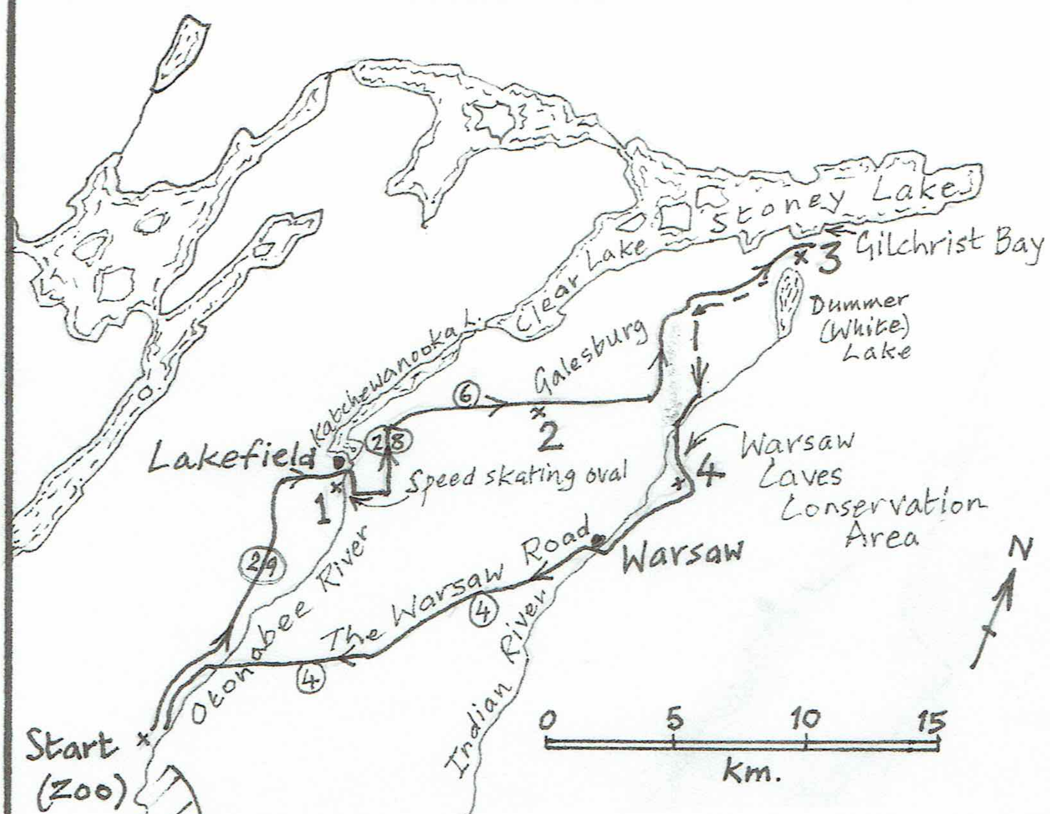


Route of Peterborough Field Naturalists Road Trip

Sat. Oct. 5, 2019

"Geological features of Peterborough-Gilchrist Bay Loop in the Land Between".

GEOLOGY FEATURES OF THE PETERBOROUGH - GILCHRIST BAY LOOP IN THE LAND BETWEEN
PETERBOROUGH FIELD NATURALISTS ROAD TRIP, OCTOBER 5, 2019
By Ken Lyon and Alan Brunger
Revised: October 11, 2019
The field trip will be led by Ken Lyon, P.Geo., and Alan Brunger, Ph.D. Ken is a graduate of Princeton and Queens Universities and a local contaminated sites hydrogeologist. Alan is Professor Emeritus, Trent University. The field trip complements Ken's upcoming presentation on October 9 to Peterborough Field Naturalists on Geological Features of The Land Between in Peterborough County. We will be joined at the Lakefield stop by Kevin Kidd, fossil expert and member of the Kawartha Rock and Fossil Club. We would like to gratefully acknowledge the Ontario Speed Skating Oval for allowing us to go on their property. A sketch map, a more detailed route map, and an introductory fossil guide are attached to this road trip log.

Vehicle Trip Meter (km)	Approx. Field Trip Time on Oct 5	Description
	1:00 PM	Entrance to **Riverview Park and Zoo** on Water St. opposite Carnegie Ave. This is the start of our trip and near the approximate southern boundary of The Land Between. The Riverview Park and Zoo is sited on the western side of the large spillway formed about 12,000 years Before Present (B.P.) by flow from glacial Lake Algonquin (present Lake Huron) and now occupied by the much smaller Otonabee River.
0		Set your vehicle trip meter to 0 kms. Drive north on Water St.
1.2		Nassau Mills Rd., entrance to Trent University on right.

1.6		**Lady Eaton Drumlin** on right hand side of road (formed by deposition from an ice-sheet moving to the southwest about 50,00 yrs. B.P.).
2.2		Water St. becomes Lakefield Rd (County Rd 29) at Woodland Dr.
3.9		Fifth Line of Smith Township. There is a small **former limestone quarry** on private property off to the northeast corner of the intersection. It used to be a good fossil collecting location but is now overgrown.
		Continue on Lakefield Rd to the west side of the Village of Lakefield, settled around 1822.
9.1	1:25	At Gerry's Bait and Tackle, turn right (south) onto the road that leads to the Lakefield water tower. The **Ontario Speed Skating Oval** is down a vehicle track on the right.
		Stop 1 - Ontario Speed Skating Oval (fossiliferous limestone and shale of Ordovician age)
		The oval was constructed in 2009 by excavating into limestone bedrock and piling the rock into berms along two sides. It is southern Ontario's only natural ice, 400-m long track speed skating facility. Please respect that this is private property and do not clamber on the rock berms. If you are making the trip on your own, please contact the Ontario Speed Skating Oval organization at ontariospeedskatingoval.com to get permission to go on their property.
		The rock is Upper Ordovician age interbedded limestone, shaly limestone and shale of the Verulam Formation, about 450 million or so years old. The deposits formed from shallow seas that probably stretched all the way to Hudson's Bay at a time when this part of Ontario was near the equator.

		There is an interesting small-scale fault in the rock outcrop just past the skating shack on the left-hand side as you go towards the water tower.
		Continuing around the track, the rocks in the berm contain a lot of fossils of ancient invertebrate animals. You may find bryozoans, gastropods (snails), bivalves (clam-like), brachiopods, pieces of crinoids or "sea lilies", and maybe even a trilobite. The book by Hewitt (1969) has photos of these types of fossils that are also found at the former Canada Cement Lakefield quarry that is nearby. The white "veins" in the rocks are calcite ($CaCO_3$) that precipitated in fractures in the rock. They are not quartz.
0	2:30	Drive back to Lakefield Rd. and reset your trip meter to 0 kms. Turn right and head into Lakefield.
0.7		Cross the bridge over the river and turn right on to Water St.
0		Reset your trip meter to 0 kms. This will let you explore the village if you make the trip on your own without having to subtract the extra kms.
		Continue on Water St. The sprawling complex on your left past Nicholls St. is the SGS Mineral Services Lakefield facility. It used to be a Canada Cement plant that closed in 1930 with the onset of the Great Depression. The stack for the old cement kiln is a Lakefield landmark. Limestone used in making the cement came from a quarry to the east. SGS, formerly Lakefield Research, operates a metallurgical and analytical testing facility here. It dates back to 1936 when Canadian Nepheline operated a mill to process ore from Canada's first nepheline syenite mine at Blue Mountain just north of Stoney Lake. The processed rock was used in the ceramic industry.
0.7		Turn left (east) on to Block Rd., County Rd 33.

1.3		Entrance to Lakefield sewage lagoons on the right. A local spot for bird watching.
2.1		Turn left (north) on to Hwy 28.
		If you drive into the parking lot at Leahy's, you can look out over the Sawer Creek Valley. This valley was a secondary glacial spillway from glacial Lake Algonquin, during the last ice-sheet retreat. If you look east, you might be able to make out an old rectangular pit in the valley floor. Marl (lime-rich mud) was mined here for the old Lakefield cement plant.
0		Reset your trip meter to 0 kms.
0.4		Entrance to the old Canada Cement Lakefield quarry is on left (west). It was a good fossil collecting location (see Hewitt 1969) but the current owner prohibits access.
3.5		Follow Highway 28 to the intersection with County Rds 29 and 6. Turn right on to Rd 6.
		The route from just east of Hwy 28 to Gilchrist Bay traverses the **Dummer Moraine**. This is a plain of glacial debris between the Canadian Shield to the north and the Peterborough Drumlin Field to the south. Chapman and Putnam (1984) describe it as a stony ground moraine left by the last glaciation. It typically has a hummocky or rough surface and broken pieces of limestone and Precambrian rock. It is a classic landscape of the southern part of The Land Between in Peterborough County.
3.8		Former Pine Grove Cheese Factory at Douro 5th Line.
7.5		Turn right on to Douro 2nd Line and park by the side of the road.
	2:45	**Stop 2 - Galesburg Inlier Unconformity** (older Precambrian rock protruding through younger Ordovician rock)

		The Galesburg Inlier Unconformity may be the only place in Ontario where you can see a younger Paleozoic limestone rock inlier resting on top of a Precambrian rock inlier. An Inlier is like an island of older rock surrounded by younger rock.
		The Precambrian rock dates back to a billion years and more from a huge mountain building event called the Grenville orogeny. This event produced mountains that rivalled the Himalayas. What we see today is the core of the old mountains after a few tens of kms of rock were eroded off, before the shallow seas of the Paleozoic era invaded the region. The Precamrian rock is granite, which is an igneous rock. The pink minerals are likely potassium feldspar. Tiny inclusions of iron oxide hematite give the grains a pink colour. The clear minerals are quartz. The black, sometimes "shiny", flecks in the rock are a type of mica called biotite.
		The limestone rock is also an inlier. The Ontario Geological Survey has mapped it as Gull River Formation surrounded by younger Bobcaygeon Formation rock. They are both Ordovician age and older than the rock at the Lakefield stop, but still around 450 million years old give or take a few million. However, the strata here are both more massive (thick-bedded) and non-fossiliferous than the Verulam formation limestone and shale at Lakefield. If you look closely at the outcrop across the road, you can find small pockets or seams of black chert (micro- or crypto-crystalline quartz, SiO_2).
		The contact between the older Precambrian rock and younger Ordovician rock is called an "unconformity" because there is a time gap between the two types of rocks. The gap at Galesburg is huge, about 450 - 500 million years. Exactly what happened in between we do not know because there is no record.

		There are a few other places in southern Ontario where you can see the same unconformity between Paleozoic and Precambrian rocks, but not many and probably none where the unconformity consists of one inlier lying on top of another.
		At Galesburg, you can see that the underlying Precambrian rock seems to have been pushed up like a small dome that warped the overlying limestone layers a bit. This might mean that the "bulge" happened after the Ordovician sediment was turned into rock.
0	3:15	Reset your trip meter to 0 kms and continue east on County Rd 6 to Gilchrist Bay Rd.
4.2		Intersection with County Rd 4 (alternate route to Warsaw Caves).
10.2		Stop sign at Fourth Line Rd N. Turn left to continue on County Rd 6.
13.9		Escarpment leading down to Indian River glacial spillway.
14.8	3:35	Turn left on to second Gilchrist Bay Rd and park by the side of the road. Gilchrist Bay Rd has two T-intersections with Rd 6; take the second one.
		Stop 3 - Gilchrist Bay (metamorphic and igneous Canadian Shield rock)
		Gilchrist Bay is at the southern edge of exposed Canadian Shield rocks. There is a good outcrop of metamorphic rock that was "cracked" open during plate tectonic movements and then invaded by magma from a large underground magma pocket called a pluton. This happened deep inside the Grenville mountain core.

		Eyles (2002) described the rock as pink granitic magma that invaded dark gneisses and even melted the dark rock in places. Gneiss is a coarse-grained, high-grade metamorphic rock that shows foliation or layering of alternating bands of different minerals. The rock was metamorphosed likely from igneous volcanic basalt that formed long before the mountain building events.
		Features called dikes mark fracture zones in the metamorphic rock which were filled by invading magma. The magma slowly cooled and crystallized to form granite. The pink colour comes from tiny inclusions of iron oxide in the mineral potassium feldspar. The whitish and clear minerals are quartz. The black grains are likely biotite, a type of mica. You should be able to find chunks of darker rock called xenoliths embedded within the granite. This type of mixed metamorphic and igneous rock is called migmatite.
		Hewitt (1969) thought that the dark rock is dark green pyroxene amphibolite and not gneiss. The amphibolite is likely hornblende, and sparkles in the sun. Hewitt also found pink granite gneiss in the outcrop. Very often lab studies have to be conducted to figure out exactly what a rock is under different classification systems. Regardless, the road cut at Gilchrist Bay is a good one from a geology perspective.
		Gilchrist Bay also marks the start of the Indian River glacial spillway. It is part of an ancient drainage system that pre-dates the glaciers. When ice melted during the last ice age, the drainage system carried water from glacial Lake Algonquin (now Huron) to glacial Lake Iroquois (now Ontario). You will see a spectacular gorge that the meltwater carved into limestone rock at Warsaw Caves, the next and last stop.

		The Warsaw Caves stop is optional. If you live north of Peterborough or if we are running late, you can skip it and do it another time. There are access points to the conservation area on the east and west sides. We are making a short stop from a point on the east side.
0	4:00	Reset your trip meter to 0 kms and retrace your way back along County Rd 6 to Dummer 4th Line Rd North.
4.5		Instead of turning right to stay on Rd 6, continue straight.
7.5		Follow Dummer 4th Line Rd N down into the glacial spillway and keep to the right where it turns into Sawmill Rd.
8.7		Stony field on the right with lots of Precambrian and Ordovician limestone erratics and an old sawmill on the left. Chapman and Putnam (1984) mapped this stretch as an esker next to the glacial spillway.
9.7		Turn left on to Dummer 3rd Line Rd North.
10.4		At Caves Rd, continue straight on Cooper Rd.
10.8		There is an unmarked access point to the conservation area.
11.5		Turn right onto Rock Rd.
11.6	4:20	Park across from 1211 Rock Rd.
		Stop 4 - Warsaw Caves (Indian River Glacial Spillway Gorge)
		This stop affords a spectacular view of the gorge that was cut by the glacial meltwaters. The view of the gorge is a short walk from the road.

		Warsaw Caves Conservation Area contains a number of interesting geological and ecological features. In addition to the spillway gorge, other geological features include: - the limestone "fissure" caves; - pot or kettle holes scoured in the limestone rock during the glacial ice melt; - an "alvar" plain (a classic landscape of the southern portion of The Land Between); and - a disappearing and re-appearing river.
		The limestone rock at Warsaw Caves is Ordovician Bobcaygeon Formation. In comparison with the rock around Lakefield, the rock at road level at Warsaw Caves has thicker beds that are not friable, much less shale and not very many fossils. Eyles (2013) contains a description of what is called the karst landform features. The Warsaw Caves website has a map showing the locations of the features and a brochure on the caves themselves.
0	4:50	Reset your trip meter to 0 kms and continue south on Rock Rd.
2.2		Turn right at the stop sign at Douglas Rd in order to stay on Rock Rd.
4.0		In Warsaw, cross over South St and take Ford St to Peterborough St/County Rd 4.
0		At the intersection of Ford St, County Rd 4 and Peterborough St, reset your trip meter to 0 kms. This will let you start from a visit to either the east or west side of the conservation area. Head west and then southwest on County Rd 4, known locally as "The Warsaw Road". It is a historically-significant "forced" road that links Peterborough and Warsaw directly. It deviates from the official surveyed road allowances in order to follow an all-season, drier, more elevated route as described below.

		Much of the Warsaw Road follows the ridge summit, or side, of an "**esker**", formed of mostly sand and gravel and thus, naturally well-drained. Eskers are sinuous ridges deposited by glacial rivers underneath the glacial ice. They can be a few hundred metres to a few kilometres long. Sometimes you can identify them by looking for sand and gravel pits.
		Warsaw is near the northern edge of the **Peterborough Drumlin Field**. These elongated glacial features were sculpted or deposited by advancing ice. They are sometimes called whalebacks. The "head" or steeper end points up-ice. No one has done an exact count, but depending on what area is considered and whether drumlin-like features are also included, there are upwards of 4,000 drumlins and drumlin-like features in the field.
0.7		Scenic view to the left of the glacial spillway valley. You can see drumlins in the distance to the south and southwest. On a clear day you might be able to see the Oak Ridges Moraine in the distant south.
3.5		County Rd 4 bends to the right around a drumlin.
5.7		Road follows the crest of an esker.
8.7		Road climbs the shoulder of the esker.
9.3		Sand pit to left in the esker.
9.7		Stay on County Rd 4 and cross Hwy 28.
		If you want to take a short detour, there is an historical plaque 0.2 km south on Hwy 28 beside the south side of the Duoro Community Centre. It commemorates an accidental dynamite explosion that occurred in 1885 when two men were transporting dynamite in a horse-drawn carriage from the Ontario Powder Co. in Tweed for work at the Trent-Severn Lock at Burleigh Falls. The blast was heard as far away as Lakefield, Peterborough and Warsaw. Only pieces of the men, wagon and horses were ever found.
11.1		Turn right on to Nassau Rd, heading west. Nassau Rd turns into Pioneer Rd in Peterborough.

15.3		Turn left on to Nassau Mills Rd. Cross over the canal and river.
16.3		Turn left on to Water St and head back to our starting point.
17.5	5:20	Entrance to Riverview Park and Zoo.
67		Total Approx. Kilometres

References and Additional Resources:

The books by Adams and Taylor and by Waddington appear to be out-of-print, but hopefully you can get them at a library. The Chapman and Putnam 1972 map and the books by Hewitt and Lemon are free downloads, as are the OGSEarth kml files. The kml files can be opened in Google Earth. More references and resources will be listed with the presentation that Ken is giving to Peterborough Field Naturalists.

Adams, P., and C. Taylor (Eds.), 2009. Peterborough and the Kawarthas (3rd Ed.). Trent University Geography Dept., Peterborough, ON. 252p.

Bonewitz, R.L., 2008. Rock and Gem: the definitive guide to rocks, minerals, gems, and fossils. Smithsonian Project Consultants, M. Carruthers and R. Efthim. Dorling Kindersley Limited, New York, NY. 360p.

Chapman, L.J., and D.F. Putnam, 1972 (reprinted 1984 with minor revisions). Physiography of the South Central Portion of Southern Ontario. Ont. Dept. of Mines and Northern Affairs, Map 2226. Scale 1:253,440.

Chapman, L.J., and D.F. Putnam, 1984. The Physiography of Southern Ontario (3rd Ed.). Ontario Geological Survey, Special Volume 2. 270p. Accompanied by Map P.2715, Scale 1:600,000.

Eyles, N., 2002. Ontario Rocks: three billion years of environmental change. Fitzhenry & Whiteside, Markham, ON. 339p.

Eyles, N., 2013. Road Rocks Ontario: over 250 geological wonders to discover. Fitzhenry & Whiteside, Markham, ON. 570p.

Hewitt, D.F., 1969 (reprinted 1988). Geology and Scenery: Peterborough, Bancroft and Madoc Area. Ontario Geological Survey, Geological Guide No.3. 113p.

Lemon, R.R.H., 1965. Fossils in Ontario. University of Toronto Press, Toronto, ON. 17p.

MiningMatters (Undated) Guide Books. https://miningmatters.ca/resources/education/mining-matters-publications/mndm-ontario-brochure • Rocks of Ontario: Ontario beneath your feet • Fossils of Ontario: old rock - ancient life
Ontario Ministry of Energy, Northern Development and Mines, OGSEarth Data, www.ontario.ca/data/ogsearth. • Bedrock Geology data downloaded as a kml file October 22, 2018 • Southern Ontario Paleozoic Geology data downloaded as a kml file March 16, 2019
Waddington, J., 1979. An Introduction to Ontario Fossils. Royal Ontario Museum, Toronto, ON. 28p.
www.otonabeeconservation.com/outdoor-recreation/conservation-areas/warsaw-caves/

1.5km 0 3km
UTM Zone 17
Scale 1:150,000

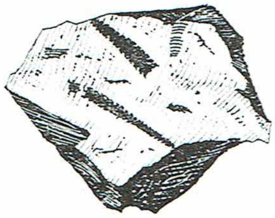
ONTARIO PALEOZOIC INVERTEBRATE FOSSILS
Revised: Oct 11, 2019

TYPE	PHYLLUM	MAIN CLASSES/GROUPS IN THE ROCKS	WHAT ARE/WERE THEY?	APPROX. TIME RANGE
Sponges	Porifera	Sponges	Multi-cellular animals with internal skeleton of spicules and with flagella cells. Some species had silica spicules.	Precambrian - Present (most Paleozoic groups now extinct)
		Stromatoporoids	Majority of fossil sponges. Habits can range from small mounds, reefs, cones or cylinders, to crusts on shells.	
Corals	Cnidaria	Solitary Rugose (horn) Corals	Skeleton tubes (corallites) housing polyps with hollow tentacles at mouth of tube. Algae live inside polyps.	Ordovician - Permian (modern corals different group)
		Colonial Rugose (horn) Corals		
		Tabulate Corals		
Bryozoans	Bryozoa	Several Bryozoans	Skeleltons with smaller pores and more complex colonial organisms than corals. Different habits (encrusting, massive or domed, branching, lacy sheet-like). Many species disappeared at end of Ordovician with global mass extinction event.	Ordovician - Present
Molluscs	Mollusca	Gastropods (snails)	Coiled or cap-like shells. Coils can be in one plane or spiral. Most shells originally aragonite. Animal protrudes from opening in shell.	Cambrian - Present (ammonoids Devonian - Cretaceous)
		Pelecypods (bivalves)	Two shells (valves) connected by muscle along plane of symmetry hinge line. Nearshore sediments. Modern bivalves include clams, cockles, mussels, oysters and scallops.	
		Cephalopods (nautiloids, ammonoids)	Straight (nautiloid), curved or coiled (ammonoid) shells that housed a predatory animal. Free swimming, straight nautiloids up to several m long. Modern cephalopods include octopus, squid and nautilus.	
Brachiopods	Brachiopoda	Inarticulates	Two shells symmetrical about a centre line. Inarticulates have equal shells of $CaPO_4$. Articulates have unequal shells of $CaCO_3$. Bottom dwelling in mud, on surface or attached to something else. Abundant and diverse in Ontario Paleozoic rocks but many disappeared at end of Ordovician with mass extinction event.	Cambrian - Present
		Articulates		
Arthropods	Arthropoda	Trilobites	Three exoskeleton lobes lengthwise divided by furrows and three body sections (head, thorax, tail) crosswise. Grew by moulting. Many had well developed eyes. At least 68 species in south-central Ontario; many disappeared at end of Ordovician in global mass extinction event.	Cambrian - Permian
		Eurypterids (sea scorpions)	Related to modern sea crabs. Likely fed on smaller invertebrates.	Silurian - Permian
Echinoderms	Echinodermata	Crinoids (sea lilies)	Skeleton of high-magnesium calcite plates forming cup-like crown. Often have stem and "root" that attached to hard surface. Feathery arms on crown gathered food. Dissociated stem columnals called St. Cuthbert Beads. Many echinoderms disappeared at end of Orodovician in mass extinction event.	Ordovician - Present (cistoids Ordovician - Devonian)
		Cistoids	Similar to crinoids but ovoid body with triangular pore openings.	
		Starfish	Calcite plate skeletons like sea lillies. Five-fold symmetry. Rare as fossils because plates fall apart.	
Graptolites	Hemichordata	Graptoloids (straight)	Floating colonies of bud-like individuals on straight or branched or netlike skeleton tubes. Graptoloids more common and resemble small, black double-edge saw blades. Closely related to vertebrates. Many disappeared at end of Ordovician.	Cambrian - Mississipian
		Dendroids (branch-like)		
Annalids	Annalida	Worms & worm burrows		Cambrian - Present

Sources: Armstrong and Carter (2010) Subsurface Paleozoic Stratigraphy of Southern Ontario, Hessin (2009) South-Central Ontario Fossils, Lemon (1965) Fossils in Ontario, Waddington (1979) An Introduction to Ontario Fossils.

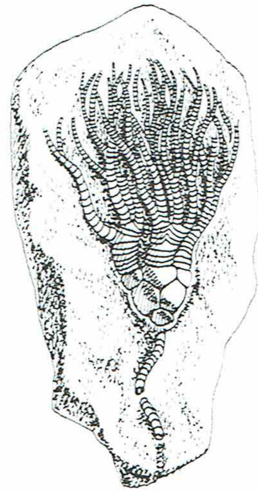
Author: Ken Lyon, P.Geo. Disclaimer: I prepared this chart to help me understand Ontario Paleozoic fossils, especially those in the south-central Ontario region. Please use this chart as an informal guide that may have some mistakes.

LEMON (1965) FOSSILS IN ONTARIO



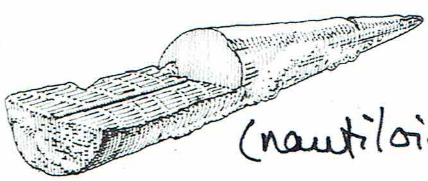
Graptolites

Trilobite



Crinoid
(sea lily)

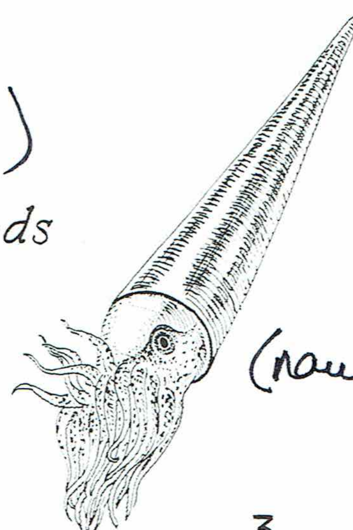
1



(nautiloid)

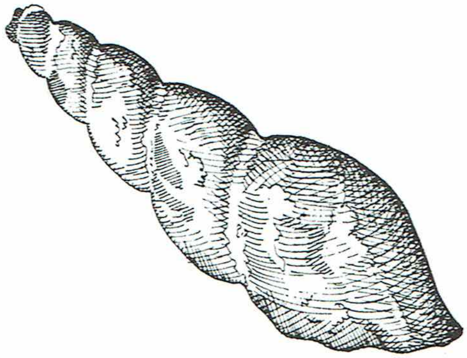
Cephalopods

2 (ammonoid)

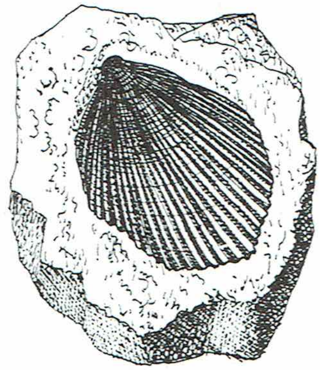


(nautiloid)

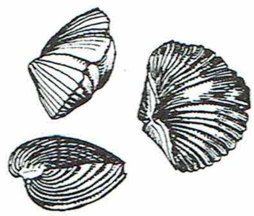
3



Gastropod
(snail)



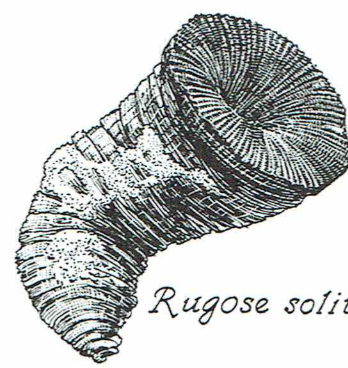
Pelecypod
(bivalve)



Brachiopods

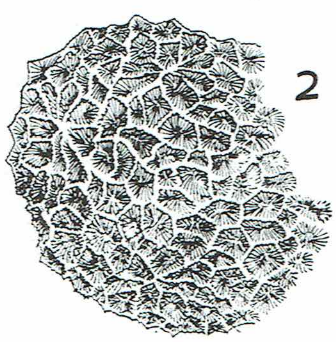
Corals

1



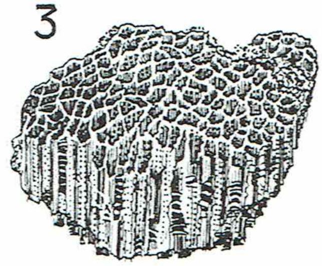
Rugose solitary

2



Rugose colonial

3



Tabulate