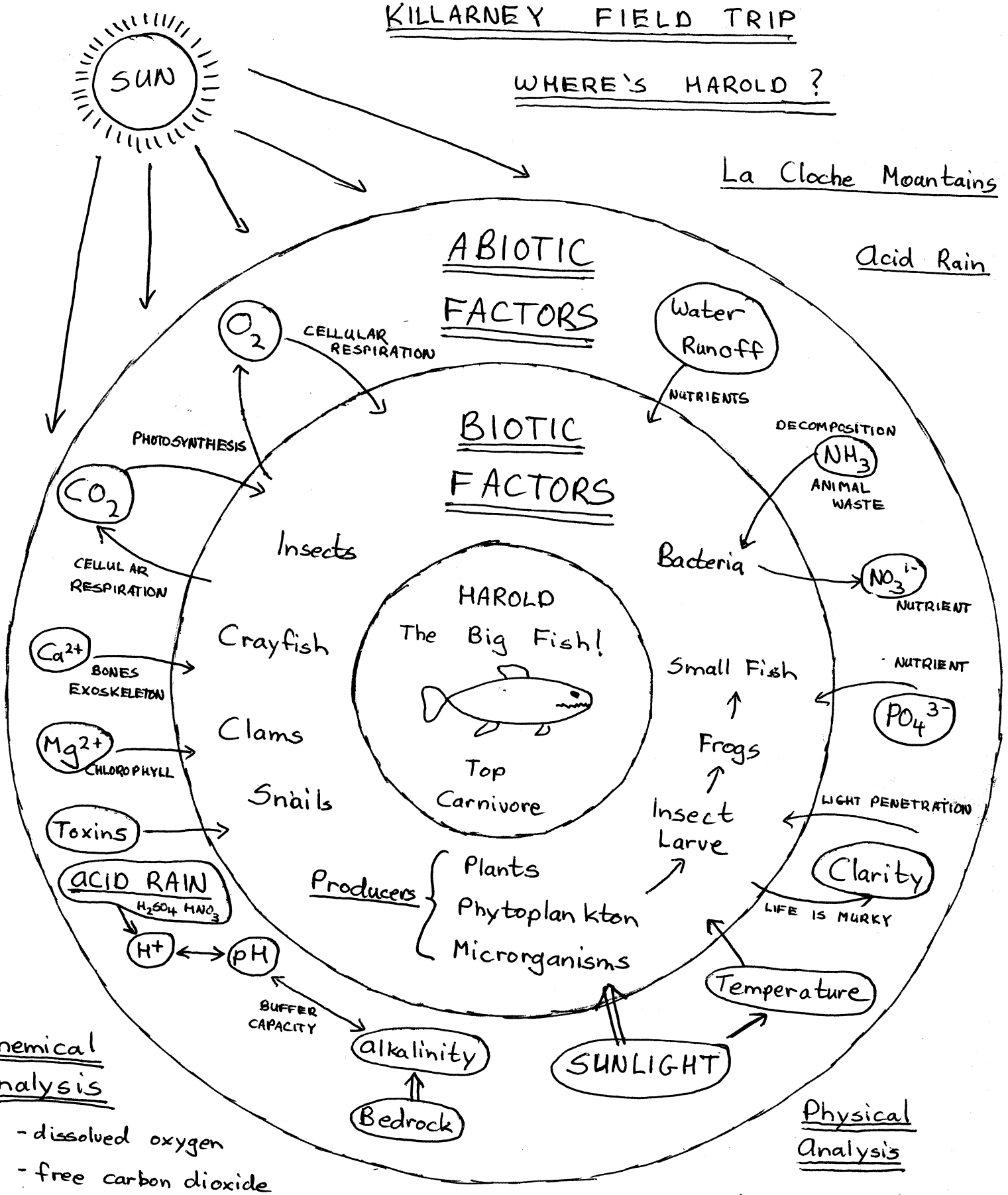
KILLARNEY FIELD TRIP

WHERE'S HAROLD ?



Chemical Analysis

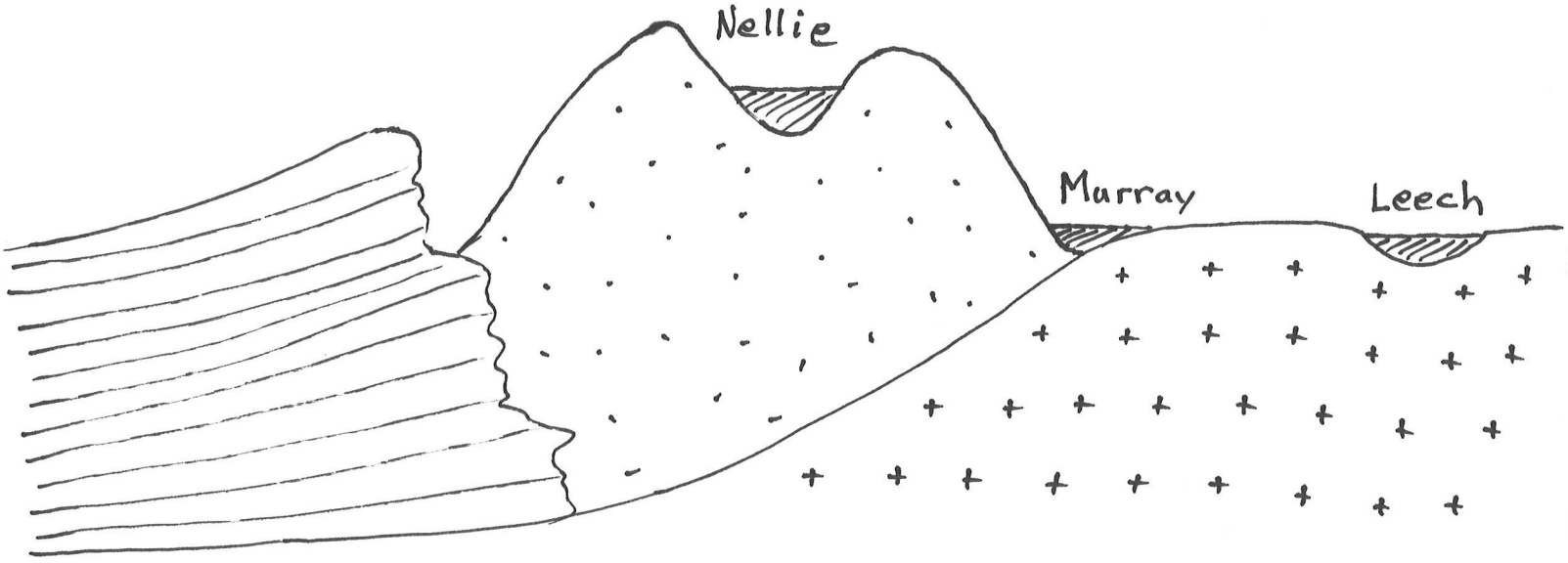
- dissolved oxygen
- free carbon dioxide
- alkalinity
- pH ([H+])
- Ca^{2+}
- Mg^{2+}
- PO_4^{3-}
- NH_3

Biological Surveys

Physical Analysis

- light penetration
- temperature profile
- water flow

La Cloche Mountains Cross Section



La Cloche Mountains

- quartzite (metamorphosed sandstone)
- ancient sea floor 700 million years old)
- upthrust by geological activity
- little to no buffering capacity

Underlying Bedrock

- basaltic lava from a volcanic epoch
- 1.2 billion years old
- reasonable buffering capacity

Limestone Bedrock

- same formation as the Niagara Escarpment
- 500 to 300 million years old
- excellent buffering capacity

Geology of Killarney

SPH 4U

Killarney Field Trip

Douglas Miller

There four major tectonic events that shaped this area, they were 4.5 billion years ago, molten lava came forth from within the earth out of a great crack creating what now is the bedrock also known as the canadian shield. The Shield under went 3 mountain building period caused by continental shifting, which resulted in the formation of folds, cracks and faults, during the time between mountain building process the mountains where weathered and eroded which produced sedimentary materials. The sedimentary materials were also brought in during the multiple time that southern ontario was flooded with warm water bringing shale, silt, clay, sand, and coral. After the giant lake drained away and left the sedimentary materials the continent drifted north and this caused the folding and squeezing if of the land the Extreme pressure was enough to change the sedimentary material into sedimentary rock [3]

Quartzite is a metamorphic rock that is created from sandstone which is put under heat and pressure. Quartzite as a rock has areas of different colours, which can be explained by the fact that sandstone is a sedimentary rock, which are rock of compact layers of matter often organic matter, because of this impurities are compound which was added during the sedimentation process. [1,2,3]

The chemical composition of the Quartzite around killarney is 98.43% SiO_2, 0.85% Al_2O_3, 0.25% Fe_2O_3, 0.04% MgO, 0.03% CaO, 0.05% TiO_2, 0.06% Na_2O, And <0.50% K_2O. The iron oxide (Fe_2O_3) is the reason for the reddish spots in the quartzite.[2]

Most silica sandstone in Ontario is from the precambrian age (from 4,500 million years ago to 570 million years ago) and have metamorphosed into quartzite. Quartzite allowed fossils to retain their shape from when it was sandstone. [2]

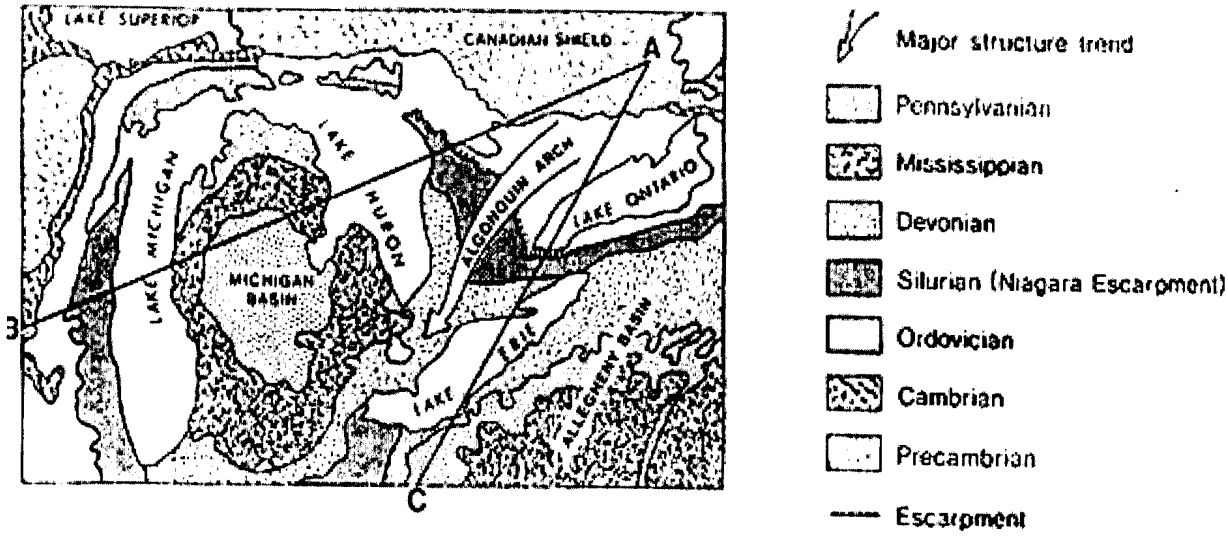


Figure 2 Overview of Algonquin Dome (ARCH) and Michigan Basin

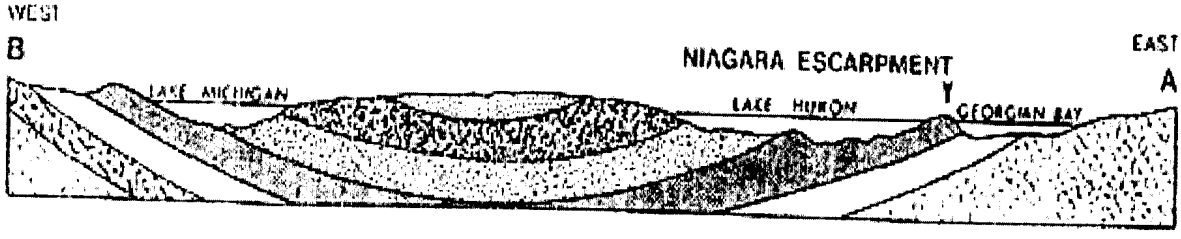


Figure 3- Michigan Basin

North of owen sound is rock that is older then the rock in owen sound Figure 3 shows a vertical cross section of Figure 2 on the line BA the layer that is Precambrian is the oldest because the rest of the layers are on top of if, Owen Sound is in the middle on the silurian layer which has the niagara escarpment on it. The rocks south of Owen Sound is younger for the same reason, and is in the Devonian layer which is between 409 million years old and 363 million years old. The Devonian layers is made up of dolomite and limestone.

Dolomite is the layered on top of limestone ($CaCO_3$). Dolomite is composed of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). There is three different combinations of calcium carbonate and magnesium carbonate. The first is limestone, with less then 10% magnesium carbonate. The second is magnesium limestone with 10-45% magnesium carbonate, and the third is Dolomite with 40-45% magnesium carbonate. [4]

Buffering capacity depends no the alkalinity of the soil which makes rock the region around killarney relatively useless because it is mostly made of quartzite which is composed of silicon and oxygen neither of which are alkali in addition to that unlike sedimentary rock's, metamorphic rock under went a metamorphosis which if it was able to react with the acid it would decrease the rate of reaction. The escarpment is made of lime stone which is both alkali and a sedimentary rock which makes it have a great buffering capacity.

GEOLOGY:

How many major tectonic events have helped shape this area?

4 major techtonic events have shaped this area

What is the chemical composition of the white quartzite rock? Why does it have some areas of different colour?

SiO_2 - colours are a result of impurites such as iron (pink) magnesium (green) etc.

What is the approximate age of this rock?

700 million years or older.

Would you expect to find fossils in this rock, why or why not?

No, too old, complex life that would leave a fossil first appeared 600 million years ago

Would you classify this rock as sedimentary, metamorphic or igneous?

Metamorphic

What is the origin of this rock and how did it get so high above sea level?

Sandy deposits at the bottom of a shallow sea created sandstone (sedimentary)

Mountain tectonic events provide pressure and heat by burying the sandstone and allowing metamorphosis to occur.

Further tectonic events provide mountain building up thrusting

Are the rock to the north older or younger and how do you know?

Older because the are underneath the La Cloche Mountains

Are the rock to the south (Manitoulin Island and Bruce Peninsula) older or younger and how do you know?

Younger because they are on top of the La Cloche Mountains

What is name, age, approximate chemical formula, origin and extent of the rock to the south?

Niagara Escarpment, 430 to 450 million years old (Silurian and Ordovician era)
$CaCO_3$ Limestone (or Calcite) - sea bed deposits from calcareous organisms (coral)
$CaMg(CO_3)_2$ Dolomite (Dolostone) - magnesium substitution of Ca in limestone creates hard cap rock creating the erosional feature of the escarpment
Extent - Rochester NY, Niagara to Tobermory, Manitoulin Island, West of Lake Mich.

Why is acid rain a problem here, but not at home?

Acid rain reacts with carbonate based rock in a neutralization reaction, therefore no acid accumulation at home. Acid rain cannot reaction with quartzite, therefore acid precipitation accumulates.


-90°
-88°
-86°
-84°
-82°
-80°
-78°
-76°
47°
46°
45°
44°
43°
42°
41°
Lake Superior
Canada
Lake
Huron
Lake
Michigan
Lake Ontario
Lake Erie
United States
km
0
50
100

PLANTS:

What do mosses lack? Why don't moss grow more than a few inches high?

Moss lack vascular tissues, therefore cannot transport water, therefore short

What do club mosses have?

Club Mosses have vascular tissues and can therefore become tall

How big did club mosses once grow and what other plants did they share the "forests" with?

10 to 30 m tall, shared the forests with giant horse tail (snake grass)

What reproductive advantage do mosses, club mosses and ferns have?

Reproduce using Spores - very small and carry on the wind
produced by the millions but must land in a favourable location with a food source

What feature to all gymnosperms have. What is the reproductive advantage of this?

Seeds in Cones - seed contains a food source of its own, therefore greater survival
cannot travel as far or a quickly as spores

What feature do angiosperms have in common? What types of plants belong to this group?

Flowering Plants
deciduous (broad leaf) trees, flowers and all grasses

CONIFER IDENTIFICATION:		
GENUS	COMMON NAME	DISTINGUISHING CHARACTERISTICS
Juniper	Common Juniper	low spreading shrubs, pointy auel like needles with a predominant white line down the middle of each needle, pee sized berry like cones, very drought tolerant, grows in rocky areas
Cedar	Eastern White Cedar	flat scale like needle with distinctive smell, small very small numerous cones, fine stripped and fibrous bark, prefers wet locations
Pine	White Pine	needles: 5 per fascicle, soft, 5 to 15 cm long fast growing when young, become wind swept when older, large long open cones, various soil conditions, good drought tolerance,
	Red Pine	needles: 2 per fascicle, sharp, 10 to 16 cm long larger round open cones, bark is scaly and has red highlights, straight trunks, good drought tolerance
	Jack Pine	needles: 2 per fascicle, 2 to 4 cm long small usually closed cones that open when exposed to fires, frequently first colonizers, prefers dry locations, very drought tolerant
Tamarack	Tamarack	needles: in tufts of 10 to 15, 2 to 5 cm long deciduous, brilliant yellow in the fall, smaller cones, prefers moist soil
Fir	Balsam Fir	needles: single flat frequently lateral origin, 1.5 to 7.5 cm, Christmas tree smell, pointy shape younger bark smooth with resin pockets
Spruce	White Spruce	single needles with rectangular cross-section (roll test), 1.5 to 2.2 cm long, hairless yellow to brown twigs, light coloured bark, less pointy shape, slender cones, not drought tolerant
	Black Spruce	very similar to White Spruce, needles finer and smaller, twigs darker, downward swooping branches, grow in clumps with a parent tree slower growing, smaller rounder cones
Hemlock	Eastern White Hemlock	needles: flat with dissimilar lengths, 2.2 cm max very small cones, dangling leader (top of tree) prefers wet soil, shade tolerant when young, frequently found in under story of mature forest
Yew	Canada Yew	shrubs, frequently growing in patches, flat needles that taper to a sharp point, needles noticeably darker on top, red berry like seeds

LICHENS and SUCCESSION:

What is a primary colonizer? What are the primary colonizers in this area?

First plant to grow on rock or bare soil - Lichens are the most common example here

What type of organism is a lichen? Describe the relationship and how it works.

Two Organisms in a symbiotic relationship - Fungus and an Algae.
The algae performs photosynthesis and feeds the Fungus glucose.
The Fungus provides a good home for the algae (protected).
20 000+ different types of Fungus makes use of a limited number of algae types)

What are three common forms of lichens?

Crustose: - closely attached to rock, cannot be removed without crumbling
grow outwards in rings

Foliose: - leaf like structure, low to the ground/rock

Fruticose: - like small shrubs, branches have radial symmetry

How do lichen cope with the drastic shifts in moisture in their environment.

Can dry out and cease all cellular functions - suspended animation, stasis.
Add water (rain, fog or humid air) and cells come to life, algae photosynthesizes and fungus grows

Describe the sequence of organisms in succession that eventually lead to the prime vegetation of white pine, jack pine or red oak.

Lichen $\longrightarrow$ Moss $\longrightarrow$ Grass $\longrightarrow$ Shrub $\longrightarrow$ Tree

Each step encourages the formation of soil, able to trap dust from the air and as the sequence progresses, organic matter produced by the plants themselves

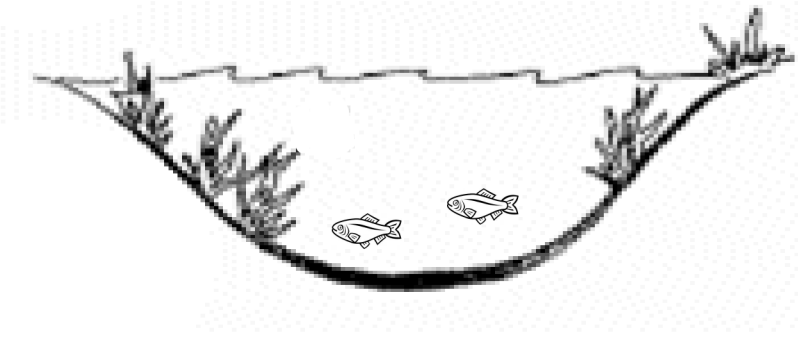
LAKE TYPES:

The following three diagrams show a progression from a newly formed lake to one that has filled in over time. Biomass increases!

Oligotrophic:

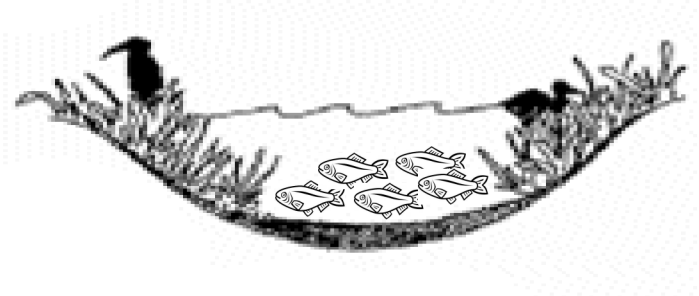
depth:	age:	water clarity:	biomass:
deep	young	clear	very low

Mesotrophic:



depth:	age:	water clarity:	biomass:
medium	medium	medium	medium

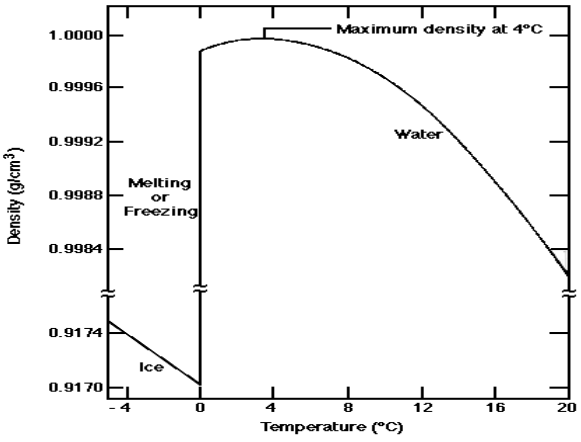
Eutrophic:



depth:	age:	water clarity:	biomass:
shallow	older	not clear	much higher

LAKE DYNAMICS:

Look carefully at the axis on this graph:



Density of water (and ice) as a function of temperature. Note maximum density of water at 4°C. (Data from Pauling 1953 and Hutchinson 1957: 204.)

At what temperature does the change of state between solid and liquid take place? What happens to the density at this point?

Change of state occurs at 0 °C, at which point the density drops 10% as ice forms.

What is the name given to the unusual behaviour density temperature behaviour of water in the liquid versus the solid state?

The anomalous behaviour of water describes this drop in density, usually solid state is more dense than liquid state.

At what temperature is water the most dense?

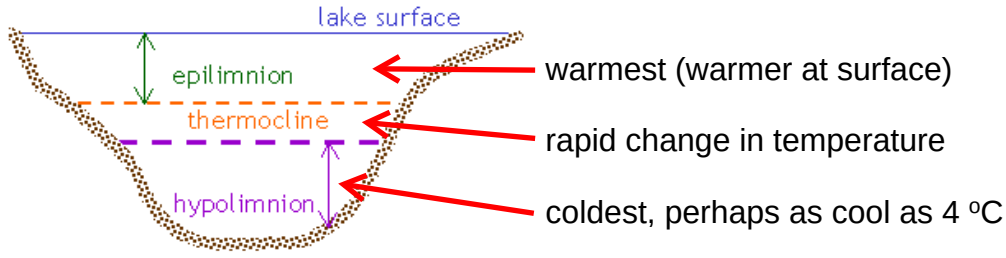
Maximun density occurs at 4 °C, below this, ice crystals begin to form.

What does this mean with respect to the stratification of water in a larger body of water?

4 °C water will sink to the bottom of a lake

Consider this diagram of a lake in early summer. Label:

- water that is the warmest
- water at 4 °C
- water that changes temperature quickly with depth



In order for turnover to occur (surface and bottom water freely mixes, what must happen? What time of the year does this happen

Turnover will occur when water is the same temperature from top to bottom. This happens once in the spring and again in the fall. Trapped gases etc can escape from the bottom of the lake at this time.

ABIOTIC REQUIREMENTS FOR LIFE:

What is the name of the process by which solar energy is trapped by plants? Write the balanced chemical equation for the overall process including an energy term?

PHOTOSYNTHSIS carbon dioxide from the air (0.04 % - plants are amazing)

$6CO_2(g) + 6H_2O(l) + \text{sunlight} \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$

What is the name of the process by which all most all eukaryotic cells access chemical energy? Write the balanced chemical equation for the overall process including an energy term?

CELLULAR RESPIRATION

$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) + \text{energy (ADP} \longrightarrow \text{ATP)}$

What are the sources of free CO_2 in lake water?

MIXING WITH AIR
rain water
cellular respiration

What consumes free CO_2 in lake water?

photosynthesis
reactions with bedrock - not likely to occur here

What could happen if CO_2 concentrations becomes higher than an acceptable range

CO_2 reacts with water to from a weak acid H_2CO_3 (carbonic acid)
Diffusion into organisms will stress natural CO_2 buffering mechanisms. If buffering is exhausted, pH will lower to the point that cell damage and possible death occurs.

What are the sources of dissolved O_2 in lake water?

MIXING WITH AIR
photosynthesis of aquatic plants

What can remove dissolved oxygen from lake water?

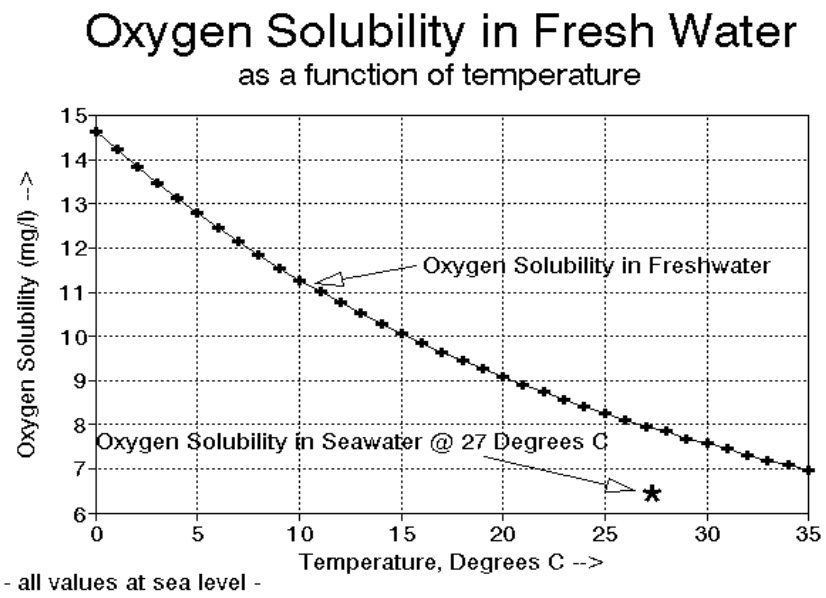
Consumption through cellular respiration in both animals and plants.
Increase in temperature will cause oxygen to leave water - see next page

What could happen if dissolved oxygen levels becomes lower than an acceptable range?

Animals and plants can suffer or die due to hypoxic environment. Algae blooms produce oxygen by day (good) but consume oxygen at night (bad) and frequently lower O_2 levels to the point that mass die offs occur.

What does it mean when water is said to be saturated with dissolved oxygen?

Oxygen spontaneously dissolves in water, but only up to a point. At the saturation point, no more oxygen will spontaneously dissolve. The saturation point represents the maximum concentration for dissolved oxygen. Temperature dependent.



Given the above relationship, why are fish, such as Carp, that can live in low oxygen levels often found warm shallow water?

Carp are adapted to low oxygen levels found in warmer water.

Why are fish such as Trout, that require relatively high levels of oxygen often found only in deep waters during the warmer months of summer?

The colder bottom waters maintain a higher concentration of dissolved oxygen. Trout are a high oxygen demand fish.

What are some of the uses of the essential mineral calcium?

Production of bone (endoskeleton) and carapace (exoskeleton)
Required for nerve function and many cellular processes.

Why would a crayfish have greater difficulty with low calcium levels than a minnow?

Crayfish periodically shed there carapace (exoskeleton) in order to grow. It becomes difficult for a crayfish to find enough calcium to build the replacement exoskeleton.

Why is the ground and lake water in the Owen Sound area particularly rich in calcium and magnesium (i.e. water hardness is very high in this area)?

Limestone and dolostone bedrock is slightly soluble and produces abundant Ca^{2+} and Mg^{2+} (limestone = $CaCO_3$, dolostone = $CaMg(CO_3)_2$

What are the sources of the nutrients nitrogen (ammonia and nitrate) and phosphorus (phosphate)

Living organisms in the food chain are the primary source of both nutrients. Animal waste contain NH_3 Phosphate can have mineral sources.
Other Nitrogen Sources - some plants that can fix nitrogen (actually bacteria housed in plant root nodules), also lightening converts N_2 to NO_x which converts to nitrate.

What effect does low levels of these nutrients have on an aquatic ecosystem?

Low levels of either nutrient is a serious stress. Nitrogen is required for all protein synthesis. Both nutrients are required for DNA synthesis

What does pH stand for, what is the mathematical relationship? what does this mean with respect to a pH change of one pH unit?

$pH = - \log[H^{1+}]$ pH is a way of expressing H^{1+} concentration in a way that deals with extremely large ranges in concentration - one unit is a 10x change

What is the pH of neutral water?

Neutral water is pH = 7

What would be a healthy pH range for an aquatic ecosystem?

A pH range between 6 and 8 is considered to be healthy. pH as low as 5 can be tolerated, pH below 5 is very difficult to tolerate.

BIOTIC REQUIREMENTS FOR LIFE:

Where does the energy requirements for both terrestrial and aquatic ecosystems ultimately come from?

The sun is the primary energy source for the vast majority of all ecosystems on earth.

When energy is transferred up the food chain (web), what is the approximate percentage of the energy is available for use to the next trophic level? What are some reasons for this?

Approximately 10% of energy is transferred up the food chain. Energy is lost because energy is used by the plant or animal to survive and the digestive/absorption process is not highly efficient. (The energy loss is chemical potential energy in the food chain ending up as heat rather than be passed on)

What organisms are at the bottom of the food chain (web) in an aquatic ecosystem?

Phytoplankton and Plants. Phytoplankton are microscopic organisms that are capable of photosynthesis

Give an example of as long as possible of a food chain (web) in an aquatic ecosystem. List the trophic level for each entry in your food chain.

Trophic Level ⟶	1st	2nd	3rd	4th
	Phytoplankton	Aquatic Macroinvertbrate	Larger Aquatic Macroinvertebrate	Small Fish	Big Fish

What organisms or stages of life are most affected by poor water quality (i.e. reduced pH due to acid rain)? Why is this so?

Small single cell organism are most strongly affected because they are unable to protect themselves from their external environment - to small to avoid diffusion. Fish eggs, frog eggs are very vulnerable for similar reasons.

What effect does this have on the rest of the food chain (food web)?

Small single cell organisms such as phytoplankton are at the bottom of the food chain, there removal will reduce or eliminate the entire food chain.

What visual evidence "clearly" indicates at there is a problem in Nellie Lake? How does this compare with Murray Lake

The clear water of Nellie Lake indicates the absence of phytoplankton and other single cell life. The water in Murray Lake is difficult to see through because of the presence of the above. Dirty looking water is alive, clean water is dead.

Why are beaver and humans not vulnerable to the reduce pH present in Nellie Lake?

Large animals are much less vulnerable because they are better able to regulate their internal environment. Water that is drunk can be easily neutralised by natural buffering processes. Diffusion is no longer an issue.

ACID RAIN:

What is the source of natural acid rain? What is the name and formula of the acid that forms from this natural source? What is the chemical equation for its formation.

Carbon dioxide from the air dissolves in rain water and produces a natural acid

$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$

Where and what is the most significant source of acid rain in this locality?

Sulphur dioxide formed from the burning of coal use for nickel refining in Sudbury is the historic source of acid rain in this area.

What is the name and formula of this acid that forms from this pollutant? What are the chemical equations for its formation?

$SO_2(g) + 1/2O_2(g) \longrightarrow SO_3(g)$

$SO_3(g) + H_2O(l) \longrightarrow H_2SO_4(aq)$ Sulphuric Acid

By using a taller smoke stack, Sudbury has been able to reduce the local impact!

Where else are significant quantities of sulphur dioxide produced?

Where ever coal is burned, SO2 is a bi-product. This includes coal burning hydro plants and metal refining processes in Ontario and the States.

What is the second most significant source of acid rain from human activity? What is the name and formula of this acid that forms from this pollutant? What are the chemical equations for its formation?

Internal combustion engine exhaust produces NO_x (NO and NO_2), both of which combine with oxygen and water to form nitric acid (HNO_3)

What is meant by buffering capacity in water with respect to acid rain?

Minerals in water are able to react with acid and neutralize acid. The type and concentration of minerals will determine how great the buffering capacity of the water will be.

What is the chemical reaction for the natural buffering that occurs in the Owen Sound area? How is this related to the bed rock in that area?

$H_2SO_4 + CaCO_3 \longrightarrow CaSO_4 + H_2CO_3$ weak natural acid

$HNO_3 + CaCO_3 \longrightarrow Ca(NO_3)_2 + H_2CO_3$

How can low pH levels in lake water affect the levels of other potentially toxic substances? Give a specific example.

Low pH can change the solubility of various metals found in the bedrock. In the Killarney area, the bedrock is rich in traces of aluminum. Aluminum is normally insoluble, however low enough pH will make it slightly soluble. The accumulation in the water in Nellie lake is twice what is considered to be safe for drinking (on a long term basis). It contributes to the blue colour of the water, particularly evident if you are under the surface looking upwards.

Nellie Lake Data 2016

Site Location:	Date:

Site Description:	Water Surface Temperature
	pH:
-	secchi depth:

alkalinity	_____ mL(tt) x 1.0009 / _____ L(sv) = _____ p.p.m. $CaCO_3$	
	Nellie: _____ p.p.m. Bognor: _____ p.p.m. Murray: _____ p.p.m.	
dissolved cxygen	_____ mL(tt) x 0.0992 / _____ L(sv) = _____ p.p.m. CO_2	
	surface (1 m) _____ mL(tt) _____ p.p.m. O_2	bottom (___ m) _____ mL(tt) _____ p.p.m. O_2
total hardness	_____ p.p.m. $CaCO_3$	
	Nellie: _____ p.p.m. Bognor: _____ p.p.m. Murray: _____ p.p.m.	
*titrant volume in mL / sample volume in L = p.p.m. (stoichiometric simplification!!)		

Aquatic Macroinvertebrate Study

Result of Trent Biotic Index:_____

Nellie Lake Data 2016

Site Location:	Date:

Site Description:	Water Surface Temperature
	pH:
-	secchi depth:

alkalinity	_____ mL(tt) x 1.0009 / _____ L(sv) = _____ p.p.m. $CaCO_3$	
	Nellie: _____ p.p.m. Bognor: _____ p.p.m. Murray: _____ p.p.m.	
dissolved cxygen	_____ mL(tt) x 0.0992 / _____ L(sv) = _____ p.p.m. CO_2	
	surface (1 m) _____ mL(tt) _____ p.p.m. O_2	bottom (___ m) _____ mL(tt) _____ p.p.m. O_2
total hardness	_____ p.p.m. $CaCO_3$	
	Nellie: _____ p.p.m. Bognor: _____ p.p.m. Murray: _____ p.p.m.	
*titrant volume in mL / sample volume in L = p.p.m. (stoichiometric simplification!!)		

Aquatic Macroinvertebrate Study

Result of Trent Biotic Index:_____

Temperature Profile Study (Nellie Lake):

Temp. (°C)	Resist. (Ω)
0.5	35.7
1.0	34.8
1.5	33.7
2.0	32.9
2.5	32.1
3.0	31.2
3.5	30.5
4.0	29.7
4.5	29.0
5.0	28.4
5.5	27.7
6.0	27.1
6.5	26.3
7.0	25.7
7.5	25.1
8.0	24.3
8.5	23.7
9.0	23.1
9.5	22.5
10.0	21.9
10.5	21.3
11.0	20.7
11.5	20.1
12.0	19.6
12.5	19.1
13.0	18.7
13.5	18.3
14.0	17.8
14.5	17.3
15.0	16.9
15.5	16.5
16.0	16.1
16.5	15.7
17.0	15.3
17.5	15.0
18.0	14.6
18.5	14.2
19.0	13.9
19.5	13.5
20.0	13.1

Depth (m)	Resist. (Ω)	Temp. (°C)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

Depth (m)	Resist. (Ω)	Temp. (°C)
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		

Trent Biotic Index

Biological Indicator Groups	***Biodiversity***					
		0-1	***2-5***	***6-10***	***11-15***	***16 +***
Stonefly nymphs present	More than one species One species only	-- --	7 6	8 7	9 8	10 9
Mayfly nymphs present	More than one species One species only	-- --	6 5	7 6	8 7	9 8
Caddisfly larvae present	More than one species One species only	-- 4	5 4	6 5	7 6	8 7
Scuds present	All above species absent	3	4	5	6	7
Isopoda present	All above species absent	2	3	4	5	6
Midge larvae present	All above species absent	1	2	3	4	--
All above species absent	Some worms that require no oxygen present.	0	1	2	--	--

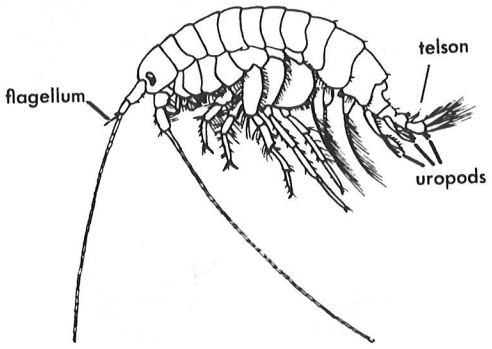
The Trent Biotic Index is a tool used to determine the general health of a river ecosystem. If the river scores 7-10 it is healthy. Rivers that score 4-7 should concern us enough to take a closer look for possible sources of pollution. Rivers scoring 0-4 are in serious trouble.

Trent Biotic Index

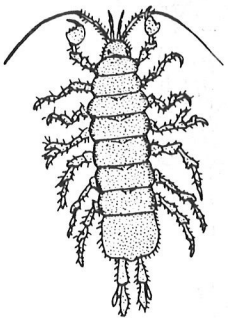
Biological Indicator Groups	***Biodiversity***					
		0-1	***2-5***	***6-10***	***11-15***	***16 +***
Stonefly nymphs present	More than one species One species only	-- --	7 6	8 7	9 8	10 9
Mayfly nymphs present	More than one species One species only	-- --	6 5	7 6	8 7	9 8
Caddisfly larvae present	More than one species One species only	-- 4	5 4	6 5	7 6	8 7
Scuds present	All above species absent	3	4	5	6	7
Isopoda present	All above species absent	2	3	4	5	6
Midge larvae present	All above species absent	1	2	3	4	--
All above species absent	Some worms that require no oxygen present.	0	1	2	--	--

The Trent Biotic Index is a tool used to determine the general health of a river ecosystem. If the river scores 7-10 it is healthy. Rivers that score 4-7 should concern us enough to take a closer look for possible sources of pollution. Rivers scoring 0-4 are in serious trouble.

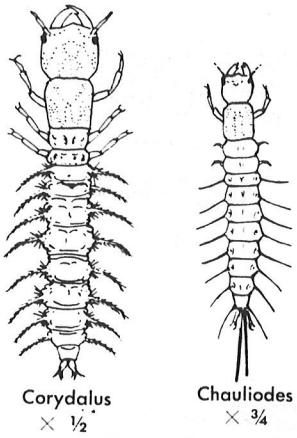
AQUATIC MACROINVERTEBRATES (WEE BEASTIES)



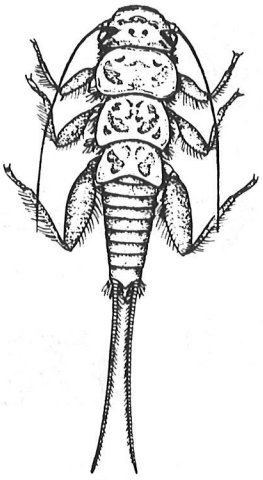
Scud
(flattened sideways)

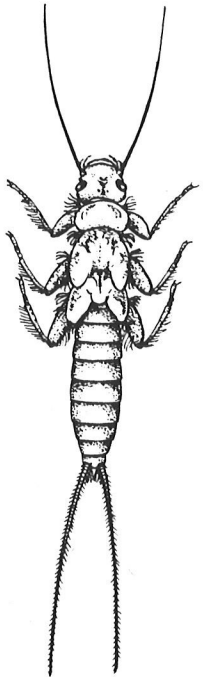


Isopod
(flattened like a pill bug)

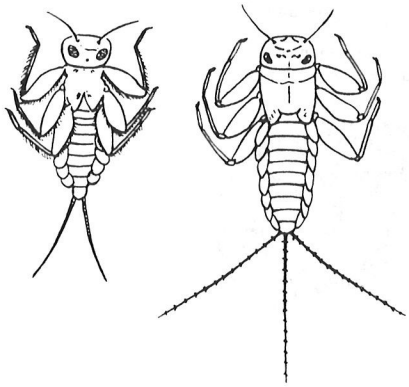


Megaloptera - Alder and Dobson Fly *can be beetle larva.

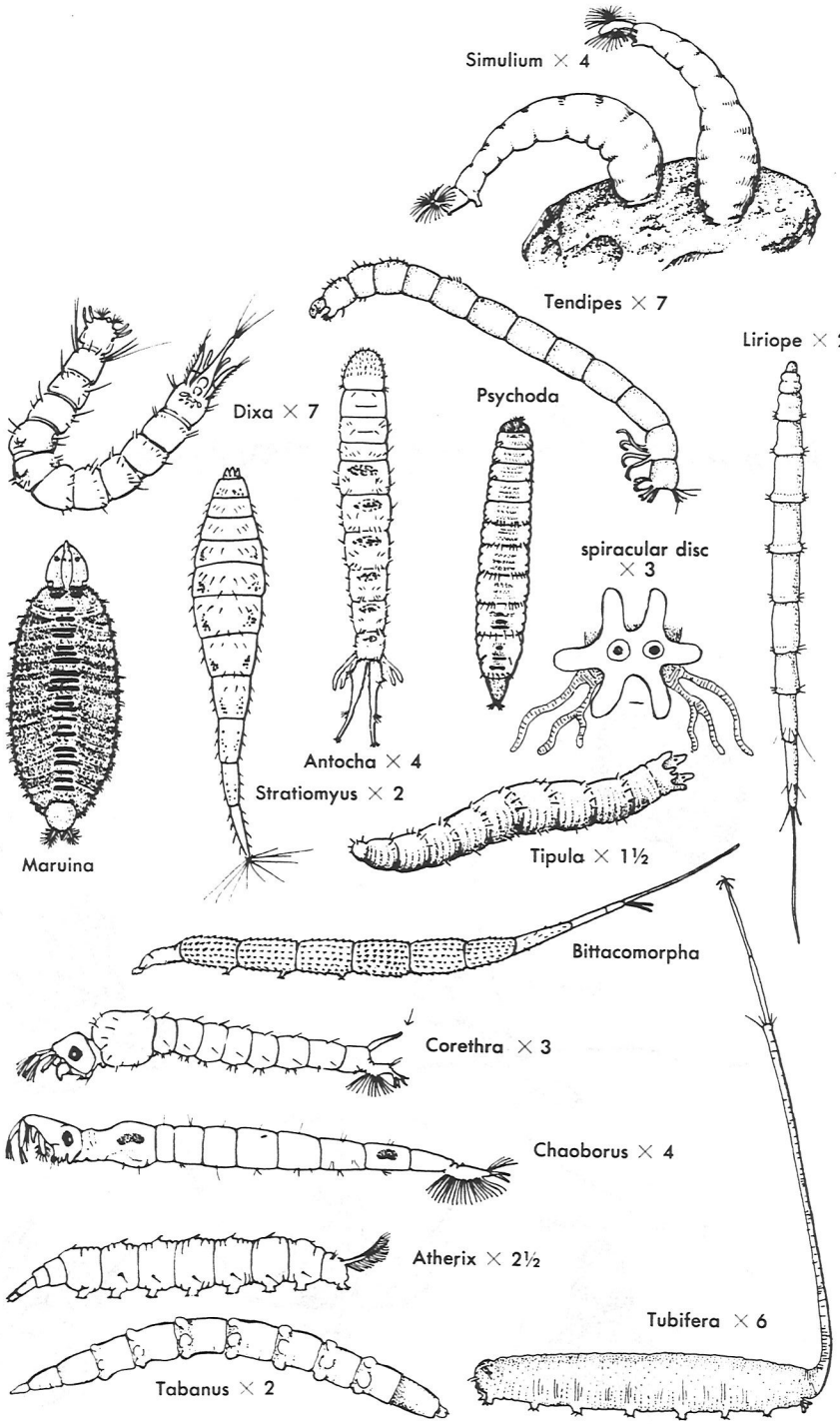




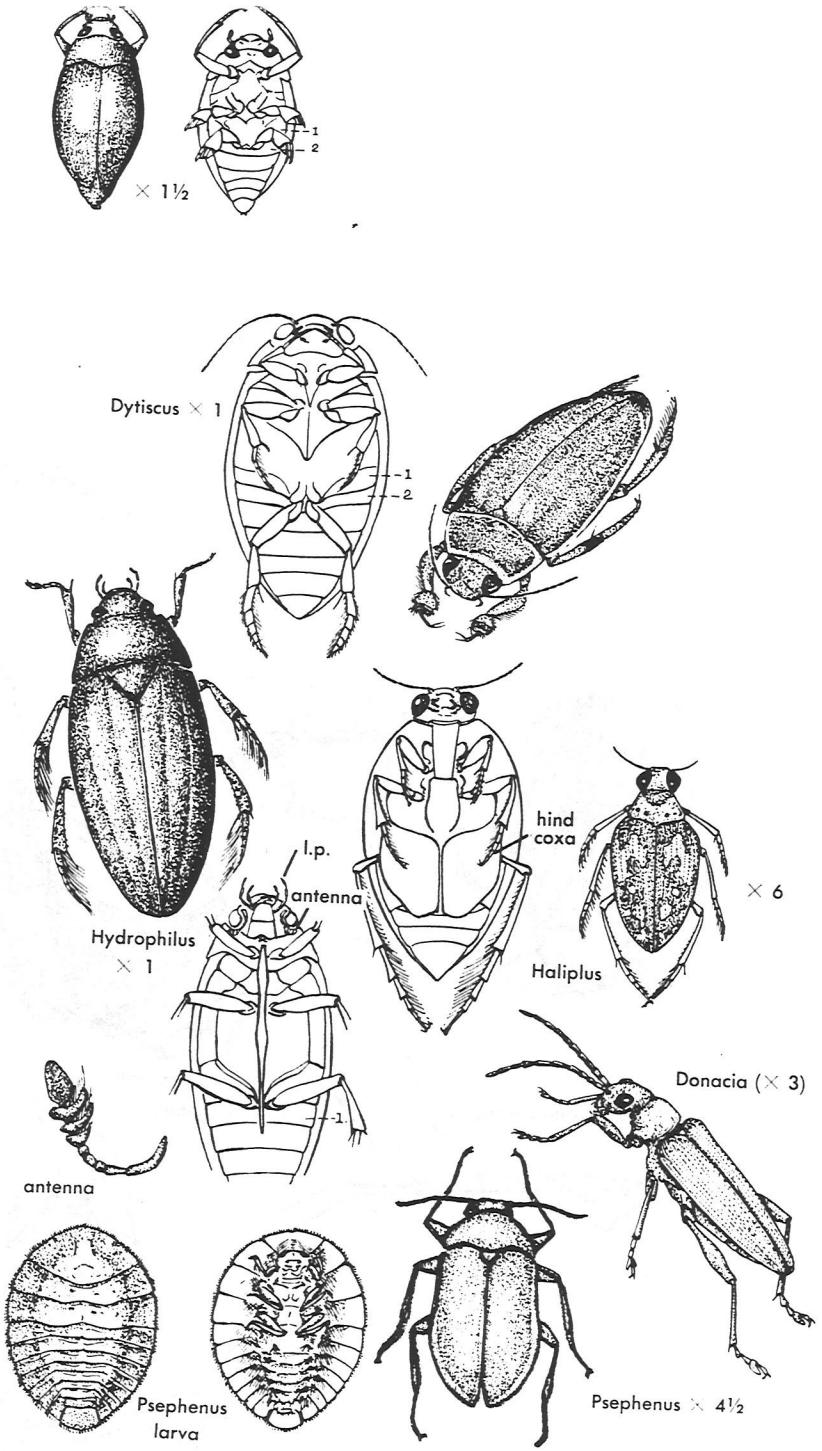
Plecoptera - Stone flies
(2 tail filaments)
(2 claws on each leg)



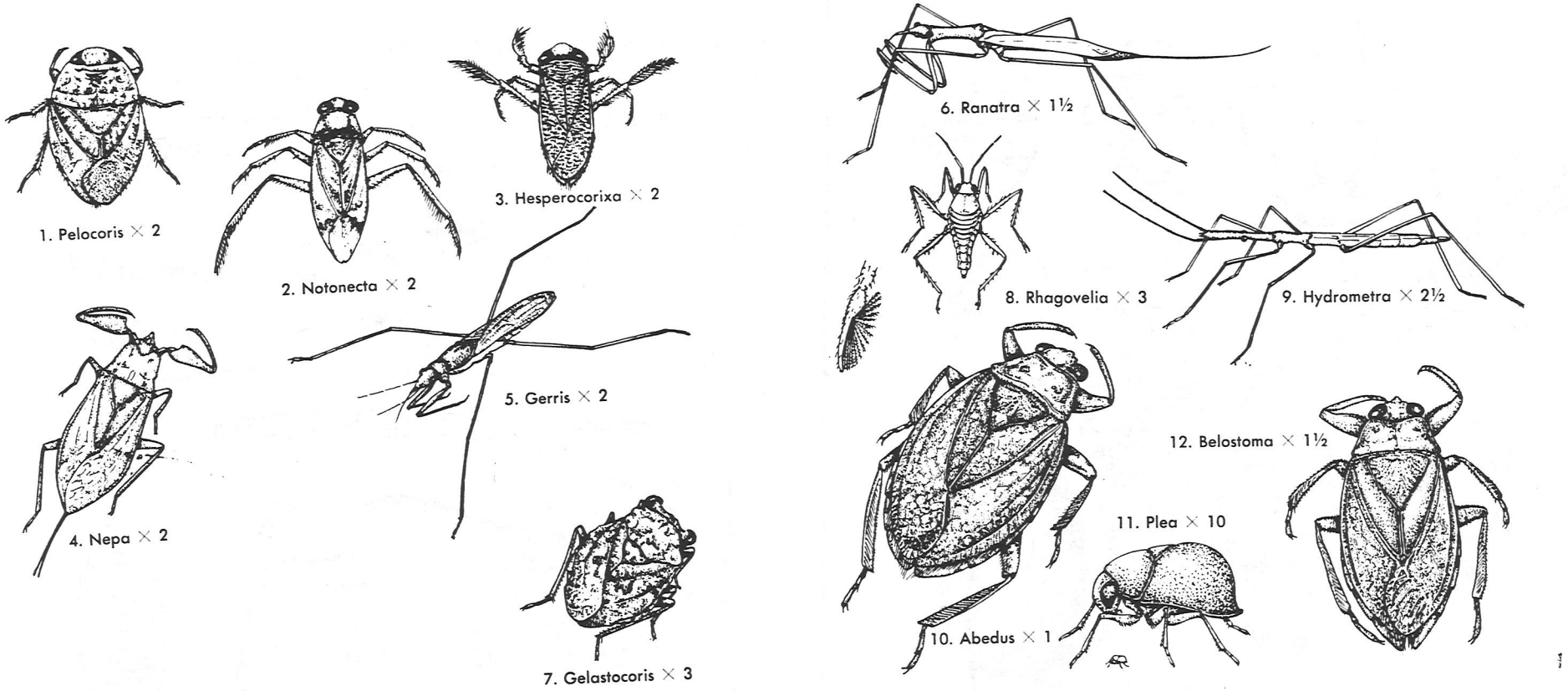
Ephemeroptera - Mayflies
(usually 3 tail filaments)
(1 claw on each leg)



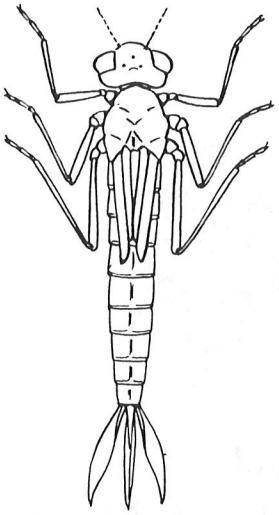
Diptera - Flies (often very small)



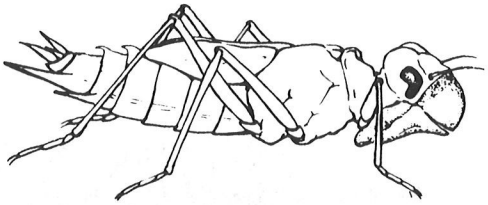
Coleoptera - Beetles (these are ad[illegible]s)
(chewing mouth parts)

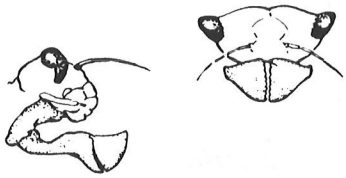


Hemiptera - True Bugs (sucking mouth parts)

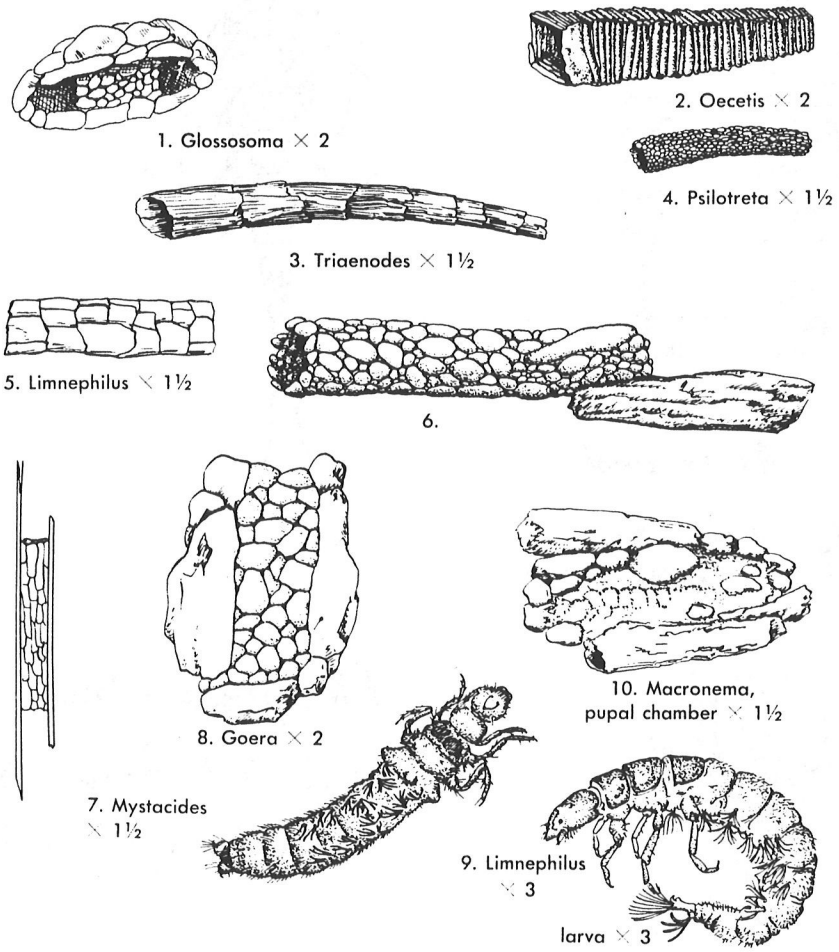


Zygoptera - Damselfly





Anisoptera - Dragonfly



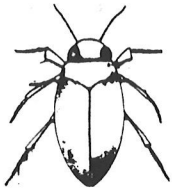
Trichoptera - Caddisfly
(hooks on the tails)
(live in cases)

Key to the Common Orders of Stream Insects

1A. Insect inside a case or structure made of leaves, twigs or stones: **Caddisfly** larvae (Trichoptera).

1B. Insect not inside a case or structure: Go to 2.

2A. Front wings form a leathery or hard cover over the entire back on the insect. Abdominal segments not visible from above: Adult **Water bugs** (Hemiptera) or **Beetles** (Coleoptera).

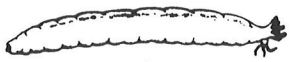


2B. Wings don't cover the entire back of the insect, **or** wings absent: Go to 3.

3A. No jointed legs on the specimen: Go to 4.

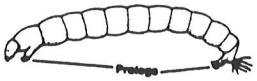
3B. Specimen with jointed legs on thorax: Go to 6.

4A. Head capsule absent, body maggot-like: Larvae of **True Flies** (Diptera).



4B. Head capsule present; Go to 5.

5A. Rear end of body has long hairs, gills, breathing tubes or a combination of these characters: Larvae of **True Flies** (Diptera).

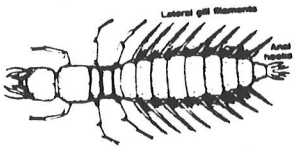


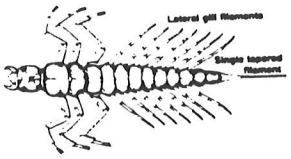
5B. Rear end of body is simple without long hairs, gills, breathing tubes or a combination of these characters: **Beetle** larvae (Coleoptera).

6A. Specimen without wing pads on its thorax, **and** without spines or long gill filaments on the abdominal segments: **Caddisfly** larvae (Trichoptera).

6B. Specimen with wing pads **or** if wing pads absent, with spines, or long gill filaments on their abdomen: Go to 7.

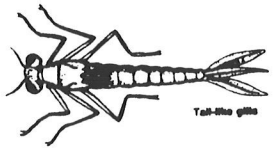
7A. Thoracic segments without wing pads. Most abdominal segments with lateral gill filaments as long as the thoracic legs: Usually larvae of **Alderfies** or **Hellgrammites** (Neuroptera), can be **Beetle** larvae (Coleoptera).

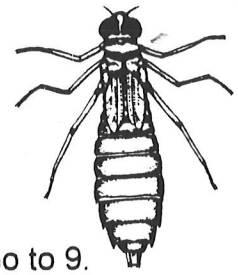




7B. Thorax with wing pads: Go to 8.

8A. No filaments or gills on abdominal segments. End of abdomen bare or with paddlelike gills: **Dragonfly** or **Damselfly** nymphs (Odonata).





8B. Two or three long filaments on the end of the abdomen: Go to 9.

9A. Usually three long filaments on end of abdomen. Abdominal segments with gills: **Mayfly** nymphs (Ephemeroptera).

9B. Usually two long filaments on end of abdomen. Abdominal segments without gills: **Stonefly** nymphs (Plecoptera).