,

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