PALEOTEC
SERVICES

A. Hickin Flatbed Peat Site Macrofossil Report MFRPT 12:07

Introduction

Thirty-four bulk samples collected from Flatbed Peat Site, B.C. (**Figure 1 & Figure 2**) by Adrian Hickin and Marten Geertsema were submitted to PALEOTEC Services for macrofossil identification and submission for AMS radiocarbon dating. Of the 34 samples submitted (**Table 1**), only the basal 15 were analyzed. They comprise overbank deposit (**Figure 3**) compressed organics (**Figure 4 & Figure 5 & Figure 6**) and dense peat (**Figure 7 & Figure 8**). **Table 2** lists the samples that were submitted for AMS dating to the Keck Carbon Cycle AMS Facility, University of California, Irvine. **Table 3** and **Table 4** show the AMS ^{14}C dating results. **Table 5** is a working table of samples listing suitable material in each sample for dating. Synoptic tables of the identified plant and animal macrofossils are listed in **Table 6** and **Table 7** respectively. **Table 8** lists the identified enumerated macrofossils for each sample analyzed. Figure 1 through 50 illustrate some of the macrofossils along with modern day analogues and also provide photographic records of the macrofossils submitted for dating.

Method

The procedure for isolating macrofossils for analysis involved the standard technique of sieving with warm tap water. For the overbank sands, a swirl technique was used to separate the organic content from the sand component. This technique involved gentle hose spraying the sides of a 1 L container of sediment creating a vortex of lighter organic material that was decanted into nested sieves. This procedure was repeated until all the observed organic material had been isolated. The compressed organics and dense peat were processed differently due to their compaction. These samples were soaked in warm water and the organic material floating on the surface was gently decanted into a 100 mesh Tyler sieve (mesh opening 0.15 mm). The remaining sample was sieved through nested 12, 20, 40 and 60 Canadian Standard Tyler series sieves (mesh openings 1.4 mm, 0.85 mm, 0.425 mm and 0.250 mm respectively). Since the material contained either organic peat peds (**Figure 19**) or moss peds (**Figure 46**) after the initial processing and examination of macrofossils, a more aggressive approach was utilized by hand massaging the peds. In many cases the peds could not be broken down entirely and many of the smaller Crustaceans (water fleas, *Daphnia* ephippia), aquatic invertebrates (moss animals, Bryozoa statoblasts) aquatic insects (larvae midge head capsules, Chrironomidae) and freshwater algae (stoneworts, *Chara* oogonia) are under represented in terms of enumeration. All material greater than 0.425 mm was examined using a binocular microscope and plant and insect fossil remains were isolated for identification and potential AMS radiocarbon dating.

Microscopic digital photography of macrofossils was done using an Infinity digital camera mounted on an Olympus binocular microscope. Images of modern analogues were downloaded from the world-wide-web and should not be reproduced commercially or published without copyright permission. In most cases, images were obtained from government, educational or public domain sites such as E-flora BC (www.geog.ubc.ca/biodiversity/eflora/), United States Department of Agriculture (USDA, http://plants.usda.gov/java/), Wikipedia (wikipedia.org) and Creative Commons (creativecommons.org) where images are free to use, share or modify, even commercially as long as the author is attributed.

In preparation for AMS radiocarbon dating, those samples containing suitable material for dating were isolated, weighed and photographed. Prior submission to a dating facility, the isolated material for dating was inspected and in some cases cleaned using an ultra sonic bath. The dried material was packaged using freshly cut, small square pieces of aluminum tin foil, folded into small packets and placed in labeled plastic sterilized 3.5 cm diameter covered petri dishes for shipment to Keck Carbon Cycle AMS Laboratory. Throughout the entire subsampling and subsequent inspection and packaging of the macrofossils for dating, new latex disposable gloves were worn and only non-carbon instruments or material were used (glass beakers, glass petri dishes, stainless steel forceps, and aluminum tin foil).

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Results & Discussion
Overbank Sands

FBRP-01, 0-30 cm Vol.: 1350 ml 9195 ± 25 yr BP

Overall, preservation of the plant and animal macrofossils in the overbank sands are poor with some plant remains being difficult to identify (**Figure 9e & f**). Many of the macrofossils have iron (Fe) staining (rust-coloured precipitate) on the surfaces likely the result of deposition in an oxygen-deprived aquatic environment containing iron bacteria that oxidize dissolved ferrous oxide. Almost all of the beetle fossils are thin and pitted, typical of sand deposited flood plain environments in which the beetle chitin has been bombarded by mineral grains in transport. As such, identification of the beetle parts was difficult since key indicators such as setigerous punctures could not be differentiated between those pits created by sand mineral grains. Identifications could only be made to the generic level and in some cases only to Family.

The basal sample, FBRP-01, 0-30 cm, unlike other samples examined contains abundant molluscs (**Figure 10**) with approximately 300 conical (vertical coiled) isolated snails varying in size from 5 mm to 2 cm as well as ostracod valves (**Figure 9a**). Snails are commonly found along the shallow edges of freshwater ponds, lakes and streams with some species being found in temporary wet areas. Snails are grazers feeding on organic material that accumulates on plants, rocks or soft bottom sediments (www.env.gov.bc.ca/wld/documents/mollusc.pdf). They are ubiquitous in calcareous sediments which indicate deposition in non-acidic waters (Miller & Tevesz, 2001). Similarly ostracodes prefer carbonate buffered water bodies. Many calcium carbonate, hollowed, tubular-shaped precipitates are abundant in FBRP-01 (**Figure 9b**) attesting to the hard water environment of the overbank deposits. Ostracodes are benthic organisms of lakes, ponds, and streams and generally do not live in high energy environments. Being detritus feeders, ostracodes prefer an organic rich, well defined, clay to fine silt textured sediment at the sediment-water interface (Delorme, 1990).

Many of the beetle (Coleoptera) fossils in this sample live in sandy flood plains that have sparsely vegetated areas. They include the pill beetle, *Morychus* sp. and scarab beetle, *Aegialia*. The rove beetle, *Olophrum* sp. live in poorly drained sites being found in emergent subaquatic vegetation (particularly *Carex*), growing in shallow water (Campbell, 1983). The tiny flea beetle, *Isochnus* is associated primarily with riparian habitats with the leaf mining larvae feeding on willow (*Salix*) and poplar (*Populus*) (Anderson, 1989).

Plant macrofossils in FBRP-01 are not as abundant as animal fossils. Absent are the submergent aquatic plants typical of ponds and the tentative identification of pondweed (*Potamogeton*?) made on the poorly preserved achenes is questionable since no pondweed remains occur in any of the five overbank bank samples examined. Although low in number, aquatic algae remains (oogonia) of stonewort (*Chara* sp.) along with mosses (**Figure 9d**) occur in this sample. Stoneworts usually grow in shallow water and in general prefer waters of moderate to high alkalinity (Wood and Imahori, 1965). A few macrofossil needles (charred and not charred) of spruce (*Picea* sp.) (**Figure 11a**) were isolated in this sample suggesting spruce was growing in the vicinity of Flatbed Peat site. Shrub/small tree nutlet of water birch, *Betula occidentalis*? also occurs in this sample. Although a definitive species could not be determined, water birch is a tall shrub/small tree growing up to 10 m high with dense, pure thickets being common. It grows on moist soils along streams mixed with poplars, willow and alders (Farrar, 1995).

A fossil wood fragment from FBRP-01, 0-30 cm (**Figure 12**) was submitted for AMS ^{14}C dating to the Keck Carbon Cycle AMS Lab, University of California, Irvine (Nov. 14/12). The wood fragment dissolved in the chemical pretreatment performed by the lab and could not be measured. A second sample comprising chitinous beetle and ant parts was submitted (Dec. 20/12) yielding a ^{14}C date of 9195 ± 25 yr BP (UCIAMS-118712). This date is approximately 1120 yr BP younger than the date obtained from the sample directly above (FBRP-02, 30-32 cm; 10315 ± 25 yr BP, UCIAMS-117268). The age discrepancy can be explained in part by the following: 1) the large sampling interval for FBRP-01 of 30 cm compared to FBRP-02, of 2 cm being a 'pinpoint sample' by comparison and 2) FBRP-01 contained both beetles and ant parts (*Myrmica* sp.), the later having the ability to burrow quit deeply into sand deposits potentially providing a blended AMS age of 'younger' ants combined with the more in situ beetle remains.

FBRP-01 contains abundant reworked late Tertiary/Cretaceous coal (**Figure 9c**).

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FBRP-02, 30-32 cm Vol.: 150 ml 10315 ± 25 yr BP

Similar to FBRP-01, this sample contains abundant reworked late Tertiary/Cretaceous coal along with many sand-cemented peds with iron (Fe) staining (rust-coloured precipitate) and modern rhizomes. No plant macrofossils were seen in this sample implying a flood plain environment that is sparsely vegetated or the more delicate plant macrofossils could not survive in this harsh depositional environment.

Many of the beetle fossils in this sample, as in FBRP-01 are thin and pitted. Pill beetles (Byrrhidae) including *Morychus* sp. have been AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine providing an age of 10315 ± 25 yr BP (UCIAMS-117268) (Nov. 14/12). Byrrhid pill beetles usually occur in sandy situations, such as shorelines, where they may be found under debris (Triplehorn and Johnson, 2005). The pill beetle *Morychus* can usually be found under stones and mosses in sandy areas near shorelines (Johnson, 1986).

FBRP-03, 32-60 cm Vol.: 250 ml

This sample is identical to FBRP-02 in terms of fossil content. Reworked coal, Fe stained sand-cemented ped and modern rhizomes occur in this sample along with pill beetle, *Morychus* sp. Plant macrofossils are absent.

FBRP-04, 60-72 cm Vol.: 90 ml

Beetle fossils in this sample are rare with miscellaneous fragments of sternites and leg fragments (femur and tibia) being recovered. Other insect fossils are minimally represented e.g. one head capsule of larva midge (Chironomidae) head capsule. Crustaceans of the water flea (*Daphnia* sp) ephippia, oribatid mites (*Hydrozetes* sp.) and discoidal horizontal snail (Gastropoda) are equally present in low numbers. *Daphnia* are often found in open water where they feed on planktonic algae and diatoms (Korhola and Rautio, 2001). Species of the mite *Hydrozetes* occur in freshwater lakes, ponds, bog pools and in very wet fens where they are found often in great densities (Solhøy, 2001).

Plant macrofossils in FBRP-04 are not abundant but contain some interesting finds compared to all the overbank samples examined. Macrofossil needle fragment of lodgepole pine (*Pinus contorta*) (**Figure 13**) and charred and not charred spruce (*Picea* sp.) needle fragments are present in this sample. Lodgepole pine is a medium-sized trees growing up to 30 m high, 60 cm in diameter and live to 200 years of age. They can be found on a wide range of soils and sites, including wet depressions. Due to their abundant seed supply in closed cones, lodgepole pine is able to colonize recently burned areas and most stands are of fire origin (Farrar, 1995). Spruces usually grow on well-drained sites with most species being shade-tolerant. Birch (*Betula* sp.) also occurs in this sample. The preservation of the one nutlet is very poor but it more than likely represents water birch as seen in FBRP-01. Water birch is a tall shrub/small tree growing up to 10 m high with dense, pure thickets being common. It grows on moist soils along streams mixed with poplars, willow and alders (Farrar, 1995). Thus pine, spruce and birch are growing in the vicinity of Flatbed Peat Site at the time FBRP-04 was deposited.

Although low in number, aquatic algae remains (oogonia) of stonewort (*Chara* sp.) along with mosses occur in this sample.

FBRP-05, 72-78 cm Vol.: 220 ml

This sample contains very few macrofossils. Beetle fossils are rare with rove beetles (Staphylinidae), scarab beetle *Aegialia* sp. and weevils (Curculionidae) being present. Species of *Aegialia* are primarily psammophiles, living on stream deposited sand bars, wind deposited sand dunes, or at least in very sandy substrates (Gordon and Cartwright, 1988). Weevils, in general feed on host-specific plants or shrubs. A couple of oribatid mites of *Hydrozetes* also occur in this sample.

Vascular plant macrofossils are absent in FBRP-05. Only algae (*Chara* sp.) remains (oogonia) of stoneworts are present in small numbers. This sample does contain reworked late Tertiary/Cretaceous coal along with many sand-cemented peds with iron (Fe) staining (rust-coloured precipitate) and modern rhizomes. Some small punky fragments of wood or twigs occur in FBRP-05.

FBRP-06, 78-78.5 cm Vol.: 100 ml 10000 ± 35 yr BP

The sands in this sample are at the contact between the underlying overbank deposit and compressed organics (**Figure 5**) containing both sand and organic material. Beetle parts including *Cytilus alternatus* (half head, 3 elytra, **Figure 15**), *Morychus* sp. (elytron-1), *Lepidophorus lineaticolis* (pronotum-1, head-1)

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and misc. sternites and legs weighing 1.61 mg were AMS dated by the Keck Lab (Nov./12) yielding ^{14}C age of 10000 ± 35 yr BP (UCIAMS-117269). The pill beetle *Cytilus alternatus*, although it lives in the vicinity of water is often collected in sandy sites among the cover of mosses and grasses. They are obligate moss feeders. Fossils of the another pill beetle, *Morychus* sp. and the weevil *Lepidophorus lineaticollis* indicate prevalence of dry local conditions. *Morychus* live in sandy places along river banks and are often found in the sparsely vegetated areas of large floodplains. *Lepidophorus lineaticollis* lives among willows and alders along sandy shorelines of rivers, at dry sites within forests and dry tundra conditons (Anderson, 1997). This sample contains a fossil head of a leafhopper (Cicadellidae) not seen in all the samples examined.They feed on grasses suggesting some grasses are present in the environment even if no delicate macrofossils of grasses were isolated. Crustaceans of the water flea (*Daphnia* sp) ephippia, and oribatid mites (*Hydrozetes* sp.) are present in this sample. *Daphnia* are often found in open water where they feed on planktonic algae and diatoms (Korhola and Rautio, 2001). Species of the mite *Hydrozetes* occur in freshwater lakes, ponds, bog pools and in very wet fens where they are found often in great densities (Solhøy, 2001).

Plant macrofossils in this sample are poorly preserved and in many cases the outer seed coat has been lost with only embryos (inner contents of seeds) being observed. Embryos of pondweed (*Potamogeton* sp.) and both seeds and embryos of the sedge family, *Eleocharis palustris-uniglumis* type occur in this sample along with cattail, *Typha latifolia* (**Figure 16**) and ditch-grass, *Ruppia cirrhosa* (**Figure 17** and **Figure 18**). Species of *Potamogeton* usually grow completely submerged and attached to the bottom of ponds at depths of up to 3 m. Ditch-grass, another submergent aquatic plant inhabits shallow alkaline waters (Porsild and Cody, 1980). Both cattail and *Eleocharis palustris-uniglumis* type are emergents living in shallow water along margins of water bodies with cattail being an aquatic or marsh herb found in swampy ground and shallow water (Scoggan, 1978). Quite a few oogonia of stoneworts (*Chara* sp.) occur in this samples. Their numbers are under represented since many oogonia were seen embedded in peat peds (**Figure 19**). Stoneworts usually grow in shallow water and in general prefer waters of moderate to high alkalinity (Wood and Imahori, 1965).

The combined plant macrofossil and animal fossils suggest dry local conditions with a shallow aquatic environment of a pond or temporary pool that is alkaline.

Compressed Organics

FBRP-07, 78.5-78.7 cm Vol.: 10 ml

This small volume (~10 ml) sample contains similar plant macrofossils as seen in FBRP-07 with animal macrofossils portraying a shallow aquatic environment. Invertebrate bryozoans (moss animals) of both *Cristatella mucedo* and *Plumatella* sp. occur in this sample. Species of the freshwater *Plumatella* and *C. mucedo* occur primarily in still or slow-flowing waters feeding on protozoans, bacteria and organic matter (www.bryozoans.nl/index_en.html). Absent from this sample are fossil beetles. Instead aquatic insects such as larvae midge (Chironomidae) head capsules are common with minor occurrences of adult crane flies (*Tipula* sp.). Larvae of midges can be found in almost any aquatic or semiaquatic habitat. Most crane flies are associated with moist environments, the adults usually being found in low, leafy vegetation along streams or around ponds in wooded areas (Wiggins, 1984). Many crustaceans of Cladocera occur in this samples. Species of *Daphnia* and *Simocephalus* are often found in open water where they feed on planktonic algae and diatoms. It should be noted that this sample, as well as other compressed organic samples examined contain peat peds that could not be broken down. As such, small fossils are under represented in terms of numbers. They include bryozoans, larvae midge head capsules and cladoceran ephippia.

Plant macrofossils in this sample include algal stoneworts (*Chara* sp.), flatstemed pondweed (*Potamogeton compressus*) (**Figure 20**) and water nymph (*Najas flexilis*). The submergent flatstem pondweed is found in shallow ponds, lakes and slow-moving waters, 1 to 2.5 m deep (Brayshaw, 1985; www.efloras.org). Water nymph is a completely submersed annual plant found in clear, lowland freshwater bodies such as ponds, lakes, and slow-moving streams to depths of four meters. It can grow in water rich in lime and can tolerate brackish water (http://www.ecy.wa.gov/programs/wq/plants/plantid2/descriptions/najfle.html).

A bulk AMS date from this sample yielded a ^{14}C age 9815 ± 20 (UCIAMS-46468).

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FBRP-08, 78.7-78.9 cm Vol.: 18 ml

This small 'pinpoint' sample (vol. ~18 ml) is similar to FBRP-07 in that it contains mostly aquatic macrofossils. Aquatic animal macrofossils in this sample include insect larvae midge head capsules and many Cladocera ephippia. Their numbers are under represented since many were observed in peat peds which could not be broken down (**Figure 21**). It is worth noting thats amples, FBRP-07, 78.5-78.7 cm, FBRP-08, 78.7-78.9 cm, FBRP-09, 79-80 cm, and FBRP-12, 86 cm contain the highest number of *Daphnia* ephippia (174, 299, 584 and 499 respectively). Note the sample volumes processed vary for these samples (10 ml, 18 ml, 110 ml, and 50 ml respectively). Most *Daphnia* are cyclical parthenogens in that natural populations are composed of females who clonally reproduce until conditions within the pond deteriorate e.g. overcrowding, declining water levels, lack of food or oxygen depletion. It is under stressful environmental conditions when males are produced along with haploid eggs which the males fertilize giving rise to resting eggs (ephippia). In ponds that dry completely, ephippia can lie dormant, even in freezing temperatures until conditions become favorable. They have been known to survive in dormancy for more than twenty years in sediment (Korhola and Rautio, 2001). The large number of *Daphnia* ephippia in these samples indicate that something in the environment has changed. For FBRP-08, the deposit is comprised of compressed organic/mineral suggesting sands have been flushed into the pond i.e. a disturbed environment.

This sample also contains the water scavenger beetle, *Cercyon* sp. Species of *Cercyon* occur mostly in various decomposing organic matter, often in wet to very wet habitats near water and are almost semi-aquatic (Smetana, 1978).

Plant macrofossils in this sample are dominated by aquatic plants including submergents and emergents. Submergent plants include two species of pondweed (*Potamogeton* spp.) and water nymph (*Najas flexilis*). Emergent aquatic plant of softstem bulrush, *Schoenoplectus tabernaemontani* is bordering the shoreline of the pond. It can be found in marshes, lakeshores and streams in the lowland, steppe and montane zones throughout British Columbia (www.geog.ubc.ca/biodiversity/eflora/). *Carex* (trigonous type) occur in this sample. The grass-like sedges are common, widespread plants that can be found in a variety of habitats including shallow water margins, meadows, grassy/moist slopes, turfy places etc. Although a species determination could not be made on the goosefoot seeds in this sample they more than likely strawberry-blite, *Chenopodium capitatum*? (**Figure 22**). This annual herb grows in mesic to dry disturbed areas and waste places and is common throughout British Columbia (http://linnet.geog.ubc.ca/Atlas). This annual herb can grow to be 20 to 100 cm tall and is found at low to medium elevation throughout British Columbia (Mackinnon et al., 1999). It is weedy in habitat and often colonizes clearings and disturbed sites. It is often spontaneous in growth in burned-over areas (Porsild & Cody, 1980).

Algae remains of stonewort *Chara* sp. peak in abundance in this sample (769 oogonia) with many of the oogonia not counted but observed in peat peds that could not be broken down (**Figure 23**). Charophytes are rapid colonizers of new or temporary water bodies. This advanced form of algae is often mistaken for higher vascular plants. Dense growths, attached but not rooted, may cover the entire bottom of pond or lake (**Figure 24**). *Chara* algae usually grow in shallow water but where water is clear, are found at depths of 6 meters or more (Wood and Imahori, 1965). They are able to grow at deeper levels than many of the vascular plants. Species of *Chara* prefer waters of moderate to high alkalinity. It often collects a coating of lime, and exudes the smell of sulphuretted hydrogen. It's affinity for lime has resulted in the name of stonewort.

In summary, the paleoenvironment locally is a shallow aquatic pond dominated by stoneworts that are rapid colinizers of new or temporary water bodies. There are a few submergent and emergent aquatic plants however stoneworts dominate. The environment is disturbed as evidenced by the high number of *Daphnia* ephippia and the only occurrence of *Chenopodium capitatum*?, a herb that colonizes clearings and disturbed sites. This plant grows in mesic to dry disturbed areas.

FBRP-09, 79-80 cm Vol.: 110 ml 9770 ± 25 yr BP

All the animal macrofossils in this sample are aquatic inhabitants. They include freshwater sponges (*Spongilla* type), bryozoans *Cristatella mucedo*, cladocerans *Daphnia* and oribatid mites of *Hydrozetes* sp. Sponges generally require relatively clean-water habitats in order to maintain the filtering of their water processing system (Frost, 2001). *Cristatella mucedo* live in lakes, ponds, and slow streams being found on most substrates in standing or lightly streaming water (www.bryozoans.nl/index_en.html). *Daphnia* ephippia are abundant in this sample. They are often found in open water where they feed on planktonic algae and diatoms (Korhola and Rautio, 2001). Insect fossils include the head capsules of midges

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(Chironomidae) and predaceous diving beetle *Acilius semisulcatus*. This aquatic beetle occurs in standing water in forested regions. Western and northern boreal populations are found in permanent ponds and are common in beaver ponds, burrow pits and small fishless lakes (Larson et al., 2000).

Stoneworts that dominated the pond in FBRP-08 have been taken over by aquatic vascular plants in FBRP-09. Emergent aquatic plants living near the shoreline include cattail (*Typha latifolia*), northern bur-reed (*Sparganium hyperboreum* type), softstem bulrush, (*Schoenoplectus tabernaemontani*) (**Figure 25**), and mare's-tail *Hippuris vulgaris* (**Figure 26**). Submersed aquatic plants include pondweeds (*Potamogeton richardsonii*) (**Figure 27**) and water nymph (*Najas flexilis*) (**Figure 28**). Richard's pondweed, *Potamogeton richardsonii* is found in shallow to deep clear lake waters, 0.5 to 3.5 m deep, often where slightly alkaline, or in slow moving rivers (Brayshaw, 1985). One persistent bud of willow (*Salix* sp.) occurs in this sample (**Figure 29**).

Macrofossils achenes of softstem bulrush, (*Schoenoplectus tabernaemontani*) (**Figure 25**) have been AMS dated from this interval yielding a ^{14}C age of 9770 ± 25 yr BP (UCIAMS-117270) (Nov. 14/12).

Summarizing the plant and animal macrofossils, the pond is a standing water body with clear-water, slightly alkaline in a forested region. Although evidence of trees is absent except for willow, the predaceous diving beetle, *Acilius semisulcatus* suggests the region is forested.

FBRP-10, 80-82 cm Vol.: 100 ml

The plant and animal macrofossil assemblage in this sample is identical to those found in FBRP-09 with a few new elements that will be discussed. Beetle fossils include the aquatic predaceous diving beetles *Acilius* sp. and *Colymbetes* sp. and long-horned leaf beetle, *Donacia* sp. Species of adult *Donacia* typically feed on the emergent leaves and flowers of a wide variety of aquatic emergent plant species. Richard's pondweed occurs in this sample (**Figure 30**, well-preserved achene with perigynum intact (outer seed coat)) and the common hornwort, *Ceratophyllum demersum* (**Figure 31 & Figure 32**). *C. demersum* grows entirely submersed without anchored roots (free-floating) in still or very slow-moving water (lakes, ponds, and quiet streams), often in hard water with stems reaching 1-3 m in length (http://linnet.geog.ubc.ca/). The aquatic emergent buckbean, *Menyanthes trifoliata* is common throughout B.C. being found in bogs, fens, marshes, shallow ponds and lakesides in the lowland, steppe and montane zones (http://linnet.geog.ubc.ca). One notable difference in this sample is the abundance of Bryophytes (mosses) compared to samples examined in the lower Flat Bed Peat site. This sample also contains many aquatic plant stems and leaves (**Figure 33**).

Combining the plant and animal macrofossil evidence, the pond is the same as seen in FBRP-09. It is a still standing body of water, slightly alkaline in a forested region.

FBRP-11, 82-84 cm Vol.: 100 ml

Floral and faunal elements in this sample continue to be the same as in FBRP-09 and FBRP-10 samples. Aquatic insect fossils dominate the faunal assemblage. They include predaceous diving beetles, *Hydroporus* sp., *Colymbetes* sp. (**Figure 34**) and *Acilius* sp. along with the long-horned leaf beetle Donaciinae. Although a species identification on *Acilius* could not be made based on the small elytron fragment isolated in this sample, it more than likely belongs to *A. semisulcatus.* Larvae head capsules of midges (Chironomidae) occur as well as cladoceran (*Daphnia* sp.) ephippia. Well-preserved moss animals statoblasts of *Cristatella mucedo* are also present (**Figure 35 & Figure 36**). *C. mucedo* live in lakes, ponds, and slow streams being found on most substrates in standing or lightly streaming water (www.bryozoans.nl/index_en.html). They are least adapted to siltation or high turbidity because of their gelatinous colony structure (Bushnell, 1973).

Plant macrofossils in FBRP-11 comprise both emergent and submergent aquatic plants. There are abundant aquatic herb plant stems and leaves (40% by volume) with some leaves of Richard's pondweed (*Potamogeton richrdsonii*) (**Figure 37** and **Figure 38**). Only two achenes of pondweed exist in this sample and water nymphs (*Najas flexilis*) are more abundant (36 seeds) (**Figure 39** and **Figure 40**). Water nymph is a completely submersed annual plant found in clear, lowland freshwater bodies such as ponds, lakes, and slow-moving streams to depths of four meters. It can grow in water rich in lime and can tolerate brackish water (http://www.ecy.wa.gov/programs/wq/plants/plantid2/descriptions/najfle.html). Emergents include cattails (*Typha latifolia*) and buckbeen (*Menyanthes trifoliata*) (**Figure 41**). Algae remains of stonewort, *Chara* sp. oogonia (**Figure 42**) occur in this sample but are lower in number compared to FBRP-08 which had the highest number (769 oogonia versus 59 oogonia). Species of *Chara* prefers shallow waters of moderate to high alkalinity.

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Evidence of shrubs or trees is rare with persistent buds of willow (*Salix* sp.) (7) and a single seed of common bearberry/kinnikinick (*Arctostaphylos uva-ursi*) being observed (**Figure 43**). Bearberry is a prostrate, much branched shrub that grows on sandy and well-drained exposed sites, dry rocky slopes, dry forest and clearings. It is common and widespread, from low elevations to alpine tundra throughout interior and northern British Columbia (MacKinnon et al., 1992). Mosses are abundant in this sample (20% by volume) as seen in FBRP-10 and continue to increase in volume in overlying samples.

FBRP-12, 86 cm Vol.: 50 ml 8845 ± 20 yr BP

Animal macrofossils in this sample portray the same environment as seen in FBRP-11 of a shallow pond. There are freshwater sponges (*Spongilla* type), some moss animals of *Cristatella mucedo* and *Plumatella* sp., many midge (Chironomidae) head capsules (220) and some oribatid mites of *Hydrozetes* sp. Aquatic beetles include predaceous diving beetles, *Colymbetes* sp. and *Acilius semisulcatus* (**Figure 44**). This aquatic beetle occurs in standing water in forested regions. Western and northern boreal populations are found in permanent ponds and are common in beaver ponds, burrow pits and small fishless lakes (Larson et al., 2000).

Plant macrofossils of aquatic plants have declined in FBRP-12 especially submergent aquatics with only one achene of pondweed (*Potamogeton* sp.) observed. Instead, some emergents exist (bulrush, *Scirpus* sp.) and mosses (Bryophytes) proliferate. Macrofossil remains of trees and shrubs are present including charred and not charred needle fragments of spruce (*Picea* sp.) (**Figure 11b**). Shrub remains include willow (*Salix* sp.) and common snowberry, *Symphoricarpos albus* (**Figure 45**). Snowberry is an erect, branching shrub (0.5-1.5 m tall) that grows in open forest, thickets, dry rocky slopes. It is most abundant in dry habitats but also can be found on moist sites, especially well-drained floodplains (MacKinnon et al., 1999). Five seeds of *Symphoricarpos albus* weighing 6.47 mg were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8845 ± 20 yr BP (UCIAMS-117271) (Nov. 14/12).

Summarizing the macrofossil evidence, the pond is much shallower (possibly a shallow depression) and the site is poorly drained allowing mosses to become more dominate. Spruce is growing locally suggesting an open forested area at Flatbed Peat site.

Compacted Dense Peat

The following samples are from autochthonous moss peat deposits which typically have low recovery of plant and insect macrofossils. However their occurrence in these samples indicate the plants and insects were growing or living locally.

FBRP-13, 95 cm Vol.: 100 ml

Felted layers of compacted mosses occur in this sample (**Figure 46**) that were very difficult to break down. As such, there were many small moss peds that had to be teased apart using two forecps. By volume, mosses dominate (99%) the floral assemblage. Modern roots permeate the felted moss ‘sheets’. Vascular plant remains are absent and elytral fragments of predaceous diving beetle (*Colymbetes* sp.) is the only animal macrofossil in this sample.

Summarizing the scant macrofossils in this sample, the paleoenvironment is a poorly drained, wet depression dominated by mosses.

FBRP-14, 100-102 cm Vol.: 100 ml (dry) expanded to 440 ml (wet) 8770 ± 25 yr BP

Similar to FBRP-13, felted layers of compacted moss are abundant (99% by volume). Some aquatic animal macrofossils are present along with the predaceous diving beetle, *Acilius* sp. Not seen in any other FBRP samples examined are seeds of water lily, *Nuphar* sp. A species identification could not be made but it more than likely belongs to yellow pond lily, *Nuphar polysepala* (**Figure 47**). It is an aquatic submergent with leaves mostly floating, occasionally emersed or submersed. It prefers slow, shallow water but is also common in ponds, lakes, and sluggish streams (www.eflora.org). Conifer remains of seeds and charred and not charred spruce (*Picea* sp.) needles are fairly abundant along with charcoal. Birch (*Betula* sp. nutlet) of medium shrub/small tree also occurs in this sample.

Charred and not charred spruce needle fragments from FBRP-14 (**Figure 11c**) were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8770 ± 25 yr BP (UCIAMS-117272) (Nov. 14/12).

continued...

Summarizing the macrofossil evidence, the presence of water lily and some aquatic insects suggests the environment is a shallow water body (wet depression) of a poorly drained site abundant in mosses. Spruce are growing locally (open forest) with evidence of a fire occurring near the site.

FBRP-15, 100-102 cm Vol.: 100 ml (dry) expanded to 300 ml (wet)

Mosses continue to dominate the floral assemblage (99% by volume). The felted, compact moss expanded three-fold upon addition of water for processing. Predaceous diving beetles that were present in many of the samples are absent. Beetle fossil remains include an elytron of marsh beetle, *Cyphon* sp. Species of *Cyphon* are always found near water, generally occurring on vegetation in damp sites. Plant macrofossils include trees of spruce (*Picea* sp.), and birches (*Betula* sp.) of medium shrub/small tree type and arboreal birch. The emergent buckbean (*Menayanthes trifoliata*) occurs in this sample. Buckbean, is common throughout B.C. being found in bogs, fens, marshes, shallow ponds and lakesides in the lowland, steppe and montane zones (http://linnet.geog.ubc.ca). See **Figure 48** & **Figure 49** for a modern analogue of the paleoenvironment for FBRP-15.

Summary

The overbank floodplain deposits contain mostly beetles typical of sparsely vegetated sandy floodplains. They include byrrhids of *Morychus* and *Cytilus alternatus*, scarab beetle, *Aegialia* and weevil *Lepidophorus lineaticollis*. These beetles indicate prevalence of dry local conditions. The floodplain is comprised of wet depression or shallow bodies of water (pools, ponds and slow flowing streams). Conical snails along with ostracodes imply a carbonate-rich environment within a low energy water environment. The scant recovery of plant macrofossils suggest vegetation cover was sparse. Algal aquatic remains of stonewort (*Chara* sp.) are growing in the shallow water bodies. Lodgepole pine, *Pinus contorta* and spruce, *Picea* sp. are present around 10,000 BP and are more than likely living in the region of Flatbed Peat site but not locally.

The compressed organic samples represent a shallow, permanent pond with many of the aquatic plants having an affinity for hard water. Aquatic emergent plants growing near the shoreline include cattail (*Typha latifolia*), softstem bulrush, *Schoenoplectus tabernaemontani*, sedges *Eleocharis palustris-uniglumis* type, northern bur-reed (*Sparganium hyperboreum* type), and mare's-tail *Hippuris vulgaris.* Plants growing submerged in the pond include pondweeds flatstemed pondweed (*Potamogeton compressus*) and Richard's pondweed (*Potamogeton richrdsonii*), ditch-grass, *Ruppia cirrhosa,* and water nymph (*Najas flexilis*). Algal remains of stonewort, *Chara* sp. peak in abundance in FBRP-08. Charophytes are rapid colonizers of new water bodies but their numbers decline as submergents aquatic plants increase in FBRP-09. Aquatic animals typical of freshwater habitats include moss animals, *Cristatella mucedo* and *Plumatella* sp., larvae midges (Chironomidae), water fleas (*Daphnia*), oribatid mites (*Hydrozetes* sp.) and snails (Gastropoda). Aquatic insects of predaceous diving beetles and water scavenger beetles dominate the pond. They include *Hydroporus* sp., *Colymbetes* sp., *Acilius semisulcatus* and *Cercyon* sp. Of particular importance is the predaceous diving beetle, *Acilius semisulcatus.* This aquatic beetle occurs in standing water in forested regions with western and northern boreal populations being found in permanent ponds. The presence of this beetle suggests that by FBRP-09 time (9770 BP), the site, locally is an open spruce forest. By FBRP-12 time (8845 BP) the pond is much shallower (possibly a shallow depression) and the site is poorly drained allowing mosses to become more dominate. Over the next 75 yr BP with peat development, the site is mostly covered by aquatic mosses with some emergents (water lily, *Nuphar* sp. and buckbean, *Menyanthes trifoliata*) growing in a poorly drained site of a wet depression. Spruce (*Picea* sp.) is well established by 8870 BP.

continued...

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Figure 16. *Typha latifolia*. Author: Bogdan; en.wikipedia.org

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Figure 20. *Potamogeton compressus*. Author: Donald Cameron. http://gobotany.newenglandwild.org/

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Figure 24. *Chara* habitat. http://en.academic.ru/dic.nsf/enwiki/149906

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Figure 27. *Potamogeton richardsonii*. Author: Donald Cameron http://gobotany.newenglandwild.org/

Figure 28. *Najas flexilis*. Background: Donald Cameron http://gobotany.newenglandwild.org/. Foreground: : per.aasen; www.flickr.com

Figure 29. *Salix richardsonii*. www.luontoportti.com

Figure 30. *Potamogeton richardsonii*. Author: Vic Ramey; bio.miami.edu

Figure 31 & 32. *Ceratophyllum demersum*. Author: David Cameron; gobotany.newenglandwild.org

Figure 34. *Colymbetes sculptilis*. Author: Stephen Luk; www.bugguide.net

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Figure 37. *Potamogeton richardsonii* leaf base. Author: Gary Fewless; uwgb.edu

Figure 38. *Potamogeton richardsonii* leaf. Author: Donald Cameron; http://gobotany.newenglandwild.org/

Figure 39. *Najas flexilis*. Author: Donald Cameron http://gobotany.newenglandwild.org/

Figure 40. *Najas flexilis*. Author: Mykt Havfruegress; www.flickr.com/photos/

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Figure 42. Top: *Chara*. Author: Vic Ramey; bio.miami.edu. Bottom: *Chara*. waynesword.palomar.edu

Figure 43. *Arctostaphylos uva-ursi*. Author: Sten Porse; en.wikipedia.org

Figure 44. *Acilius semisulcatus*. Author: Charley Eiseman; www.charleyeiseman.com

Figure 45. *Symphoricarpos albus*. Authors: Background: davisla.wordpress.com. Inset: botanicalgarden.ubc.ca.

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Figure 48. *Menyanthes trifolia* and *Nuphar* habitat. http://www.fs.fed.us/wildflowers/regions/alaska/AlaganikSlough/index.shtml

Figure 49. *Menyanthes trifolia* habitat. Source image and author could not be located.

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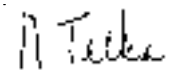
PALEOTEC Services



Mar. 25, 2013
Updated: July 19, 2013

Table 1. Flatbed Peat Site Samples.

Field Name	New Sample ID	Measurement (Bottom Up) (cm)	Depth Below Surface (cm)	Material	Description
ASH100728-02-Lower Sand	FBRP-01	0-30	275-305	Sand	Over-bank Sand
ASH100728-02-Paleosol	FBRP-02	30-32	273-275	Sand	
ASH100728-02-Upper Sand	FBRP-03	32-60	245-273	Sand	
ASH100728-02-Bm Sand	FBRP-04	60-72	233-245	Sand	
ASH100728-02-Ae sand	FBRP-05	72-78	227-233	Sand	
ASH100728-02-Contact	FBRP-06	78-78.5	226.5-227	Organics/mineral	Contact
ASH100728-02-01	FBRP-07	78.5-78.7	226.3-226.5	Organics	Compressed Organics
ASH100728-02-02	FBRP-08	78.7-78.9	226.1-226.3	Organics/mineral	
ASH100728-02-03	FBRP-09	79-80	225-226	Organics	
ASH100728-02-04	FBRP-10	80-82	223-225	Organics	
ASH100728-02-05	FBRP-11	82-84	221-223	Organics	
ASH100728-02-06	FBRP-12	86	219	Organics	
ASH100728-02-07	FBRP-13	95	210	Organics	Dense Peat
ASH100728-02-08	FBRP-14	100-102	203-205	Organics	
ASH100728-02-09	FBRP-15	105-106	199-200	Organics/Dark	
ASH100728-02-10	FBRP-16	115-117	188-190	Organics	
ASH100728-02-11	FBRP-17	125-127	178-180	Organics	
ASH100728-02-12	FBRP-18	135-137	168-170	Organics	
ASH100728-02-13	FBRP-19	147-149	156-158	Organics	
ASH100728-02-14	FBRP-20	156-157	148-149	Organics/Charcoal?	
ASH100728-02-15	FBRP-21	165-170	135-140	Organics	
ASH100728-02-16	FBRP-22	180-185	120-125	Organics	
ASH100728-02-17	FBRP-23	190-195	110-115	Organics	
ASH100728-02-18	FBRP-24	200-205	100-105	Organics	
ASH100728-02-19	FBRP-25	210-215	90-95	Organics	
ASH100728-02-20	FBRP-26	220-225	80-85	Organics	
ASH100728-02-21	FBRP-27	235-240	65-70	Organics	
ASH100728-02-22	FBRP-28	245-250	55-60	Organics	
ASH100728-02-23	FBRP-29	265-270	35-40	Organics	
ASH100728-02-24	FBRP-30	273-275	30-32	Organics	
ASH100728-02-25	FBRP-31	275-277	28-30	Organics	
ASH100728-02-26	FBRP-32	277-279	26-28	Organics	Desicated Sphagnum and LFH
ASH100728-02-27	FBRP-33	285-290	15-20	Organics	
ASH100728-02-28	FBRP-34	290-295	10-15	Organics	

Table 2. Flatbed Peat Site samples submitted for AMS ^{14}C dating.

Marten Geertsema (Adrian Hickin) BC Forest Service, Prince George, BC, 6 organic samples for AMS ^{14}C dating including 6 IRMS ^{13}C measurements. **Prepaid** (see email correspondence).

#	Sample No.	Material for AMS/Comments	Wt. (mg)	Est. Age
1	FBRP-01, 0-30 cm	wood fragment	16.57	11 ka
2	FBRP-02, 30-32 cm	beetle parts **FRAGILE**	2.15	10.5 ka
3	FBRP-06, 78-78.5 cm	beetle parts **FRAGILE & MICRO**	1.61	10 ka
4	FBRP-09, 79-80 cm	bulrush (Scirpus sp.) seeds (4)	3.37	<10 ka
5	FBRP-12, 86 cm	snowberry shrub seeds (5)	6.47	<10 ka
6	FBRP-14, 100-102 cm	charred and not charred conifer needles	?	<10 ka
	Total: 6			

Marten Geertsema (Adrian Hickin) BC Forest Service, Prince George, BC, 1 organic sample for AMS ^{14}C dating including 1 IRMS ^{13}C measurement. **Prepaid** (see credit account).

#	Sample No.	Material for AMS/Comments	Wt. (mg)	Est. Age
1	FBRP-01-B, 0-30 cm	beetle parts **FRAGILE**	2.3	11 ka
	Total: 1			

Table 3. AMS radiocarbon dating results.

KECK CARBON CYCLE AMS FACILITY
EARTH SYSTEM SCIENCE DEPT, UC IRVINE

^{14}C results | Paleotec/Geertsema | Nov 14 2012

UCIAMS #	Sample name	Other ID	$\delta^{13}C$ (‰)	±	fraction Modern	±	$D^{14}C$ (‰)	±	^{14}C age (BP)	±
117268	FBRP-02, 30-32 cm		-27.6	0.1	0.2769	0.0008	-723.1	0.8	10315	25
117269	FBRP-06, 78-78.5 cm .19mgC		-26.7	0.1	0.2881	0.0011	-711.9	1.1	10000	35
117270	FBRP-09, 79-80 cm		-25.6	0.1	0.2964	0.0009	-703.6	0.9	9770	25
117271	FBRP-12, 86 cm		-25.1	0.1	0.3326	0.0008	-667.4	0.8	8845	20
117272	FBRP-14, 100-102 cm		-26.0	0.1	0.3357	0.0008	-664.3	0.8	8770	25

Radiocarbon concentrations are given as fractions of the Modern standard, $D^{14}C$, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).

Sample preparation backgrounds have been subtracted, based on measurements of ^{14}C-free wood.

All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with $\delta^{13}C$ values measured on prepared graphite using the AMS spectrometer. These can differ from $\delta^{13}C$ of the original material, if fractionation ocurred during sample graphitization or the AMS measurement, and are not shown.

Comments:
Sample FBRP-01, 0-30 cm dissolved in ABA treatment and could not be measured.

$\delta^{13}C$ values shown above were measured to a precision of <0.1‰ relative to standards traceable to PDB, using a Thermo Finnigan Delta Plus stable isotope ratio mass spectrometer (IRMS) with Gas Bench input.

Table 4. AMS radiocarbon dating results.

KECK CARBON CYCLE AMS FACILITY
EARTH SYSTEM SCIENCE DEPT, UC IRVINE

^{14}C results | Paleotec/Geertsema | Dec 20 2012

UCIAMS #	Sample name	Other ID	$\delta^{13}C$ (‰)	±	fraction Modern	±	$D^{14}C$ (‰)	±	^{14}C age (BP)	±
118712	FBRP-01-B, 0-30 cm		-24.2	0.1	0.3184	0.0009	-681.6	0.9	9195	25

Radiocarbon concentrations are given as fractions of the Modern standard, $D^{14}C$, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).

Sample preparation backgrounds have been subtracted, based on measurements of ^{14}C-free wood.

All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with $\delta^{13}C$ values measured on prepared graphite using the AMS spectrometer. These can differ from $\delta^{13}C$ of the original material, if fractionation ocurred during sample graphitization or the AMS measurement, and are not shown.

Comments:
$\delta^{13}C$ values shown above were measured to a precision of <0.1‰ relative to standards traceable to PDB, using a Thermo Finnigan Delta Plus stable isotope ratio mass spectrometer (IRMS) with Gas Bench input.

Table 5. Adrian Hickin samples for AMS dating, 2012.

Sample No.	Comments/Material for AMS	Lab. No.	Wt. (mg)	Est. age
FBRP-01, 0-30 cm	sand: a lot of reworked late Tertiary coal; **wood fragment**	13-70	16.57	
FBRP-02, 30-32 cm	sand: a lot of reworked coal; possibly Coleoptera (**beetle**) **parts** (weathered and thin, rust-coloured Fe stained) may be marginal	13-88	2.15	
FBRP-03, 32-60 cm	sand: modern/young ECM's/rhizomes; pill beetle <1 mm-sized fragments-chitin is thin; insufficient in weight	14-38	—	
FBRP-04, 60-72 cm	sand: ECM's, 'fuzzy' mychorrizae: possible AMS ('cocktail of macros) combining **pine needle frg.** (4 mm long) and **charred conifer needle frg.** (1 mm long), **tiny wood frg.** and **birch nutlet** (no wings)	14-38.5	1.61	
FBRP-05, 72-78 cm	sand: ECM's, 'fuzzy' mychorrizae: possible AMS combining **weevil parts and scarab (beetles) parts**	14-39	1.06	
FBRP-06, 78-78.5 cm	organics/mineral: large silt/sand peds-some with embedded Chara, one with weevil prothorax & partial head. Possible AMS using **pill beetle & weevil parts**	14-39.5	1.61	
FBRP-07, 78.5-78.7 cm	compact organics: no terrestrial material. Mostly submergent aquatics: pondweed, Najas. Nothing for dating.	14-40	—	UCIAMS-46468 9815 ± 20
FBRP-08, 78.7-78.9 cm	organics/mineral: **wood fragments** (disturbed environment-many goosefoot (Chenopodium) seeds not seen in other samples)	14-40.5	1) 28.29 2) 18.02 3) 6.39	
FBRP-09, 79-80 cm	compact organics: a lot of peat peds-difficult to process without damaging fossils; AMS **4 bulrush (Scirpus) seeds**	14-41	3.37	
FBRP-10, 80-82 cm	compact organics: **roots with bark fragments CAUTION** (prefer not to date this interval)	13-87	9.04	
FBRP-11, 82-84 cm	compacted organics: **twig fragment** (no bark; abrupt ends)	14-42	13.14	
FBRP-12, 86 cm	compacted organics: Mostly peat peds and mosses. AMS: Symphoricarpos albus-**common snowberry shrub seeds: 5 seeds** and fragments-**NICE** for dating!	14-43	6.47	
FBRP-13, 95 cm	dense peat: 100% mosses	14-50.5	—	
FBRP-14, 100-102 cm	dense peat: **charred and not charred conifer needles** & frgs.; 100% mosses	13-89	26.4	
FBRP-15, 105-106 cm	dense peat: 100% mosses	14-51		
FBRP-16, 115-17 cm				

Table 6. Plant macrofossils from Flatbed Peat Site, FBRP

	FBRP-01, 0-30 cm	FBRP-02, 30-32 cm	FBRP-03, 32-60 cm	FBRP-04, 60-72 cm	FBRP-05, 72-78 cm	FBRP-06, 78-78.5 cm	FBRP-07, 78.5-78.7 cm	FBRP-08, 78.7-78.9 cm	FBRP-09, 79-80 cm	FBRP-10, 80-82 cm	FBRP-11, 82-84 cm	FBRP-12, 86 cm	FBRP-13, 95 cm	FBRP-14, 100-102 cm	FBRP-15, 105-106 cm
PLANT MACROFOSSILS:															
Algal remains:															
Characeae															
Chara sp.	+			+	+	++	+	+++	+	+	+	+			
Non Vascular Plants															
Bryophytes ....."mosses"	+			+			+		+	++	++	++	+++	+++	+++
Vascular Plants:															
Pinaceae ....."pine family"															
Pinus contorta Dougl. ex Loud.				+											
Picea sp.	+											+		++	+
Typhaceae....."Cat-tail family"															
Typha latifolia L.						+			+	+	+				
Sparganiaceae ....."bur-reed family"															
Sparganium hyperboreum type									+						
Potamogetonaceae .."pondweed family"															
Potamogeton richardsonii (A.Benn.) Rydb.									+	+	+				
Potamogeton compressus L.							+								
Potamogeton sp.						+			+	+	+	+			
Potamogeton spp.								+							
Potamogeton? sp.	+														
Ruppia cirrhosa (Petagna) Grande						+									
Najadaceae															
Najas flexilis (Willd.) Rostk. & W.L.E.Schmidt							+	+	+	++	++				
Cyperaceae ....."sedge family"															
Carex lenticular type											+	+			
Carex trigonous type								+			+				
Schoenoplectus tabernaemontani (C.C. Gmel.) Palla								+	+						
Scirpus sp.												+			
Scirpus small type												+			
Eleocharis palustris-uniglumis type						+									
Salicaceae ....."willow family"															
Salix sp.									+		+	+			
Betulaceae ....."birch family"				+											
Betula occidentalis?	+														
Betula medium shrub/small tree type														+	+
Betula arboreal type															+
Chenopodiaceae ...."goosefoot family"															
Chenopodium capitatum?								+	+						
Caryophyllaceae ..."pink family"															
Symphoricarpos albus (L.) S.F.Blake												+			
Ceratophyllaceae .."hornwort family"															
Ceratophyllum demersum L.										+					
Nymphaeaceae ....."water lily family"															
Nuphar sp.														+	

Table 6. Plant macrofossils from Flatbed Peat Site, FBRP (cont'd)

	FBRP-01, 0-30 cm	FBRP-02, 30-32 cm	FBRP-03, 32-60 cm	FBRP-04, 60-72 cm	FBRP-05, 72-78 cm	FBRP-06, 78-78.5 cm	FBRP-07, 78.5-78.7 cm	FBRP-08, 78.7-78.9 cm	FBRP-09, 79-80 cm	FBRP-10, 80-82 cm	FBRP-11, 82-84 cm	FBRP-12, 86 cm	FBRP-13, 95 cm	FBRP-14, 100-102 cm	FBRP-15, 105-106 cm
PLANT MACROFOSSILS:															
Rosaceae ....."rose family"															
Potentilla sp.							+					+			
Haloragaceae ....."water milfoil family"															
Hippuris vulgaris L.									+						
Ericaceae ....."heath family"															
Arctostaphylos uva-ursi (L.)Spreng.											+				
Gentianaceae ....."gentian family"															
Menyanthes trifoliata L.										+	+				+
Lamiaceae ....."mint family"															
Mentha sp										+		+			
Unidentifiable plant taxa														+	
Other:															
carbonates	+++														
wood/twig	+			+	+			+				+			
charcoal	+											+		+	+
peat/moss peds	+						++	++	++	++	++	+		++	++
deciduous leaf	+														
reworked late Tertiary or Cretaceous coal	++	++	+		+	+									
modern roots/rhizomes	+	+												+	
sand cemented peds		+	+	+	+	+									
modern/aged ECM's			+	+	+										
woody herbaceous stems									+						
aquatic herb plant stems									+	++	++				
fungal spores (*Glomus*? sp.)															+

Table 7. Animal Macrofossils from Flatbed Peat Site, FBRP

	FBRP-01, 0-30 cm	FBRP-02, 30-32 cm	FBRP-03, 32-60 cm	FBRP-04, 60-72 cm	FBRP-05, 72-78 cm	FBRP-06, 78-78.5 cm	FBRP-07, 78.5-78.7 cm	FBRP-08, 78.7-78.9 cm	FBRP-09, 79-80 cm	FBRP-10, 80-82 cm	FBRP-11, 82-84 cm	FBRP-12, 86 cm	FBRP-13, 95 cm	FBRP-14, 100-102 cm	FBRP-15, 105-106 cm
ANIMAL MACROFOSSILS:															
PORIFERA ....."sponges"															
HAPLOSCLERINA															
Spongillidae															
Spongilla type									+			+			
PLATYHELMINTHES															
TUBELLARIA ....."flatworms"							+								+
BRYOZOA															
Cristatella mucedo L.							+		+	+	+	+			
Plumatella sp.							+			+		+		+	
ANNELIDA															
HIRUDINEA ....."leeches"						+									
ARTHROPODA															
INSECTA															
HEMIPTERA ....."bugs"							+								
Cicadellidae ....."leafhoppers"						+									
COLEOPTERA ....."beetles"	+			+	+	+		+	+	+		+			+
Dytiscidae .."predaceous diving beetles"															
Hydroporus sp.											+				
Colymbetes sp.										+	+	+	+		
Acilius semisulcatus Aubé									+			+			
Acilius sp.										+	+			+	
Hydrophilidae ..."water scavenger beetles"															
Cercyon sp.								+							
Staphylinidae ....."rove beetles"					+										
Olophrum sp.	+														
Scarabaeidae ....."scarab beetles"															
Aegialia sp.	+				+										
Helodidae ....."marsh beetles"															
Cyphon sp.															+
Byrrhidae ....."pill beetles"		+													
Simplocaria sp.			+			+									
Morychus sp.	+	+				+									
Cytilus alternatus (Say)						+									
Chrysomelidae ....."leaf beetles"	+														
Donaciinae										+	+				
Curculionidae ....."weevils"	+	+		+	+	+								+	
Lepidophorus lineaticollis Kirby						+									
Isochnus sp.	+														
TRICHOPTERA ....."caddisflies"	+														
DIPTERA ....."flies"										+					
Tipulidae ....."crane flies"															
Tipula sp.							+								
Chironomidae ....."midges"				+		+	+		+	+	+	++		+	

Table 7. Animal Macrofossils from Flatbed Peat Site, FBRP (cont'd)

	FBRP-01, 0-30 cm	FBRP-02, 30-32 cm	FBRP-03, 32-60 cm	FBRP-04, 60-72 cm	FBRP-05, 72-78 cm	FBRP-06, 78-78.5 cm	FBRP-07, 78.5-78.7 cm	FBRP-08, 78.7-78.9 cm	FBRP-09, 79-80 cm	FBRP-10, 80-82 cm	FBRP-11, 82-84 cm	FBRP-12, 86 cm	FBRP-13, 95 cm	FBRP-14, 100-102 cm	FBRP-15, 105-106 cm
ANIMAL MACROFOSSILS:															
HYMENOPTERA ....."wasps and ants"															
Ichneumonidae											+				
Formicidae ....."ants"															
Myrmica sp.	+														
CRUSTACEA															
Cladocera ....."water fleas"															
Daphnia sp.	+			+		+	++	++	+++	+	+	+++			
Simocephalus sp.						+	+	+	+						
Ostracoda ....."ostracodes"	+														
ARACHNIDA															
Oribatei ....."oribatid mites"											+			+	
Hydrozetidae															
Hydrozetes sp.				+	+	+			+	+		+			
MOLLUSCA															
Gastropoda ....."snails, limpets"															
conical vertical snails	+++														
discoidal horizontal snail				+											
Other:															
immature mandibles															+

PALEOTEC SERVICES

Table 8. PLANT MACROFOSSIL & FOSSIL ARTHROPOD REPORT MFRPT: 12-07

Sample No.: Flatbed peat, FBRP series

Locality:

Latitude: Longitude:

Collectors: Adrian Hickin and Marten Geertsema

Submitter: Adrian Hickin

Sample: **FBRP-01, 0-30 cm** Material: sand (overbank) Volume: ~1350 ml
Lab No.: 13-70

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 3 (one with calcium outer coat intact)
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stems with leaves fragments: ~20
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp.	+	charred needles: tip: 1, frgs.: 2 (mm-sized); not charred needle frg.-1
Potamogetonaceae .."pondweed family"		
Potamogeton? sp.	+	many 'ear-shaped' seeds (poorly preserved, sand pitting on surfaces)
Betulaceae ....."birch family"		
Betula occidentalis?	+	bract: 1
Other:		
carbonates	+++	abundant encrustations (mostly tubular shaped)
wood	+	fragments: 3 (without bark)
charcoal	+	fragment: 1
deciduous leaf	+	fragment: 1
reworked late Tertiary or Cretaceous coal	++	many fragments
modern rhizomes	+	fragments

ANIMAL MACROFOSSILS:

ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	misc. frgs.: femurs, sternites, mesosternum
Staphylinidae ....."rove beetles"		
Olophrum sp.	+	pronotum: 1
Scarabaeidae ....."scarab beetles"		
Aegialia sp.	+	head: 1, elytra; 2, elytron fragment: 1
Byrrhidae ....."pill beetles"		
Morychus sp.	+	elytron fragments: 3
Chrysomelidae ....."leaf beetles"	+	head: 1
Curculionidae ....."weevils"	+	rostrum frg.; 1, pronotum: 1, elytron: 1, femurs & tibia: 3
Isochnus sp.	+	elytra: 3

continued…

TRICHOPTERA ....."caddisflies"	+	larva case fragments: 2 (made of sand grains and shell fragments)
HYMENOPTERA ....."wasps and ants"		
Formicidae ....."ants"		
Myrmica sp.	+	head: 1, thoracic frg.: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephiphium: 1
Ostracoda ....."ostracodes"	+	valves: ~50
MOLLUSCA		
Gastropoda ....."snails, limpets"		
conical vertical snails	+++	~300 (size 2mm to 1 cm)

Key: +=taxon present, +++=taxon is abundant
Note: The term seed is used generically to include all forms of seeds including achenes, nutlets etc.
Report based upon examination of organics greater than 425 microns (0.425 mm)
If the information provided above proves critical for the submitter's work, A. Telka should be consulted concerning the possibility of more detailed determinations or updates on the validity of the original conclusions.

Comments:

-4% organic content (55 ml total volume sieved 1350 ml)
-piece of wood for AMS (photo taken) didn't survive chemical pretreatment by the dating lab
-Dec. 20/12, chitinous beetle and ant parts dated by Keck Carbon Cycle Dating AMS Lab, University of California, Irvine yielding a ^{14}C age of 9195 ± 25 yr BP (UCIAMS-118712); date is younger than (~1000 yr BP) than date at FBRP-02—included ant parts that are probably slightly younger than the deposited beetle parts, therefore a blended overall old date
-water birch, Betula occidentalis: size and form-generally a tall shrub with stems in clumps; may become a small tree with a leaning crooked trunk, up to 12 m high and 30 cm in diameter; habitat-grows on moist soils along streams, mixed with poplars, willows and alders. Dense, pure thickets are common.

Sample: **FBRP-02, 30-32 cm** Material: sand (overbank) Volume: ~150 ml
Lab No.: 13-88

PLANT MACROFOSSILS:

No plant macrofossils

Other:

reworked late Tertiary/Cretaceous coal	++	small fragments in 0.85-0.425 mm fraction)
sand cemented peds	++	Fe stained (rust-coloured)
modern rhizomes	+	fragments

ANIMAL MACROFOSSILS:

ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"		
Byrrhidae ....."pill beetles"	+	head: 1, pronota: 2, elytron: 1, femurs: 6, tibia: 4, sternites: 8, metasternum: 1 (all are thin, pitted surfaces)
Morychus sp.	+	pronotum: 1
Curculionidae ....."weevils"	+	prothorax frg.: 1

Comments:
-beetle parts are thin, pitted, Fe stained with adhering mineral grains
-10% organic content (15 ml total volume sieved 150 ml)
-FBRP-02, 30-32 cm, Various beetle parts from this sample were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 10315 ± 25 yr BP (UCIAMS-117268) (Nov. 14/12).

Sample: **FBRP-03, 32-60 cm** Material: sand (overbank) Volume: ~250 ml
Lab No.: 14-38

PLANT MACROFOSSILS:

No plant macrofossils

Other:		
reworked lateTertiar/Cretaceous coal	+	small fragments
sand cemented peds	++	Fe stained (rust-coloured)
modern rhizomes and ECM's	+	fragments
INSECTA		
COLEOPTERA ....."beetles"		
Byrrhidae ....."pill beetles"		
Morychus sp.	+	elytra frgs., pronotum frg.: 1, sternites: 3 (all are thin, pitted surfaces, <1 mm in size),

Comments:
Nothing for AMS dating.
6% organic content (15 ml sieved organics; original volume processed 250 ml)

Sample: **FBRP-04, 60-72 cm** Material: sand (overbank) Volume: ~90 ml
Lab No.: 14-38.5

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 58
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stems with leaves fragments: 3
Vascular Plants:		
Pinaceae ....."pine family"		
Pinus contorta Dougl. ex Loud.	+	2-needle pine needle frg.: 1 (4 mm in length)
Picea sp.	+	charred needle frg.: 1 (1.5 mm in length)
Betulaceae ....."birch family"	+	nutlet: 1 (poorly preserved-missing styles and wings)
Other:		
sand cemented peds	+	Fe stained (rust coloured)
wood/twig	+	tiny, punky fragments
modern/aged ECM's	+	fragments with 'fuzzy' moldy clumps

ANIMAL MACROFOSSILS:

ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	sternites: 2 (pitted, thin chitin), femur: 1, tibia: 1
Curculionidae ....."weevils"	+	sternite: 1
DIPTERA ....."flies"		
Chironomidae ....."midges"	+	larvae head capsule: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 3
ARACHNIDA		
Oribatei ....."oribatid mites"		
Hydrozetidae		
Hydrozetes sp.	+	mites: 3

MOLLUSCA
Gastropoda ....."snails, limpets"

discoidal horizontal snail	+	1

Comments:
16.66% organic content (15 ml sieved organics; original volume processed 90 ml)

Sample: **FBRP-05, 72-78 cm** Material: sand (overbank) Volume: ~220 ml
Lab No.: 14-39

PLANT MACROFOSSILS:

Algal remains:
Characeae

Chara sp.	+	oogonia: 14

Other:

reworked late Tertiary/Cretaceous coal	+	few small fragments
sand cemented peds	+	Fe stained (rust coloured)
wood/twig	+	tiny, punky fragments
modern/aged ECM's	+	fragments with 'fuzzy' moldy clumps

ANIMAL MACROFOSSILS:

ARTHROPODA
INSECTA

COLEOPTERA ....."beetles"	+	misc. parts: femurs-3, sternites-2
Staphylinidae ....."rove beetles"	+	elytron: 1
Scarabaeidae ....."scarab beetles"		
Aegialia sp.	+	elytron: 1
Curculionidae ....."weevils"	+	half head: 1, elytron: 1, elytra frgs.: 3, sternite-1

ARACHNIDA
Oribatei ....."oribatid mites"
Hydrozetidae

Hydrozetes sp.	+	mites: 2

Comments:
6.8% organic content (15 ml sieved organics; original volume processed 220 ml)

Sample: **FBRP-06, 78-78.5 cm** Material: sand (contact with compressed organic) Volume: ~100 ml
Lab No.: 14-39.5

PLANT MACROFOSSILS:

Algal remains:
Characeae

Chara sp.	++	oogonia: 156

Vascular Plants:
Typhaceae....."Cat-tail family"

Typha latifolia L.	+	seed outer 'skin': 1 (poorly preserved)

Potamogetonaceae .."pondweed family"

Potamogeton sp.	+	embryos only: 3 (poorly preserved)
Ruppia cirrhosa (Petagna) Grande	+	seed: 1 (poorly preserved)

Cyperaceae ....."sedge family"

Eleocharis palustris-uniglumis type	+	seeds: 6, embryos: 6

Other:

reworked late Tertiary/Cretaceous coal	+	fragments: 2
sand cemented peds	+	fragments (some with embedded *Chara*)

ANIMAL MACROFOSSILS:

ANNELIDA		
HIRUDINEA ....."leeches"	+	cocoons: 3
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"		
Cicadellidae ....."leafhoppers"	+	head: 1
COLEOPTERA ....."beetles"	+	misc. fragments: articulated legs, femurs, tibia, metasterna, sternites
Byrrhidae ....."pill beetles"		
Simplocaria sp.	+	head: 1, elytra: 2
Morychus sp.	+	half pronotum: 1, elytron: 1
Cytilus alternatus (Say)	+	half head: 1, elytra: 3
Curculionidae ....."weevils"	+	articulated prothorax and partial head: 1, half pronotum: 1
Lepidophorus lineaticollis Kirby	+	head: 1, pronotum: 1
DIPTERA ....."flies"	+	pupa fragment: 1
Chironomidae ....."midges"	+	larva head capsule: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 21
Simocephalus sp.	+	ephippia: 3
ARACHNIDA		
Oribatei ....."oribatid mites"		
Hydrozetidae		
Hydrozetes sp.	+	mites: 2

Comments:
-20% organic content (20 ml sieved organics; original volume processed 100 ml)
-Beetle parts including *Cytilus alternatus* (half head, 3 elytra), *Morychus* (elytron-1), *LepidophorMcPlaus lineaticolis* (pronotum-1, head-1) and misc. sternites and legs weighing 1.61 mg were AMS dated by the Keck Lab (Nov./12) yielding ^{14}C age of 10000 ± 35 yr. BP (UCIAMS-117269).

Sample: **FBRP-07, 78.5-78.7 cm** Material: compressed organics Volume: ~10 ml
Lab No.: 14-39

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 27
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stems with leaves fragments: 5
Vascular Plants:		
Potamogetonaceae .."pondweed family"		
Potamogeton compressus L.	+	seeds: 2
Najadaceae		
Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt	+	seeds: 3, half seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Other:		
peat peds	++	many small fragments with visible bryozoan statoblasts and *Daphnia* ephippia imbedded in peds

ANIMAL MACROFOSSILS:

PLATYHELMINTHES		
TUBELLARIA ....."flatworms"	+	cocoons: 2
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 8
Plumatella sp.	+	statoblasts: 12
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"	+	scutellum: 1
DIPTERA ....."flies"		
Tipulidae ....."crane flies"		
Tipula sp.	+	head capsule: 1
Chironomidae ....."midges"	+	larvae head capsules: 65, adult thoraces: 4
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	++	ephippia: 174
Simocephalus sp.	+	ephippia: 4

Comments:
100% organic content (15 ml sieved organics; original volume processed 10 ml-expanded)
-mostly submergent aquatic plant fragments (stems, leaves)
--small fossils (e.g. Plumatella statoblasts, midge head capsules) under represented-embedded in peat peds
-bulk AMS date (M. Geertsema) UCIAMS-46468 9815 ± 20

Sample: **FBRP-08, 78.7-78.9 cm** Material: compressed organics/mineral Volume: ~18 ml
Lab No.: 14-40.5

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+++	oogonia: 769
Vascular Plants:		
Potamogetonaceae .."pondweed family"		
Potamogeton spp.	+	seeds: 6
Najadaceae		
Najas flexilis (Willd.) Rostk. & W.L.E.Schmidt	+	seed: 1
Cyperaceae ....."sedge family"		
Carex trigonous type	+	seeds: 3, fragments: 4
Schoenoplectus tabernaemontani (C.C. Gmel.) Palla	+	seed: 1
Chenopodiaceae ...."goosefoot family"		
Chenopodium capitatum?	+	seeds: 14
Other:		
wood	+	fragments
peat peds	++	many small fragments with visible *Daphnia* ephippia & *Chara* oogonia imbedded in peds

ANIMAL MACROFOSSILS:

ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	miscellaneous frgs.: sternites: 2, femur: 1, tibia: 2
Hydrophilidae ....."water scavenger beetles"		
Cercyon sp.	+	elytron: 1, head: 1
DIPTERA ....."flies"		

Chironomidae ....."midges"	+	larvae head capsules: 14
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	++	ephippia: 299
Simocephalus sp.	+	ephippia: 3

Comments:
-Chara and Daphnia under represented since mineral soil peds couldn't be broken down
-disturbed environment: Chenopodium present (not seen in any other sample), many Daphnia and Chara

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Sample: **FBRP-09, 79-80 cm** Material: compressed organics Volume: ~110 ml
Lab No.: 14-41

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 4
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: 3
Vascular Plants:		
Typhaceae....."Cat-tail family"		
Typha latifolia L.	+	seeds: 3
Sparganiaceae ....."bur-reed family"		
Sparganium hyperboreum type	+	seed: 1
Potamogetonaceae ."pondweed family"		
Potamogeton richardsonii (A.Benn.) Rydb.	+	seeds: 7, half seeds: 16
Potamogeton sp.	+	seeds: 3
Cyperaceae ....."sedge family"		
Schoenoplectus tabernaemontani (C.C. Gmel.)	+	seeds: 4
Najadaceae		
Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt	+	seeds: 4, half seeds: 4
Salicaceae ....."willow family"		
Salix sp.	+	persistent bud: 1
Chenopodiaceae ...."goosefoot family"		
Chenopodium sp.	+	seed: 1
Haloragaceae ....."water milfoil family"		
Hippuris vulgaris L.	+	seeds: 2
Other:		
woody herbaceous stems	+	fragments: 7
aquatic herb plant stems	+	many fragments
peds	++	many small fragments with visible *Daphnia* ephippia & *Chara* oogonia imbedded in peds

ANIMAL MACROFOSSILS:

PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	3-cell: 2
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 6
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	small elytron frg.: 1
Dytiscidae ....."predaceous diving beetles"		

Acilius semisulcatus Aubé	+	pronotum: 1
DIPTERA ....."flies"		
Chironomidae ....."midges"	+	larvae head capsules: 161, half head capsules: 2
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+++	ephippia: 584
Simocephalus sp.	+	ephippia: 3
ARACHNIDA		
Oribatei ....."oribatid mites"		
Hydrozetidae		
Hydrozetes sp.	+	mites: 3

Comments:
-a lot of peds; aggressive sieving after initial 'softer' sieve
-aquatic plant fragments
- FBRP-09, 79-80 cm macrofossil achene of *Schoenoplectus tabernaemontani*. Four achenes weighing 3.37 mg were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 9770 ± 25 yr BP (UCIAMS-117270) (Nov. 14/12).

Sample: **FBRP-10, 80-82 cm** Material: compressed organics Volume: ~100 ml
Lab No.: 13-87

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 42
Non Vascular Plants:		
Bryophytes ....."mosses"	++	many fragments
Vascular Plants:		
Typhaceae....."Cat-tail family"		
Typha latifolia L.	+	seeds: 3
Potamogetonaceae .."pondweed family"		
Potamogeton richardsonii (A.Benn.) Rydb.	+	seeds: 3 (one with perigynium)
Potamogeton sp.	+	seed: 1
Cyperaceae ....."sedge family"		
Scirpus sp.	+	seed: 1
Najadaceae		
Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt	++	seeds: 26, half seeds: 25
Ceratophyllaceae .."hornwort family"		
Ceratophyllum demersum L.	+	seed: 1
Gentianaceae ....."gentian family"		
Menyanthes trifoliata L.	+	half seed: 1
Lamiaceae ....."mint family"		
Mentha sp.	+	seed: 1
Other:		
aquatic herb plant stems & leaves	++	many fragments
peds	++	many small flat fragments with visible *Daphnia* ephippia & *Chara* oogonia & *Plumatella* statoblasts, *Cristatella mucedo* statoblasts imbedded in peds

ANIMAL MACROFOSSILS:

PLATYHELMINTHES		
TUBELLARIA ....."flatworms"	+	cocoons: 5
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 8

Plumatella sp.	+	statoblasts: 1
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	miscellaneous frgs.: tibia, sternite, mandibles
Dytiscidae ....."predaceous diving beetles"		
Colymbetes sp.	+	elytron fragment: 1
Acilius sp.	+	elytron fragment: 1
Chrysomelidae ....."leaf beetles"		
Donacia sp.	+	pronotum: 1, elytron: 1
DIPTERA ....."flies"	+	adult thoraces: 8
Chironomidae ....."midges"	+	larvae head capsules: 21
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 14
ARACHNIDA		
Oribatei ....."oribatid mites"		
Hydrozetidae		
Hydrozetes sp.	+	mites: 3

Comments:

-many aquatic stems and leaves in >12

-many mosses not counted

- *Daphnia* ephippia & *Chara* oogonia & *Plumatella* statoblasts, T*Cristatella mucedo* statoblasts imbedded in peds therefore counts are nil to under represented

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Sample: **FBRP-11, 82-84 cm** Material: compressed organics Volume: ~100 ml
Lab No.: 14-42

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 59
Non Vascular Plants:		
Bryophytes ....."mosses"	++	many fragments (20% by volume)
Vascular Plants:		
Typhaceae....."Cat-tail family"		
Typha latifolia L.	+	seeds: 11
Potamogetonaceae .."pondweed family"		
Potamogeton richardsonii (A.Benn.) Rydb.	+	leaves
Potamogeton sp.	+	seeds: 2
Najadaceae		
Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt	++	seeds: 26, half seeds: 20
Cyperaceae ....."sedge family"		
Carex lenticular type	+	seed: 1
Carex trigonous type	+	seed: 1
Salicaceae ....."willow family"		
Salix sp.	+	persistent buds: 7
Ericaceae ....."heath family"		
Arctostaphylos uva-ursi (L.)Spreng.	+	seed: 1
Gentianaceae ....."gentian family"		
Menyanthes trifoliata L.	+	seed: 1, half seeds: 3
Other:		
aquatic herb plant stems & leaves	++	many fragments (40% by volume)
peds	++	many small flat fragments

ANIMAL MACROFOSSILS:

BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 14
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"		
Dytiscidae ....."predaceous diving beetles"		
Hydroporus sp.	+	pronotum: 1
Colymbetes sp.	+	elytron fragments: 6
Acilius sp.	+	elytron fragment: 1
Chrysomelidae ....."leaf beetles"		
Donaciinae	+	pronotum fragment: 1
DIPTERA ....."flies"	+	adult thoraces: 15
Chironomidae ....."midges"	+	larvae head capsules: 90; adult thoraces: 2
HYMENOPTERA ....."wasps and ants"		
Ichneumonidae	+	adult thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 147
ARACHNIDA		
Oribatei ....."oribatid mites"	+	mite: 1

Comments:
-adbundant submergent aquatic plant fragments 40% of picked residue; mosses 20%, 405 peds

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Sample: **FBRP-12, 86 cm** Material: compressed organics Volume: ~50 ml
Lab No.: 14-43

PLANT MACROFOSSILS:

Algal remains:		
Characeae		
Chara sp.	+	oogonia: 3
Non Vascular Plants:		
Bryophytes ....."mosses"	++	many fragments
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp.	+	charred needles: tip-1, frgs.-2; not charred needles: tips and bases-3
Potamogetonaceae .."pondweed family"		
Potamogeton sp.	+	seed: 1
Cyperaceae ....."sedge family"		
Carex lenticular type	+	seed: 1
Scirpus sp.	+	seed: 1
Scirpus small type	+	seed: 1
Salicaceae ....."willow family"		
Salix sp.	+	persistent buds: 3
Caryophyllaceae ..."pink family"		
Symphoricarpos albus (L.) S.F.Blake	+	seeds: 5, fragments: 3
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Lamiaceae....."mint family"		
Mentha sp.	+	seed: 1
Other:		
peds	++	many small flat fragments
charcoal	+	fragment: 1
twig	+	fragment with bark attached

ANIMAL MACROFOSSILS:

PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	3-cell: 46; 1-cell: 2
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 2
Plumatella sp.	+	statoblasts: 10
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	misc. frgs.: femur-2, pro & mesosterna: 2
Dytiscidae ....."predaceous diving beetles"		
Colymbetes sp.	+	elytron fragment: 1
Acilius semisulcatus Aubé	+	pronotum: 1, elytron fragment: 1
DIPTERA ....."flies"		
Chironomidae ....."midges"	++	larvae head capsules: 220; adult thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+++	ephippia: 499
ARACHNIDA		
Oribatei ....."oribatid mites"		
Hydrozetidae		
Hydrozetes sp.	+	mites: 5

Comments:
Macrofossil seed of snowberry, *Symphoricarpos albus* from FBRP-12, 86 cm. Five seeds weighing 6.47 mg were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8845 ± 20 yr BP (UCIAMS-117271) (Nov. 14/12).

Sample: **FBRP-13, 95 cm** Material: dense peat Volume: 100 ml dry expanded to ~320 ml (wet)
Lab No.: 14-50.5

PLANT MACROFOSSILS:

Non Vascular Plants:		
Bryophytes ....."mosses"	+++	many fragments (99% by volume)

ANIMAL MACROFOSSILS:

ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"		
Dytiscidae ....."predaceous diving beetles"		
Colymbetes sp.	+	elytra fragments: 8

Comments:
-mostly mosses (99%)
-felted layers of compacted mosses-difficult to process without being aggressive

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Sample: **FBRP-14, 100-102 cm** Material: compacted dense peat Volume: ~100 ml dry expanded to ~440 ml (wet)
Lab No.: 13-89

PLANT MACROFOSSILS:

Non Vascular Plants:

Bryophytes ....."mosses"	+++	many fragments, charred stem frg.: 1
Vascular Plants:		
Pinaceae ....."pine family"	+	conifer seeds (no wings): 3
Picea sp.	++	charred needles: tips & bases-22, frgs.~60; not charred needles: whole-2, tips & bases-37, frgs.-35
Betulaceae ....."birch family"		
Betula medium shrub/small tree type	+	seed: 1 (missing wings)
Nymphaeaceae ....."water lily family"		
Nuphar sp.	+	seeds: 2, half seed: 1, frg: 1
Unidentifiable plant taxa	+	seed: 1
Other:		
moss peds	++	many small flat fragments
charcoal	+	fragments: 36
modern roots	+	fragments

ANIMAL MACROFOSSILS:

BRYOZOA		
Plumatella sp.	+	statoblasts: 6
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"		
Dytiscidae ....."predaceous diving beetles"		
Acilius sp.	+	elytra fragments: 4
Curculionidae ....."weevils"	+	head rostrum frg.: 1
DIPTERA ....."flies"		
Chironomidae ....."midges"	+	larvae head capsules: 5
ARACHNIDA		
Oribatei ....."oribatid mites"	+	mites: 4

Comments:
Charred and not charred spruce needle fragments from FBRP-14 were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8770 ± 25 yr BP (UCIAMS-117272) (Nov. 14/12).
-all mosses
-fire event
-mostly spruce needles, charred and not charred
-midge h.c. subfamily Tanypodinae, Tribe Procladius (AT ided)

Sample: **FBRP-15, 105-106 cm** Material: compacted dense peat Volume: ~100 ml dry, expanded to 300 ml (wet)
Lab No.: 14-51

PLANT MACROFOSSILS:

Non Vascular Plants:		
Bryophytes ....."mosses"	+++	many fragments (99% by volume)
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp.	+	charred needle frg.-1; not charred needles: tips & bases-1, frgs.-2; twig terminal frg.: 1
Betulaceae ....."birch family"		
Betula medium shrub/small tree type	+	seed: 1 (missing wings); bract frg.: 1
Betula arboreal type	+	seeds: 2
Gentianaceae ....."gentian family"		
Menyanthes trifoliata L.	+	half seed: 1

Other:		
moss peds	++	many small flat fragments
charcoal	+	fragments: 16
fungal spores (*Glomus*? sp.)	+	spores: 17

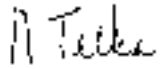
ANIMAL MACROFOSSILS:

PLATYHELMINTHES		
TUBELLARIA ....."flatworms"	+	cocoons: 10
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	misc. frgs.: femur: 1
Helodidae ....."marsh beetles"		
Cyphon sp.	+	elytron: 1
Other:		
immature mandibles	+	3

Comments:

*volume expanded to ~300 ml (wet)
-99% moss
-no Dysticidae, Cyphon present
-birch

Alice Telka



PALEOTEC SERVICES
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Mar. 25/13

Figure 1. Flatbed Peat Site (FBRP). The section consists of ~3 m of overbank sand (basal, 0-78 cm), overlain by compressed organics (~78-95 cm) with dense peat (95-295 cm) at the top of the section. Photo courtesy of A. Hickin.

Figure 2. Flatbed Peat Site (FBRP) showing basal sands transitioning to compressed organics and dense peat. Photo courtesy of A. Hickin.

Figure 3. Overbank sand deposits from Flatbed Peat Site. Photo courtesty of A. Hickin.

Figure 4. Photo of contact between underlying overbank sands and compressed organics from Flatbed Peat Site. Photo courtesty of A. Hickin.

Figure 5. Close-up photo of contact between underlying overbank sands and compressed organics from Flatbed Peat Site. Photo courtesty of A. Hickin.

Figure 6. Close-up photo of contact (FBRP-06, 78-78.5 cm) between underlying overbank sands and compressed organics from Flatbed Peat Site. Photo courtesty of A. Hickin.

Figure 7. Flatbed Peat Site (FBRP) showing upper dense peat unit. Photo courtesy of A. Hickin.

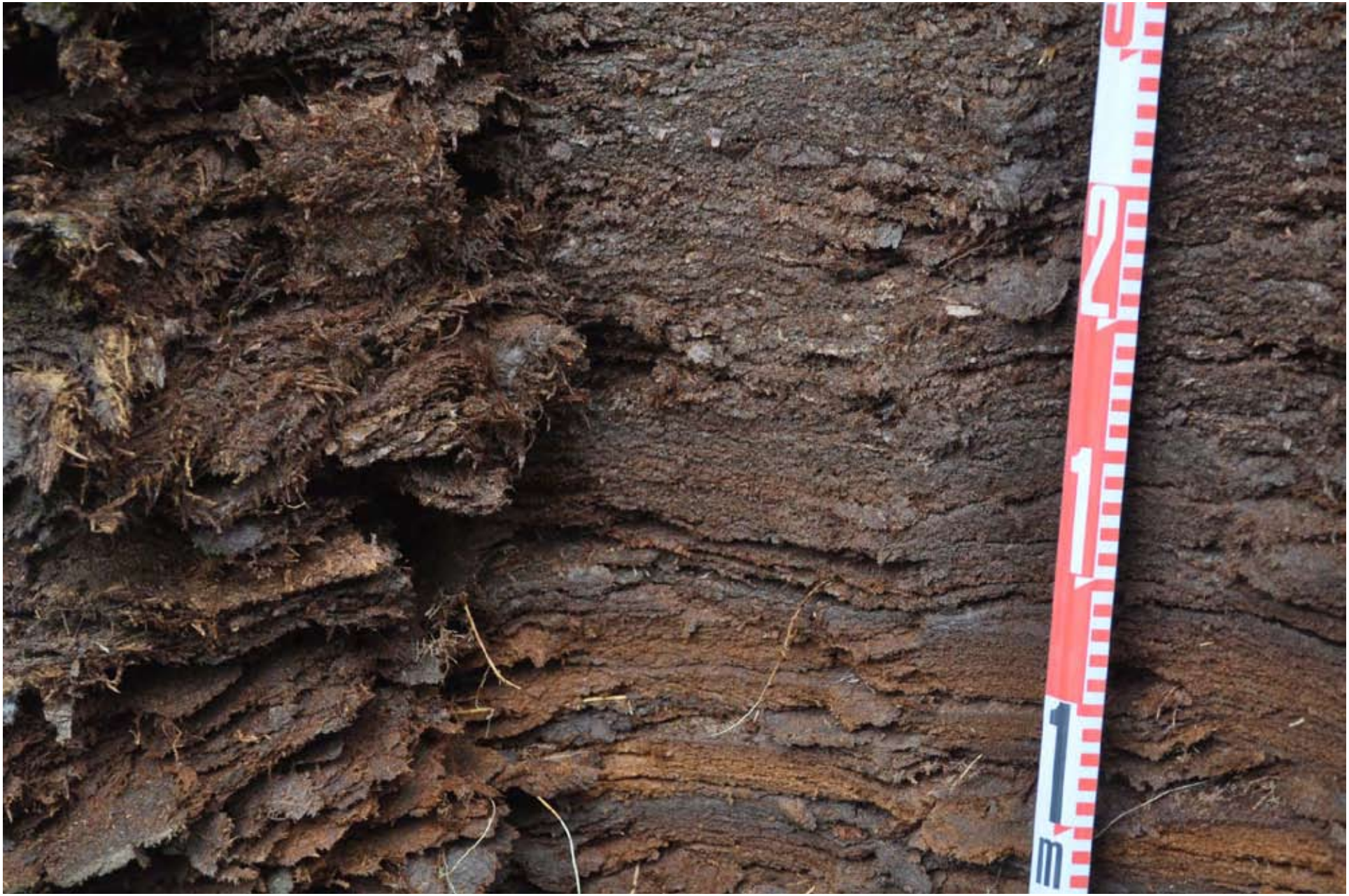

Figure 8. Close-up photo of dense peat (95 -277 cm) showing felted moss layer from Flatbed Peat Site. Photo courtesty of A. Hickin.

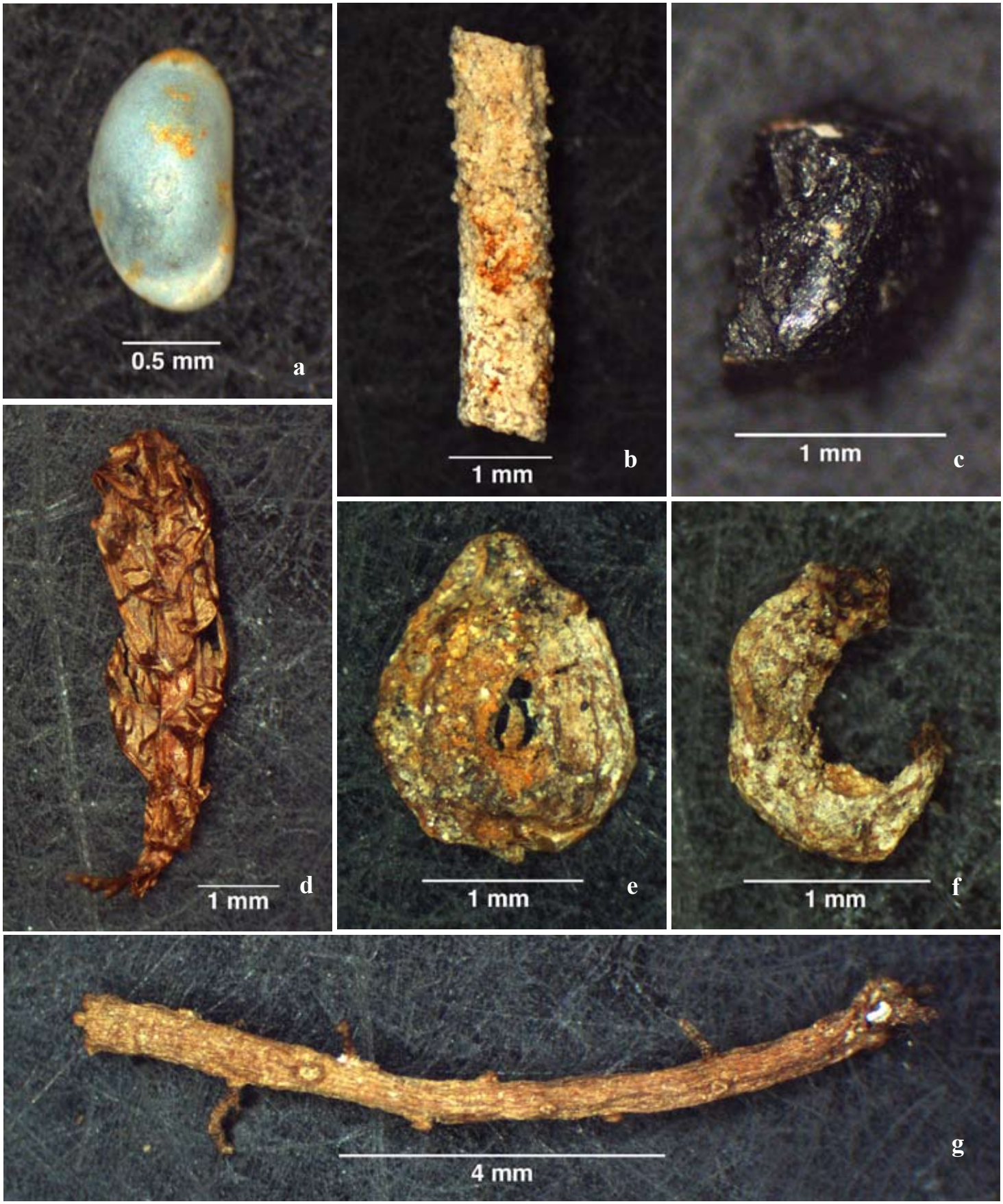

Figure 9. FBRP-01, 0-30 cm fossils. Top: (a) ostracode valve, (b) calcium carbonate cylinder, (c) late Tertiary/Cretaceous reworked coal. Middle: (a) moss, (b) unknown seed (*Potamogeton*?), (c) unknown partial seed. Bottom: (g) aged rhrizome. Note the poor preservation of the seeds and Fe staining (rust-coloured precipitate) on the fossils.

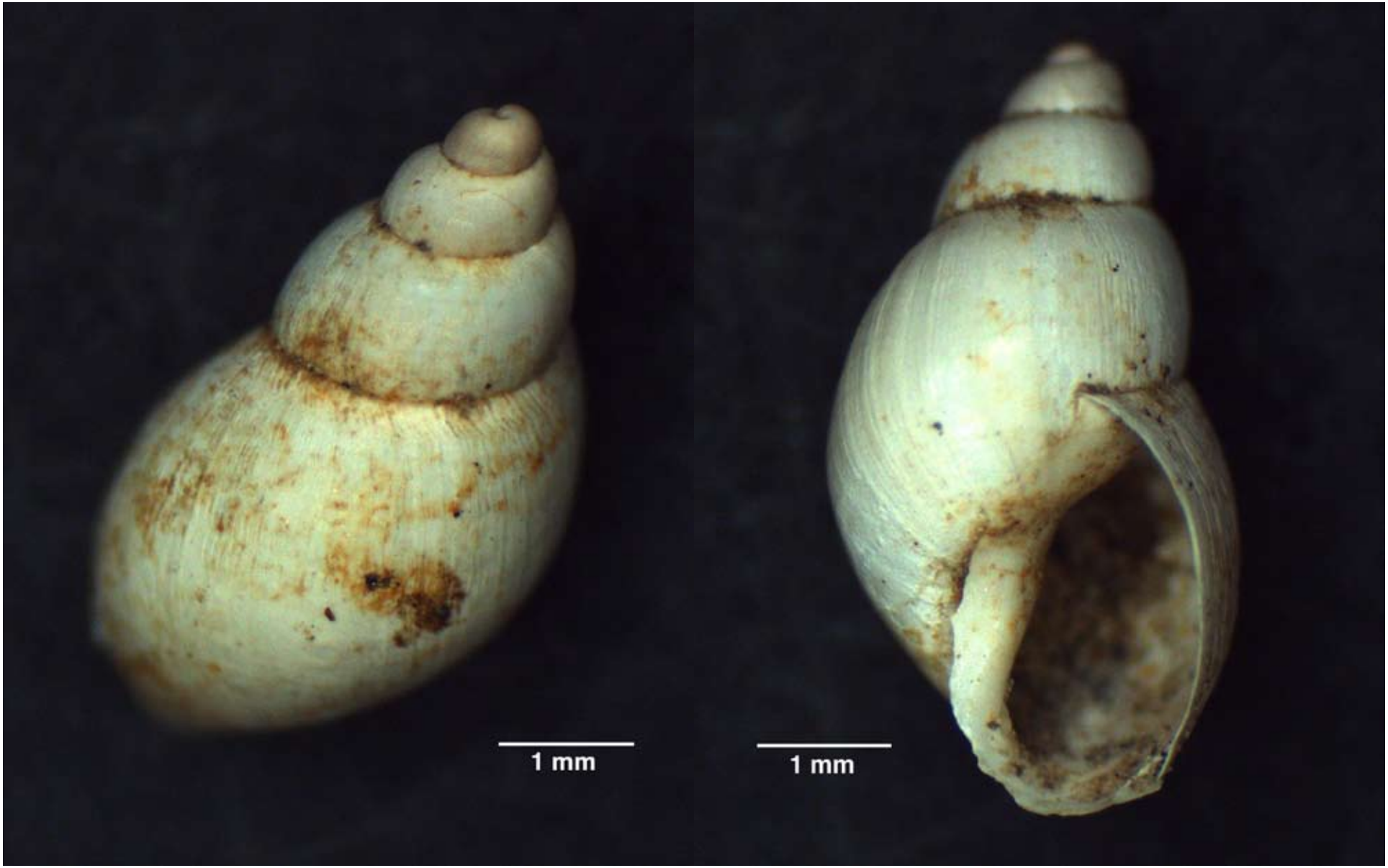

Figure 10. Opposite views of a conical (vertical coiled) snail from FBRP-01, 0-30 cm. Approximately 300 snails of this type were isolated in this sample varying in size from 5 mm to 2 cm.

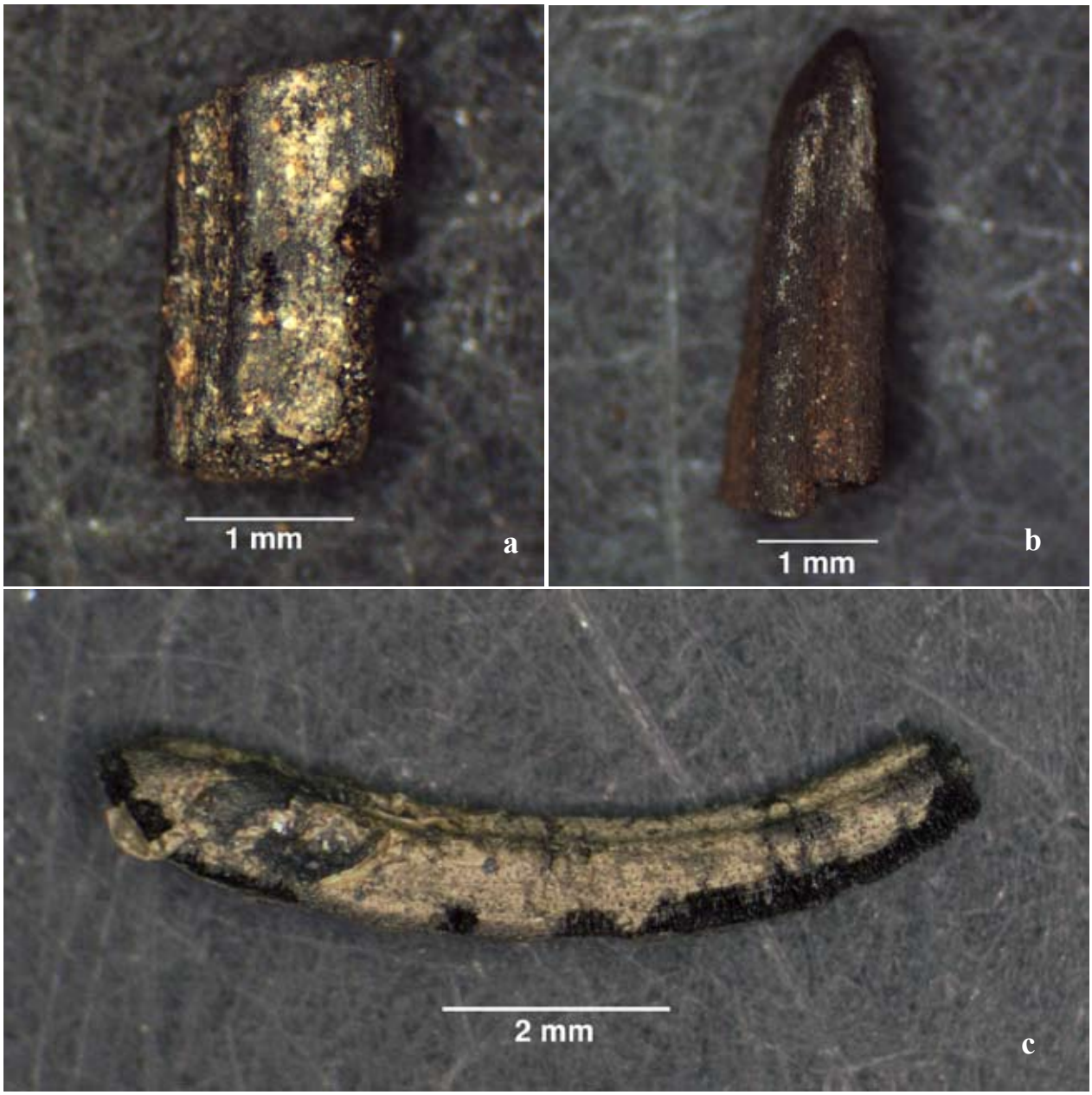

Figure 11. Spruce (*Picea* sp.) macrofossil needle fragments. 11a: FBRP-01, 0-30 cm. 11b: FBRP-12, 86 cm and 11c: FBRP-14, 100-102 cm charred spruce needle. Charred and not charred spruce needle fragments from FBRP-14 were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8770 ± 25 yr BP (UCIAMS-117272) (Nov. 14/12).

Figure 12. Fossil wood fragment from FBRP-01, 0-30 cm. This wood was submitted for AMS ^{14}C dating to the Keck Carbon Cycle AMS Lab, University of California, Irvine (Nov. 14/12). The wood fragment dissolved in the chemical pretreatment (acid, base, acid) performed by Keck Carbon Cycle AMS Facility and could not be measured.

Figure 13. Photo of lodgepole pine, *Pinus contorta*. It is a medium-sized tree growing up to 30 m high and 60 cm in diameter. It occurs on a wide range of soils and sites, including wet depressions. This pine easily colonizes recently burned areas, and most stands are of fire origins (Farrar, 1999). Left inset: FBRP-04, 60-72 cm macrofossil fragment of two-needle pine, *Pinus contorta.*

Figure 14. Left: Scarb beetle, *Aegialia terminalis*. Black scale bar is 1 mm. *Aegialia* species appear to be primarily psammophiles, living on stream deposited sand bars, wind deposited sand dunes, or at least in very sandy substrates (Gordon & Cartwright, 1988). Right: FBRP-05, 72-78 cm *Aegialia* sp. elytron.

Figure 15. Top: Image of a pill beetle, *Cytilus alternatus*. Adults and larvae of this 5-6 mm long beetle feed on moss. They can be found in sandy beaches, under logs, leaves and stones but in general are found in damp mossy habitats (www.bugguide.net/). Bottom left: FBRP-06, 78-78.5 cm fossil elytron of *Cytilus alternatus*. This elytron is one of three that were dated from FBRP-06, 78-78.5 cm along with other beetle parts including *Morychus* elytron, *Lepidophorus lineaticolis* pronota, head and misc. sternites and legs. The beetle parts weighing 1.61 mg were AMS dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 10000 ± 35 yr BP (UCIAMS-117269) (Nov. 14/12).

Figure 16. Photo of cattail, *Typha latifolia*. Left inset: Macrofossil achene of *Typha latifolia* from FBRP-06, 78-78.5 cm. Cattails are emergent aquatic plants living in shallow water along margins of water bodies as well as swampy ground in shallow water (Scoggan, 1978).

Figure 17. Close-up mage of ditch-grass, *Ruppia cirrhosa* showing fruits on elongated stalks. Ditch-grass is a submergent aquatic plant that inhabits shallow alkaline waters (Porsild and Cody, 1980). Left inset: Macrofossil fruit of *Ruppia cirrhosa* from FBRP-06, 78-78.5 cm.

Figure 18. Photo of ditch-grass, *Ruppia cirrhosa*. This submergent aquatic plant inhabits shallow alkaline waters.

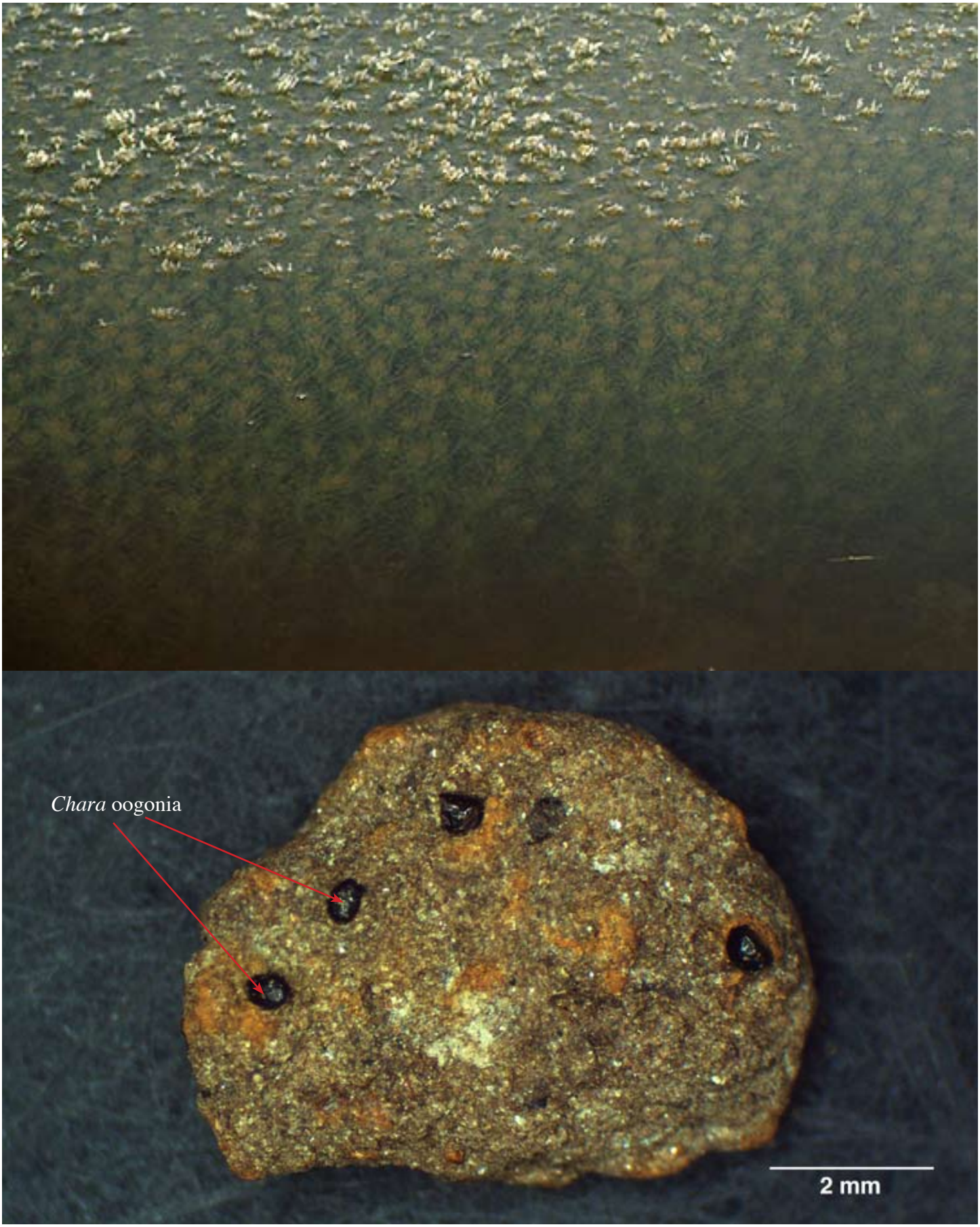

Figure 19. Top: Image of submergent freshwater algae, *Chara*. Below: FBRP-06, 78-78.5 cm, peat ped with embedded *Chara* oogonia (black spheres). FBRP-06 contained many *Chara* oogonia (150, many seen but not counted in peds) and FBRP-08 contained the most *Chara* (769 oogonia, many not counted in peds) from all FBRP samples examined.

Figure 20. Left: Photo of flatstem pondweed, *Potamogeton compressus*. This submerged aquatic plant is found in shallow ponds, lakes and slow-moving waters, 1 to 2.5 m deep (Brayshaw, 1985; www.efloras.org). Right top: macrofossil achene of flatstem pondweed from FBRP-07, 78.5-78.7 cm. Middle: same achene after cross-sectioning for identification. Bottom: close-up of *P. compressus*.

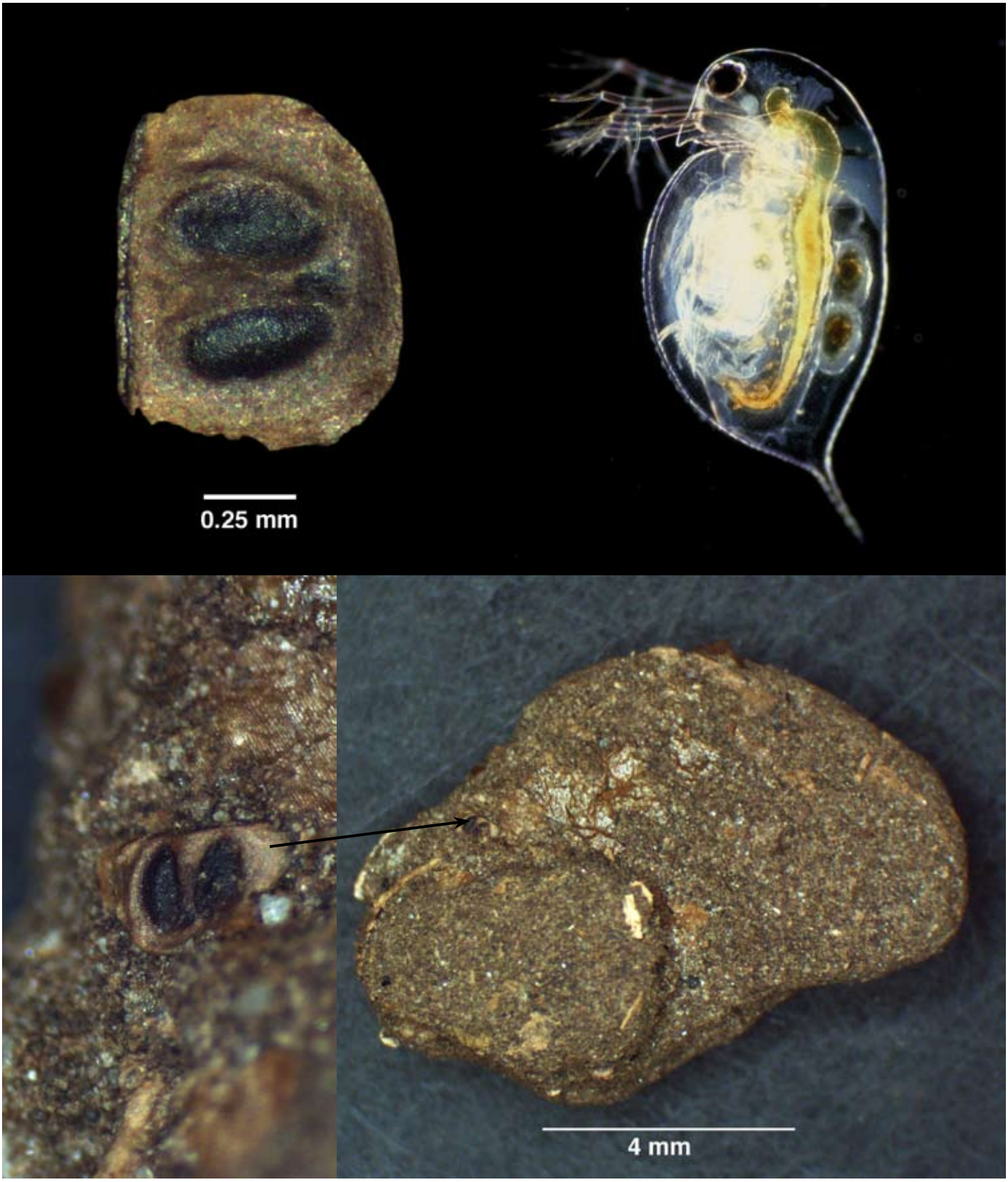

Figure 21. Top left: FBRP-09, 79-80 cm, water flea (*Daphnia* sp.) ephippium. Top right: Image of water flea, *Daphnia pulex*, releasing ephippia. It is a planktonic crustacean measuring 0.2 to 5 mm in size. *Daphnia pulex* occurs in a wide range of aquatic habitats, although it is most closely associated with small, shaded pools where they feed on planktonic algae and diatoms. Bottom: Peat ped from FBRP-09, 79-80 cm showing close-up of embedded *Daphnia* ephippium (left).

Figure 22. Photo of strawberry-blite, *Chenopodium capitatum*. This annual herb can grow to be 20 to 100 cm tall and is found at low to medium elevation throught British Columbia (Mackinnon et al., 1999). It is weedy in habitat and often colinzies clearings and disturbed sites. It is often spontaneous in growth in burned-over areas (Porsild & Cody, 1980). Right inset: Macrofossil seed of *Chenopodium catpitatum*? from FBRP-08, 78.7-78.9 cm. *Chenopodium* seeds were fairly abundant in this sample and not seen in any other samples examined.

Figure 23. Top: Photo of freshwater algae *Chara*. Bottom: FBRP-08, 78.7-78.9 cm peat ped with embedded *Chara* oogonia.

Figure 24. Photo of a small, freshwater pond with limy crust on algal *Chara* (white calcium carbonate encrusted algae). Left inset: FBRP-08, 78.7-cm *Chara* oogonium with calcium carbonate coating. *Chara* oogonia are abundant in this sample (769, with many not counted but observed in peat peds (Figure 23).

Figure 25. Photo of softstem bulrush, *Schoenoplectus tabernaemontani*. It can be found in marshes, lakeshores and streams in the lowland, steppe and montane zones throughout British Columbia (www.geog.ubc.ca/biodiversity/eflora/). Right inset: FBRP-09, 79-80 cm macrofossil achene of *Schoenoplectus tabernaemontani*. Four achenes weighing 3.37 mg were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 9770 ± 25 yr BP (UCIAMS-117270) (Nov. 14/12).

Figure 26. Photo of mare's-tail *Hippuris vulgaris*. This aquatic emergent herb grows in streamsides, lake shores and shallow ponds in the lowland, steppe and montane zones of British Columbia. It is common throughout BC. Left inset: FBRP-09, 79-80 cm macrofossil fruit of *Hippuris vulgaris*.

Figure 27. Top: Photo of Richard's pondweed, *Potamogeton richardsonii*. This submerged aquatic plant is found in shallow to deep clear lake waters, 0.5 to 3.5 m deep, often where it is slightly alkaline, or in slow moving rivers (Brayshaw, 1985). Bottom: Sectioned *Potamogeton richardsonii* macrofossil achene from FBRP-09, 79-80 cm.

Figure 28. Image of water nymph, *Najas flexilis*. Right inset: Close-up of *Najas flexilis* plant. Water nymph is a completely submersed annual plant found in clear, lowland freshwater bodies such as ponds, lakes, and slow-moving streams to depths of four meters. It can grow in water rich in lime and can tolerate brackish water (http://www.ecy.wa.gov/programs/wq/plants/plantid2/descriptions/najfle.html).

Figure 29. Photo of wooly or Richardson's willow, *Salix richardsonii*. This willow is a branching shrub which forms dense thickets that grow to about 1 to 2 m (3.3 to 6.6 ft) tall, but is known to reach 6.5 m (21 ft). Right inset: macrofossil of willow (*Salilx* sp.) persistent bud from FBRP-09, 79-80 cm.

Figure 30. Photo of Richard's pondweed, *Potamogeton richardsonii*. Right inset: FBRP-10, 80-82 cm, a well preserved macrofossil achene enclosed in perigynium (outer seed coat) of Richard's pondweed, *Potamogeton richardsonii*.

Figure 31. Photo of coontail/hornwort, *Ceratophyllum demersum*. Left inset: FBRP-10, 80-82 cm macrofossil achene of *Ceratophyllum demersum*. This aquatic plant grows entirely submersed without anchored roots (free-floating). It grows in still or very slow-moving water (lakes, ponds, and quiet streams), often in hard water with stems reaching 1-3 m in length (http://linnet.geog.ubc.ca/).

Figure 32. Close-up photo of coontail/hornwort, *Ceratophyllum demersum*. The common name is derived from the shape of the stems and leaves being similar to a raccoon's tail. With numersous side shoots on the stem of a single specimen, the plant appears to be a large, bushy mass. This dense growth can outcompete other underwater aquatic vegetation.

Figure 33. FBRP-10, 80-82 cm. Aquatic plant fragments.

Figure 34. Top & Bottom right: Image of predaceous diving beetle *Colymbetes sculptilis* (length 14.1-18 mm) showing close-up of elytron surface. This beetle occurs among emergent plants such as cattail (*Typha*), sedges (*Carex*) or bulrushes (*Scirpus*) at the margin of lakes and permanent or longer-lasting temporary pools (Larson et al, 2000). Bottom left: *Colymbetes* sp. fossil elytron fragment from FBRP-11, 82-84 cm.

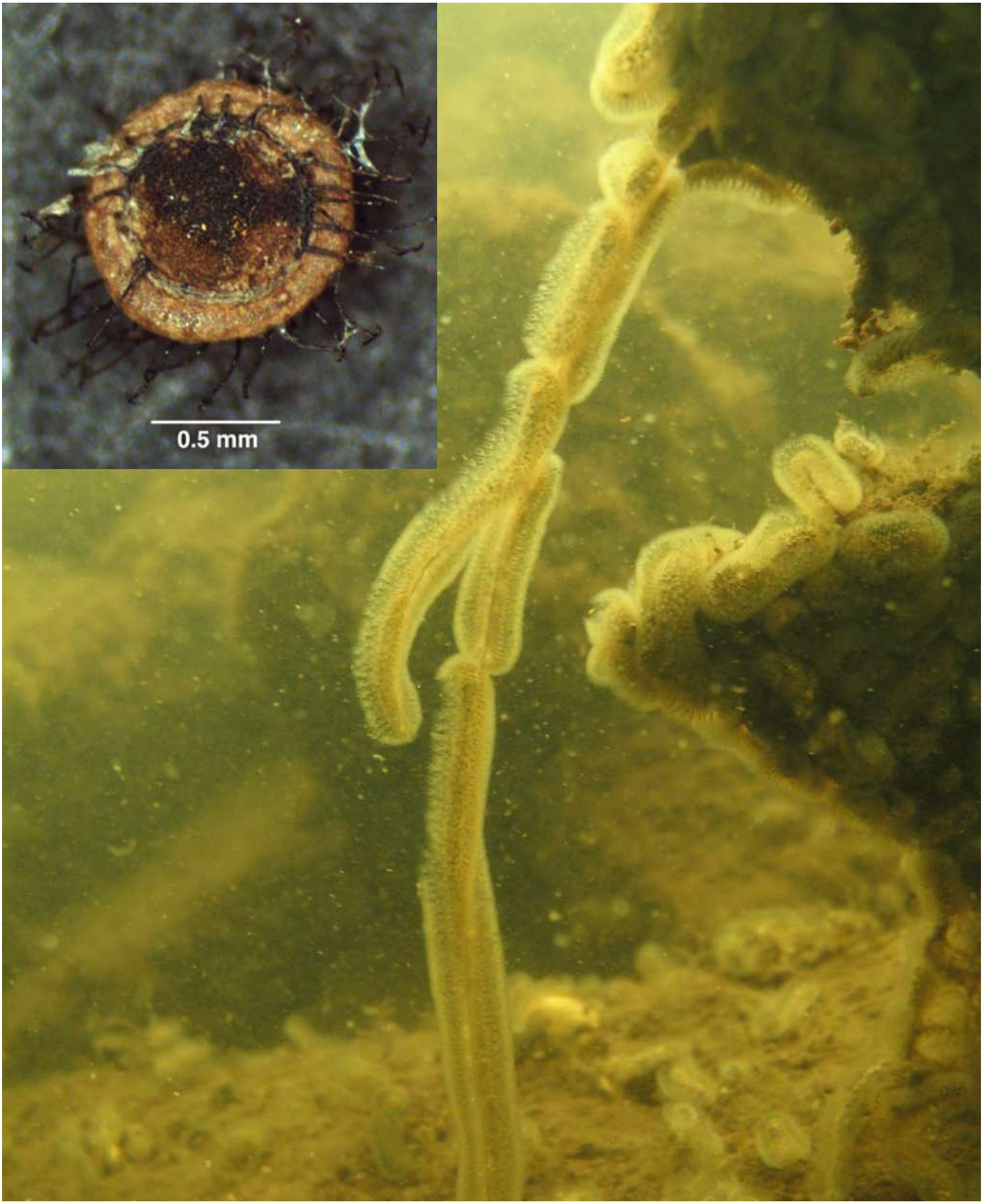

Figure 35. Image of bryozoan moss animal, *Cristatella mucedo* colonies. The colony has two to three rows of polyps that align a shared open space giving the appearance of a caterpillar. The colony starts as a round mound and elongates as it grows. As the colony matures the zooids die and become filled to capacity with statoblasts waiting to rupture and release them into open water. Top inset: FBRP-11, 82-84 cm fossil statoblast of *Cristella mucedo*.

Figure 36. Photo of *Cristella mucedo* gelatinous colony. Top inset: FBRP-11, 82-84 cm fossil statoblast of *Cristella mucedo*.

Figure 37. Left: FBRP-11, 82-84 cm, pondweed, *Potamogeton richardsonii* leaf from felted peat layers. Right: Photo of Richard's pondweed, *Potamogeton richardsonii*. The broadly ovate to lanceolate shaped leaves are 2 to 13 cm long by 1-3 cm wide. Note how the leaf is clasping the stem at their cordate base.

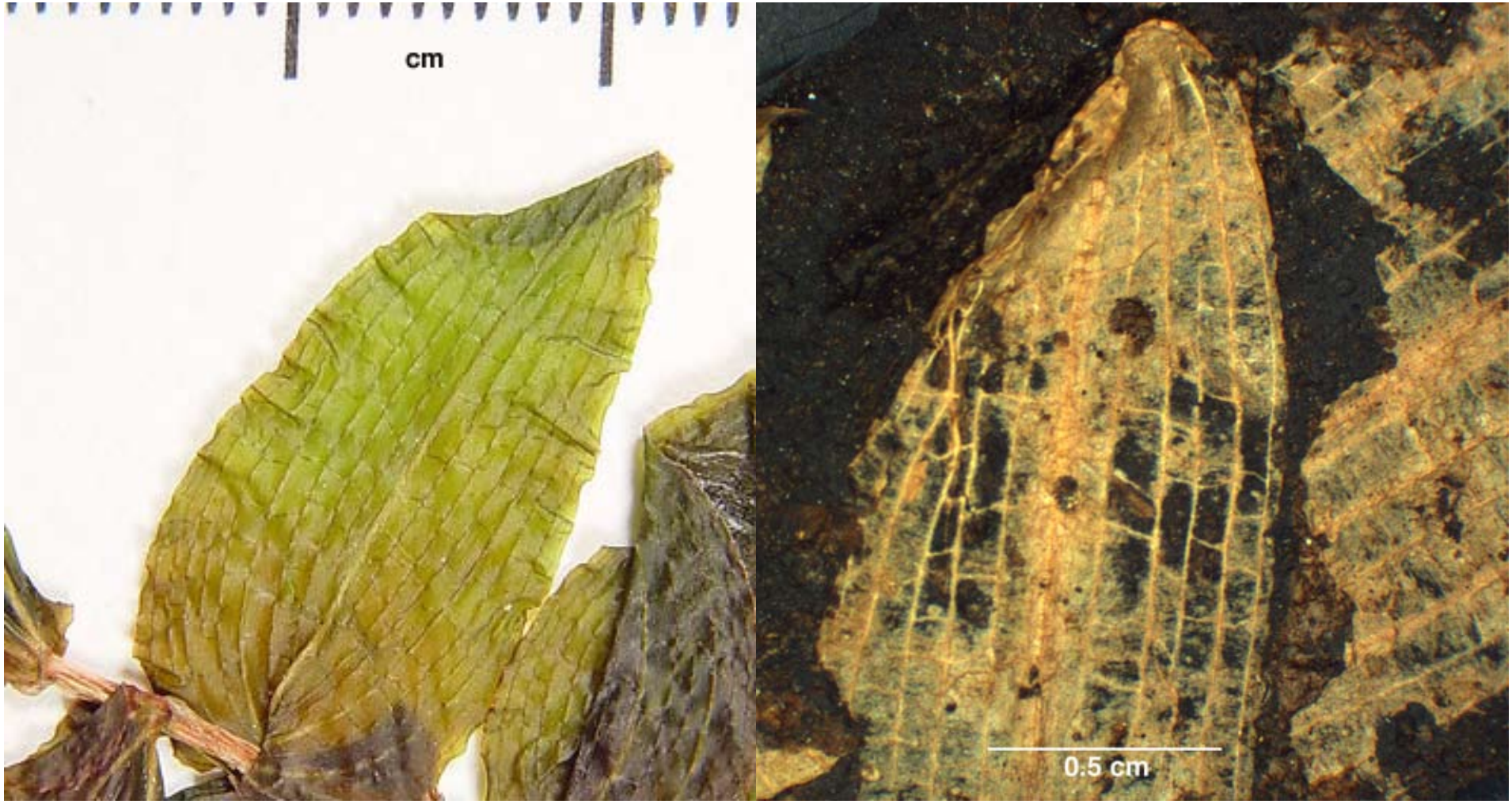

Figure 38. Left: Photo of Richard's pondweed, *Potamogeton richardsonii* leaves. The broadly ovate to lanceolate shaped leaves are 2 to 13 cm long by 1-3 cm wide. Right: FBRP-11, 82-84 cm, pondweed, *Potamogeton richardsonii*? embedded leaf in felted peat layers.

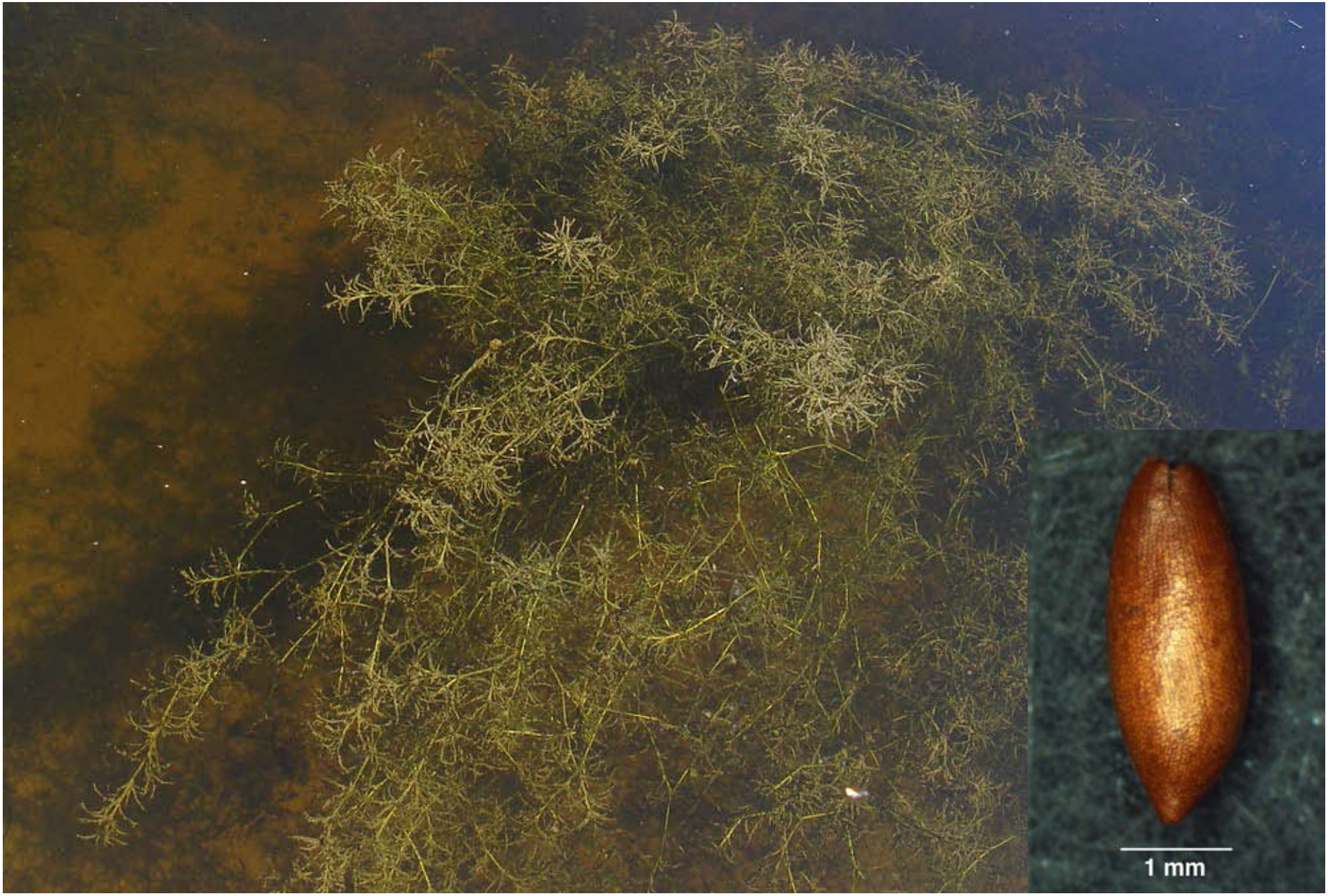

Figure 39. Photo of water nymph/naiad, *Najas flexilis*. Right inset: Macrofossil seed of *Najas flexilis* from FBRP-11, 82-84 cm. Water nymph is a completely submersed annual plant found in clear, lowland freshwater bodies such as ponds, lakes, slow-moving streams, heathland pools. It can grow in water rich with in lime and can tolerate brackish water that is between one and four meters deep (http://www.ecy.wa.gov/programs/wq/plants/plantid2/descriptions/najfle.html).

Figure 40. Photo water nymph, *Najas flexilis*. Where abundant, this is an important plant for waterfowl, which eat all parts of the plant. Right inset: Macrofossil seed of *Najas flexilis* from FBRP-11, 82-84 cm. Note flatness of seed compared to Figure 39 water nymph seed.

Figure 41. Photo of buckbean, *Menyanthes trifoliata*. Left inset: FBRP-11, 82-84 cm macrofossil seed of *Menyanthes trifoliata*.

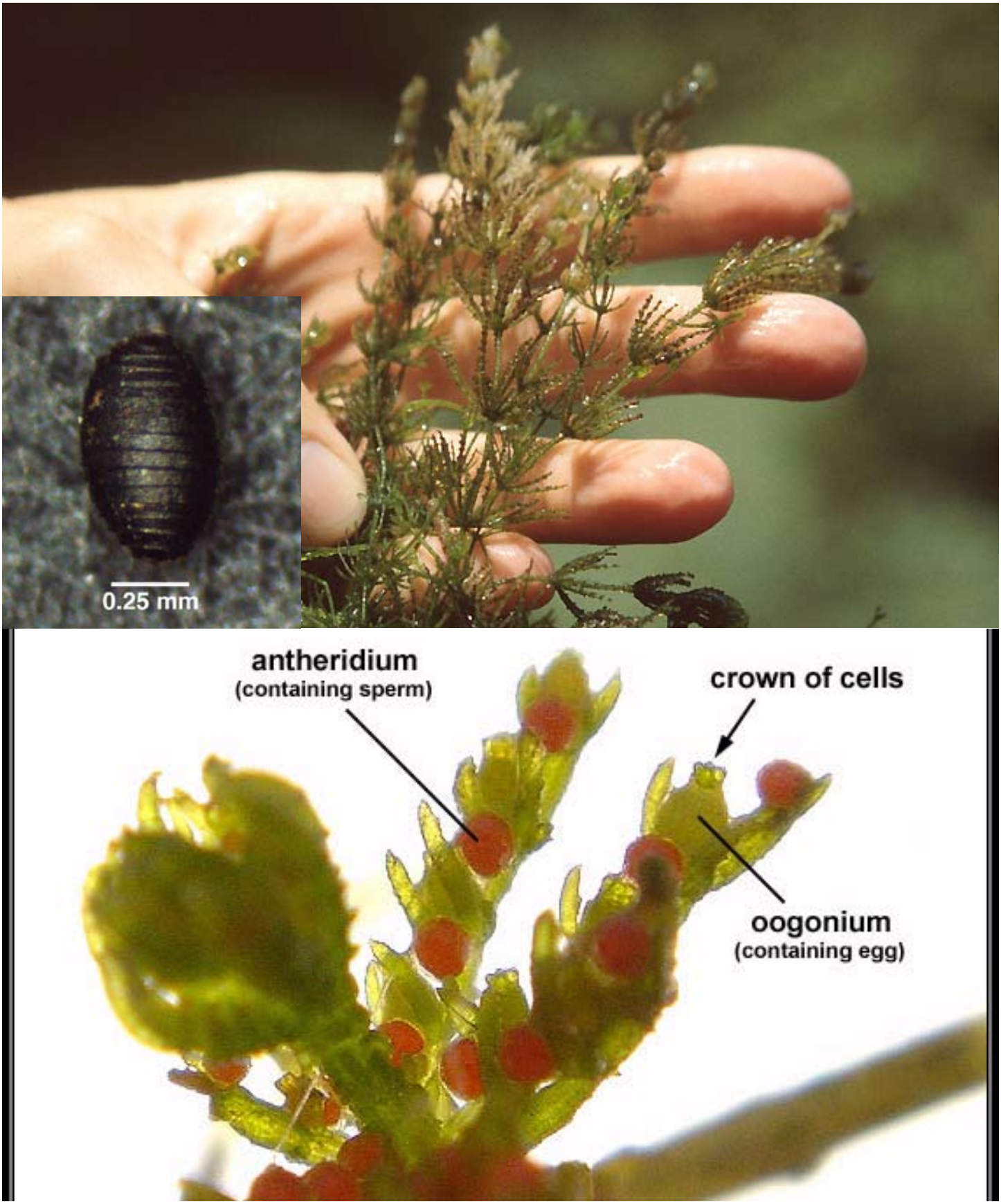

Figure 42. Top: Image of freshwater algae stonewort (*Chara* sp.). Top left inset: *Chara* oogonium from sample FBRP-11, 82-84 cm. Bottom: Close-up view of the fruiting branches of *Chara* showing the easily recognizable sex organs. The sperm-bearing antheridia are bright orange, while the egg-bearing oogonium is green with a distinctive crown of cells.

Figure 43. Photo of common bearberry/kinnikinick, *Arctostaphylos uva-ursi*. This prostrate, much-branched shrub grows on sandy and well-drained exposed sites, dry rocky slopes, dry forest and clearings. It is common and widespread, from low elevations to alpine tundra throughout interior and northern British Columbia (MacKinnon et al., 1992). Right inset: macrofossil seed of bearberry, *Arctostaphylos uva-ursi* from sample FBRP-11, 82-84 cm.

Figure 44. Top & Bottom left: Photos of predaceous diving beetle, *Acilius semisulcatus*. Bottom right: fossil pronotum of *A. semisulcatus* from FBRP-12, 86 cm. This aquatic beetle occurs in standing water in forested regions. Western and northern boreal populations are found in permanent ponds and are common in beaver ponds, burrow pits and small fishless lakes (Larson et al., 2000).

Figure 45. Image of common snowberry, *Symphoricarpos albus*. This erect, branching shrub (0.5-1.5 m tall) grows in open forest, thickets, dry rocky slopes. It is most abundant in dry habitats but also can be found on moist sites, especially well-drained floodplains (MacKinnon et al., 1999). Left inset: Macrofossil seed of snowberry from FBRP-12, 86 cm. Five seeds weighing 6.47 mg were AMS ^{14}C dated by the Keck Carbon Cycle AMS Lab, University of California, Irvine yielding a ^{14}C age of 8845 ± 20 yr BP (UCIAMS-117271) (Nov. 14/12). Right inset: snowberry berry-like drupes (fruit) with two seeds inside.

Figure 46. Top: FBRP-13, 95 cm, felted, thin sheet, of compacted mosses. Bottom: close-up of the moss 'sheet' showing modern root contamination.

Figure 47. Image of Rocky Mountain/yellow pond lily, *Nuphar polysepala*. Seeds of *Nuphar* sp. occur in FBRP-14, 100-102 cm. It is an aquatic submergent plant with leaves mostly floating, occasionally emersed or submersed. It prefers slow, shallow water but is is also common in ponds, lakes, and sluggish streams (www.eflora.org).

Figure 48. Image of emergent buckbean, *Menyanthes trifoliata* (white flowering plant in foreground) with yellow water lily growing in the shallow water in the background. This habitat is similar to the paleoenvironment of FBRP-14, 100-102 cm & FBRP-15, 105-106 cm. Missing are open stands of spruce trees and birch trees.

Figure 49. Image of buckbean, *Menyanthes trifoliata* habitat (white flowering plants) with spruce growing in the background and birch/poplar in the foreground. This is probably the paleoenvironment of sample FBRP-15, 105-106 cm with aquatic mosses growing among the buckbean emergents.