Water facts 2

GOVERNMENT OF WESTERN AUSTRALIA
WATER AND RIVERS COMMISSION SEPTEMBER 1996

Macroinvertebrates & Water Quality

Many water quality investigators are extending their water monitoring to include a study of aquatic invertebrates. Although on its own invertebrate monitoring can not give an exact picture of the health of the waterway, used with other biological assessment and with the physical and chemical parameters already measured, it can contribute to a comprehensive look at water quality.

Streams, rivers, wetlands, and lakes are homes for many small animals called macroinvertebrates; mainly insects, crustaceans, and molluscs. These animals live in the water for all or most of their lives, so their survival is closely linked to the water quality. In turn, the survival of larger animals like fish is dependent on macroinvertebrates as a source of food.

Coodanup Senior High School students collecting macroinvertebrates.

Macroinvertebrates are sensitive to different chemical and physical conditions. If there is a change in water quality, perhaps because of a pollutant entering the water, or a change in the flow downstream of a dam, then the macroinvertebrate community will also change. Because they are monitoring the water all their lives, the diversity and abundance of macroinvertebrates can be used as an indication of the water's health. Different parts of the State and different types of waterbody will have their own characteristic fauna. Once you are familiar with the species in your local area you can use them as an additional way of monitoring the waterway you are studying.

Water Quality Monitoring

Physical and chemical measures of clarity and purity

- temperature
- acidity
- turbidity
- salinity
- dissolved oxygen
- nutrients

Biological measures of variety and numbers of plants and animals

- **macroinvertebrates**
- algae
- verge vegetation
- faecal coliform

What are Macroinvertebrates?

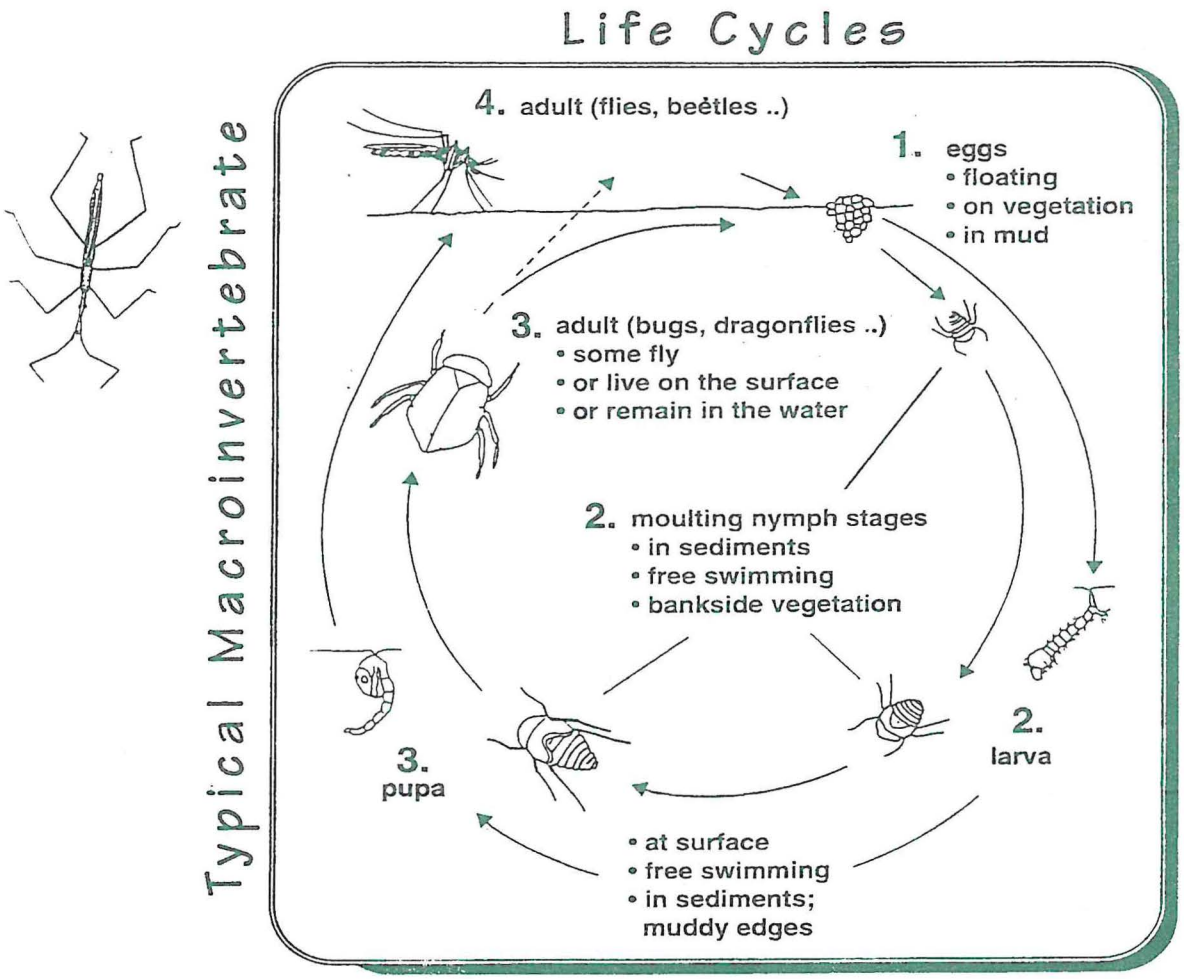
Invertebrates are animals without a backbone. Macroinvertebrates are big enough to be seen with the naked eye, though they can be very small. Animals retained on a 0.25mm mesh net are termed macroinvertebrates. Most that you find will probably be less than 2cm. Aquatic macroinvertebrates spend part or all of their life-cycle in water. Many people call them water bugs, but bugs are just one group within the macroinvertebrates. The main groups of aquatic macroinvertebrates are worms, snails, crustaceans (eg prawns and marron) and insects (such as mayflies, stoneflies, beetles, bugs and flies). For many of the insects only the larval stages are truly aquatic.

Because many streams in WA do not flow all year, the animals must be tolerant of a wide variation in physical and chemical conditions. Most have a phase within their life cycle that allows them to survive or escape extreme conditions. The temporary nature of many of our south-west creeks has led to a very characteristic macroinvertebrate fauna, more similar to those in arid areas of Australia than those in the wetter south-east or the tropics.

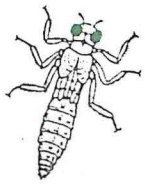
Life Cycles

Aquatic insects show both complete and incomplete metamorphosis with the larval stages quite different to the adult. For most, the aquatic juvenile stage occupies by far the major proportion of the life cycle and is largely a feeding machine, leaving for the adult only a brief reproductive role. Some dragonfly larvae take three years to mature. For lots of useful ideas about life cycle activities refer to the extensive Gould League materials.

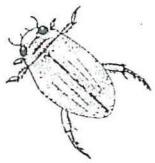
Note: The term nymph is rarely used in the world of science, and all juvenile stages are referred to as larvae. Many older texts will have nymph.



Predators



such as dragonfly and damselfly larvae, adult beetles and beetle larvae, some midge larvae, and some stonefly larvae



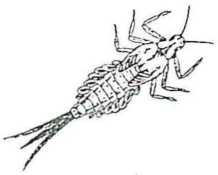
prey on smaller animals.

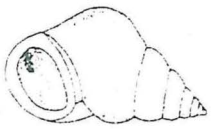
Predators can only occur if the stream supports enough of the smaller animals they feed on.

Filter feeders

such as mussels, some fly larvae and some midge larvae
take small particles of organic matter from the water.
Filter feeders need some algae and tiny fragments of plant and animal material in the water, but not so much they cannot filter it.

Scrapers



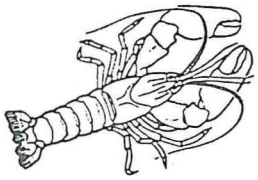


such as snails, limpets, and mayfly larvae

scrape fine algal growth off hard surfaces.

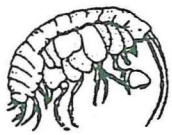
Scrapers need a film of algae growing on rocks and logs, but not so much that they cannot move over it.

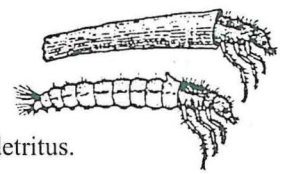
Collectors



such as worms, gilgies and marron
take small particles of organic matter from the sediment.
Collectors rely on microorganisms to break up larger plant material on the stream bed, and on having enough algae growing in the water for sufficient to die and fall to the bottom.

Shredders





such as amphipods and some caddisfly larvae

break up larger particles from leaves, bark, and other detritus.

Shredders need to have trees growing along streams, so that plant material falls into the water, and slow flowing streams so that the plant matter is not swept away.

The riparian environment

The most important feature in a stream zone is vegetation. Logs, branches, bark and leaves that fall into the water provide habitat for aquatic organisms. Leaf litter forms the basis of a food web for the macroinvertebrate animals which feed on this material, or on the bacteria and fungi which cause it to decay.

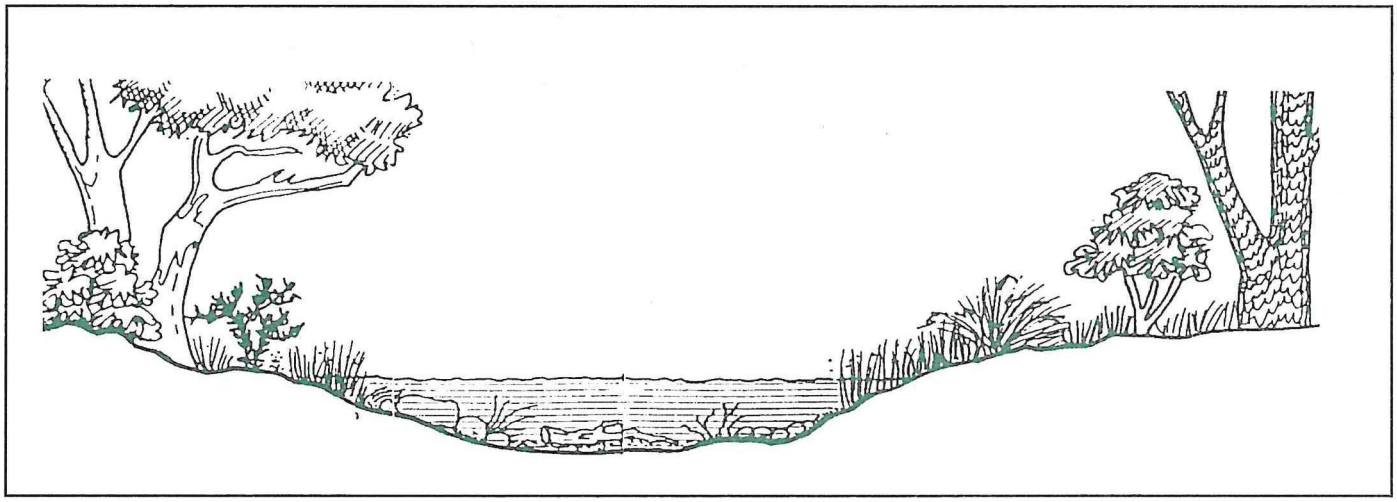
Aquatic plants, particularly reeds and sedges, vary the physical structure of the zone by providing a surface on which animals can live. As well, they balance the water flow, light availability and temperature around them. Aquatic animals have no control over body temperature. The dappling of light by native trees and shrubs beside the water can significantly modify water temperatures, reducing the extreme variations which make it difficult for animals to survive.

Trees, shrubs and reeds protect banks from erosion, help to control the water flow, and act as nutrient filters.

Grow your own macroinvertebrates.....

... by setting up an artificial home. A suitable structure can be made by putting rocks into a basket of wire mesh. Alternatively, make a cylinder of gutter guard and fill it with stones or onion bags. Put the "home" into at least 50cm of water and anchor it in place.

Little animals are carried into the basket by water currents. After a sufficient time to allow for colonisation (about four to six weeks) carefully remove the basket and rinse with river water over a bucket to collect the macroinvertebrates.



Stream profile of a 'typical' healthy river in the south west of Western Australia

Bonus for habitats

- Fencing and vegetation around waterways protects the bank.
- A well vegetated catchment reduces the salt and silt entering waterways.
- Native sedges, rushes and reeds protect the aquatic zone from pollutants, while trees and shrubs provide shade and shelter.
- Pools, gravel, rock crevices, and scour holes are part of the natural diversity of a dynamic water course and provide a range of habitats.

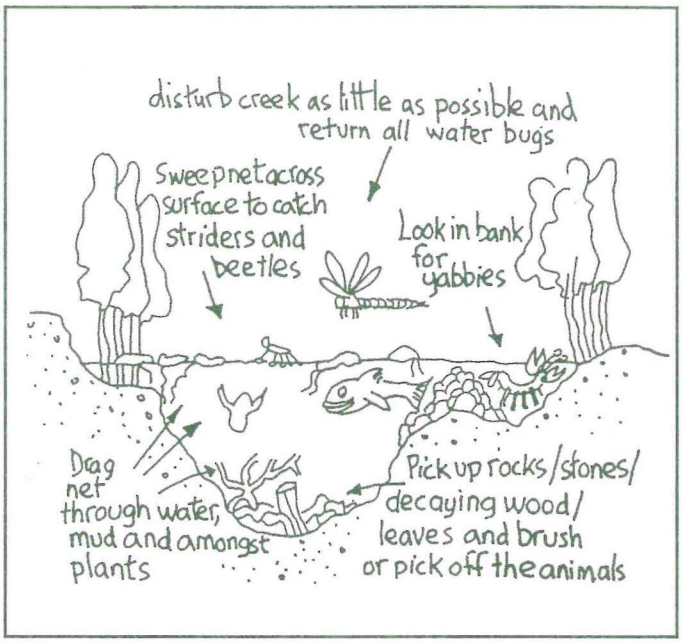
Habitat hazards

- Bare surface soils which are easily loosened by wind, water or stock result in harmful loads of sediment carried into water with surface runoff.
- Stock trampling the water's edge pollutes this critical area by removing protective vegetation, and damaging egg laying and larval growth sites.
- Overuse or incorrect use of fertilisers, herbicides and pesticides may result in these hazardous chemicals getting into waterways.
- Where possible, logs and branches that have fallen into the water should be left there as these provide valuable living space for macroinvertebrates.

How to sample for Macroinvertebrates

Macroinvertebrates live in many different places in the water. Some live on the water's surface, some in the water itself, others in sediment on the bottom or on submerged rocks, logs and leaf litter. Emergent vegetation at the water's edge is an important habitat zone. The idea is to sample as many of these different microhabitats as possible.

The simplest method is to use a long-handled dip net (you can make one using a coat hanger and a stocking, or order one from Ribbons of Blue). In flowing water place the flat side of the triangle horizontally on the bottom of the creek, with the net hanging downstream so that the current flows into it. Disturb the sediment and stones immediately upstream of the net by brushing or stirring with hands or feet so that animals are dislodged and swept into the net. The pattern of disturbance should be consistent at each site. In still water bounce the net backwards over the bottom to stir up sediment, then swoop it forward. Repeat, swirling the debris back into the net. Scrape the net up against emergent vegetation and submerged rocks and logs. Carefully rinse the net several times to let excess sediment pass through.



Observations

- Empty the contents of the net into a white tray with about 2cm of water.
- Keep the tray very still and carefully watch the water for movement. (A twig may turn out to be a caddisfly larva).
- Use tweezers, a dropper, a paintbrush, or a very fine sieve to collect any animals.
- Transfer them to a petri-dish or white ice-block tray for closer observation with a magnifying glass.

Records

- Count how many of each type of organism you see to get an idea of diversity and abundance.
- Keep a long-term record of the different types you see and relate to seasonal changes.
- Draw simple diagrams of each type.
- Use a key for identification.
- Study animals under a microscope.
- Do a pollution index assessment.
- Find out about life-cycles and habitat requirements of each kind of organism collected.

Reference collection

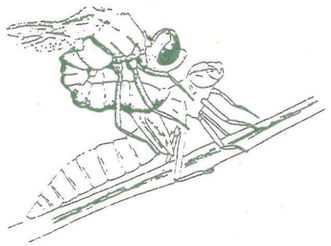
Some collectors preserve one of each type of macroinvertebrate in a solution of 70% alcohol and a bit of 5% glycerol - keeping each in a tiny sample bottle. These reference collections can then be identified, and become a valuable resource for future activities.

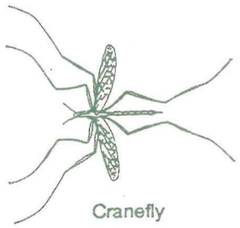
Minimise Disturbance

Remember that you will be disturbing animals and their homes when you look for invertebrates. Try to keep your impact to the minimum needed to study them. Return your invertebrates to the water as soon as your observations are over. Any tadpoles or fish should be quickly returned to the main waterbody - they don't tolerate this study as well as the invertebrates. Remember all native fish and amphibians are protected.

Freshwater Macroinvertebrates - Where they're commonly found

Though the Gilgie, Dragonfly and Water spider are noticeably "large", most macroinvertebrates are tiny to very small : 1 mm — 20 mm

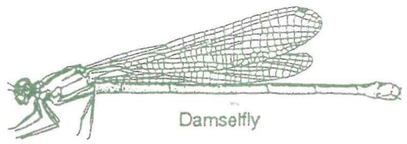

Emerging dragonfly


Cranefly

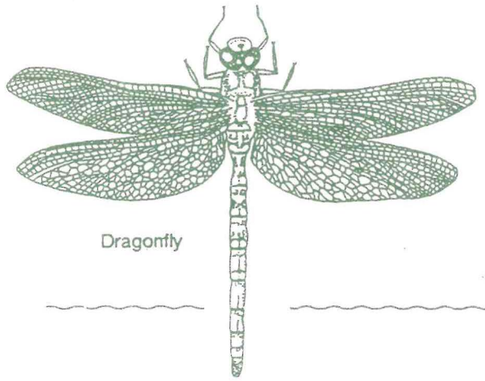

Marchfly larva


Biting midge


True midge


Damselfly

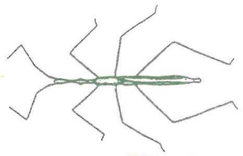
From the margins and surface to the air


Dragonfly


Caddisfly


Mosquito

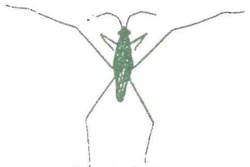

Mayfly

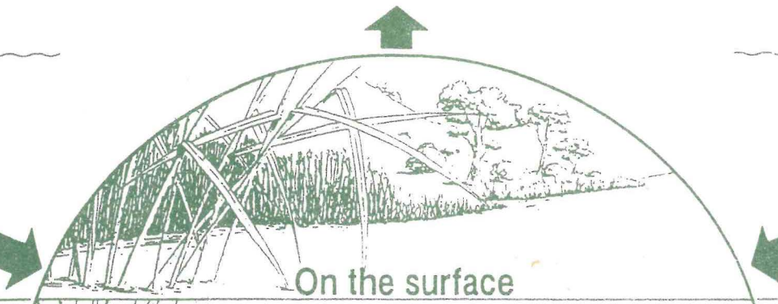

Water measurer


Fisher spider


Whirligig beetle

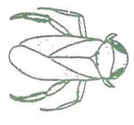

Springtail


Pond skater


On the surface

Beneath the surface

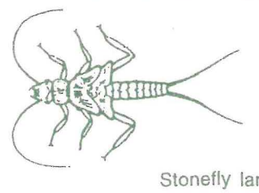

Back swimmer

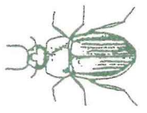

Water boatman

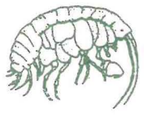

Water mite

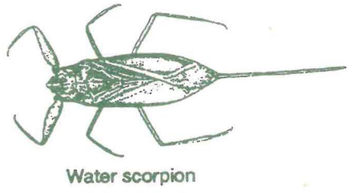

Mosquito larva


Mosquito pupa

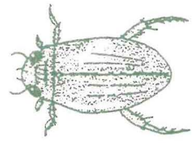

Stonefly larva


Water scavenger beetle

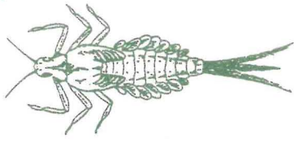

Amphipod

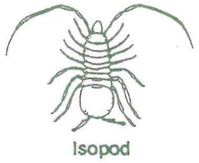

Water scorpion

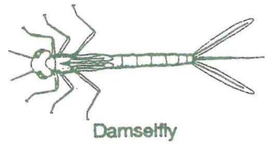

Caddisfly larva

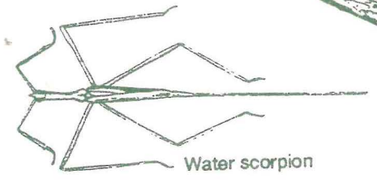

Water tiger


Water flea

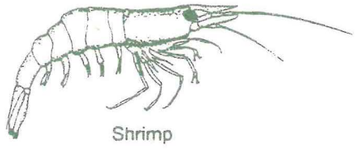

Mayfly larva


Isopod

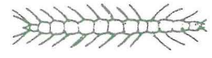

Damselfly

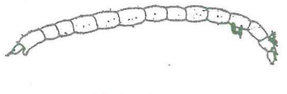

Water scorpion

Among the rocks, litter and sediments


Shrimp


Leech


Whirligig larva


Midge larva


Biting midge larva


Freshwater mussel


Hydra


Freshwater cockle

Bladder snail

Freshwater snail

Dragonfly larva

Flatworm

Gilgie

Freshwater worm

Cranefly larva

There are a number of different things that can pollute water and consequently affect macroinvertebrates. Pollutants include domestic waste and animal wastes (eg: from paddocks, dairies, horse stables and yards). These wastes can contribute to the development of toxins, bacteria, and viruses. They enter water courses through run off, or seep in through groundwater.

Fertilisers, pesticides and industrial wastes can also pollute waterways. High levels of nutrient in the form of nitrogen and phosphorus from fertilisers and waste water can activate excessive algal growth (algal blooms). The death and decay of these algae can produce toxins and stagnant conditions.

Pollutants can also be naturally occurring things that are in the wrong place. Salinity and turbidity of water can be exaggerated by poor catchment management.

Pollutants and Macroinvertebrates

Because their whole lives are spent in a water environment macroinvertebrates are very sensitive to any pollutants. The variety and numbers of freshwater macroinvertebrates can be a good indication of water quality.

For example, downstream of a sewage treatment plant discharge, where organic and nutrient enrichment is occurring, there will tend to be large numbers of individuals of a very few species. Snails and bloodworms might thrive in such conditions, but more sensitive animals such as mayflies are likely to be rare or absent.

The water conditions greatly influence the effect of a pollutant. For instance, a toxic chemical entering the water might only affect very sensitive animals like stoneflies if the water is flowing. But, in summer when there is little or no flow, all the animals are likely to be affected.

The response to pollutants can vary enormously. Most species of mayfly larvae don't respond well to sediment or organic pollutants, but some are quite tolerant. The larvae of dragonflies and damselflies can be quite tolerant of salinity, but are harmed by other pollutants. In general, pesticides in the water tend to reduce the diversity of macroinvertebrates, and eutrophic conditions (excess nutrient) will reduce overall diversity but increase the abundance of a few species.

Some animals can act as pollution indicator species because they respond to specific changes in the water conditions. Stoneflies are very sensitive and require low temperature, and high levels of dissolved oxygen. Red midge larvae (bloodworms) are very tolerant to low levels of dissolved oxygen. Mayflies scrape algae off hard surfaces so depend on having enough nutrient in the water to allow algae to grow, but not so much that algal growth is excessive. Some caddis fly larvae are shredders - they break up leaf litter for food, and as they also build their cases from leaf litter, they require vegetated streamlines with native trees overhanging the water.

Calculating a water condition index using macroinvertebrates

The following guide to water bugs is divided into three groups according to how sensitive they are to pollution; **sensitive, tolerant,** and **very tolerant.** Each animal has a number next to it (in square brackets). When you have completed the collection and identification, add the numbers together to get a water condition index for the part of the stream you've sampled. For the index **ONLY COUNT EACH TYPE OF ANIMAL ONCE.** The higher the total, the cleaner the water.

Using your index you can compare your sample site with other sites. You can compare the same site at different times of year, or with different sites on the same stream, or with different streams.

Remember that the water condition index is only a rough guide, and its accuracy depends on how well you do your sampling, and on the time of year. To make comparisons meaningful, it is important to use the same sampling technique at each site. Take the same number of samples and the same amount of care with each sample, and try to sample a variety of habitats. The presence of various freshwater invertebrates varies according to season and the nature of the waterbody, as well as the condition of the water. Spring is the best time of year to sample.

As a general guide, high diversity indicates better water conditions whereas high abundance of only a few species may indicate poorer conditions.

Useful references

Australian Freshwater Life by WD Williams, Macmillan 1980

Freshwater Invertebrates by Ralph Miller, Gould League of Victoria, 1983

Wetlands Wildlife Gould League

Ponding Activities by W Wallace, Gould League

Freshwater Life Gould League of WA

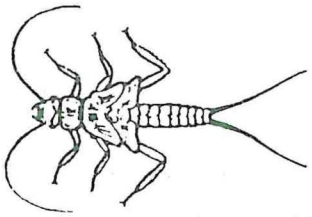
Survival Swamps and Streams Gould League

Environmental Awareness to Action Ribbons of Blue, Teacher's Manual.

A guide to wetland invertebrates of Southwestern Australia by Jenny Davis and Faye Christidis.

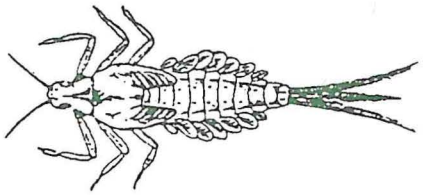
STONEFLY LARVAE [8]

*Stonefly larvae have two long tails, tubes of thread-like gills on their undersides, wing pads, antennae, and two claws on each foot. They are found among stones or plants in clear, cool, well oxygenated streams. **



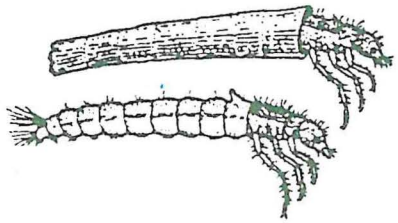
MAYFLY LARVAE [7]

Mayfly larvae have three long filaments at the end of their abdomen, with wing pads and lateral gills along the abdomen. They have short antennae, and a single claw on each foot. They are found under stones in fast flowing water or among plants in slow flowing water. +



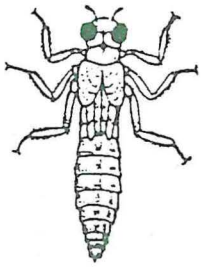
CADDISFLY LARVAE [6]

*These are worm-like insect larvae with three pairs of legs on the first three body segments. They are usually found in cases made from rolled leaves or hollow twigs, with only their head and legs protruding when they move. **



DRAGONFLY LARVAE [6]

*Dragonfly larvae are short, chunky predators with wing pads and internal gills. They are found on plants, among stones and leaf litter, or on the bottom. **

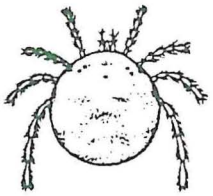


DAMSELFLY LARVAE [6]

*Damselfly larvae are more slender than dragonflies, have a distinct head section, and three gills on the tail tip. They are also found on plants, among stones and leaf litter, or on the bottom. **

WATER MITE [5]

*Water mites are only just visible. They have a flat disc-like body, and swim in openwater, among plants, or on the bottom in slowly flowing water. **



ARTWORK: * Gould League of WA

\+ Waterwatch SA

MACROINVERTEBRATES DATA SHEET

INVERTEBRATE	NUMBER FOUND	SENSITIVITY RATING
Sensitive		
Stonefly larvae		8
Mayfly larvae		7
Caddisfly larvae		6
Dragonfly larvae		6
Damselfly larvae		6
Water mites		5
Tolerant		
Gilgies or marron		4
Freshwater mussels		4
Beetle larvae		4
Beetles (Coleoptera)		3
Bugs (Hemiptera)		3
Water fleas		3
Freshwater shrimp		3
Amphipods		3
Snails		3
Flatworms		3
Leeches		3
Very Tolerant		
Fly larvae		2
Midge larvae		1
Aquatic earthworms		1
MACROINVERTEBRATE WATER CONDITION		

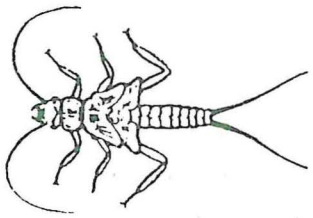
- *Count the number of each different type of macroinvertebrate found.*
- *If a macroinvertebrate is present, circle its sensitivity rating.*
- *At the end of your collecting session, add up the circled numbers to get the macroinvertebrate water condition index.*
- *Use the index to work out your stream quality rating from the table below.*

To make results comparable you must use the same collecting technique on all occasions.

Water Condition Index	Stream Quality Rating
19 or less	Poor
20-34	Fair
35-49	Good
50 or more	Excellent

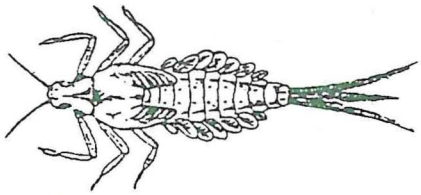
STONEFLY LARVAE [8]

*Stonefly larvae have two long tails, tubes of thread-like gills on their undersides, wing pads, antennae, and two claws on each foot. They are found among stones or plants in clear, cool, well oxygenated streams. **



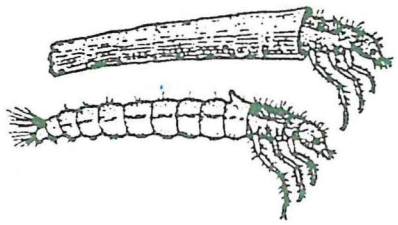
MAYFLY LARVAE [7]

Mayfly larvae have three long filaments at the end of their abdomen, with wing pads and lateral gills along the abdomen. They have short antennae, and a single claw on each foot. They are found under stones in fast flowing water or among plants in slow flowing water. +



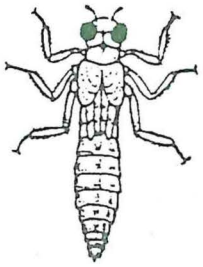
CADDISFLY LARVAE [6]

*These are worm-like insect larvae with three pairs of legs on the first three body segments. They are usually found in cases made from rolled leaves or hollow twigs, with only their head and legs protruding when they move. **



DRAGONFLY LARVAE [6]

*Dragonfly larvae are short, chunky predators with wing pads and internal gills. They are found on plants, among stones and leaf litter, or on the bottom. **

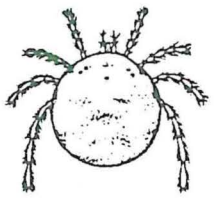


DAMSELFLY LARVAE [6]

*Damselfly larvae are more slender than dragonflies, have a distinct head section, and three gills on the tail tip. They are also found on plants, among stones and leaf litter, or on the bottom. **

WATER MITE [5]

*Water mites are only just visible. They have a flat disc-like body, and swim in openwater, among plants, or on the bottom in slowly flowing water. **

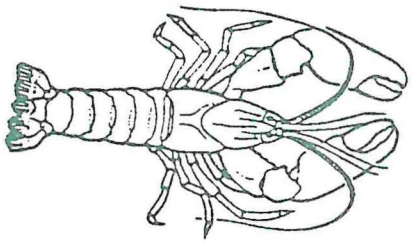


ARTWORK: * Gould League of WA

\+ Waterwatch SA

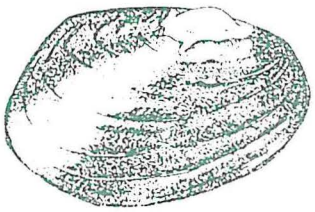
GILGIES AND MARRON [4]

*Have strong grasping claw-like forelegs. Marron grow up to 40cm. They are both found in burrows, among rocks on stream banks, and in holes on the bottom. **



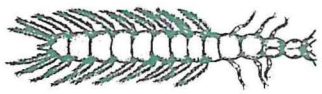
FRESHWATER MUSSEL [4]

Mussels are soft bodied animals enclosed in two hard, hinged shells. They can be found on stable sandy or muddy bottoms. +



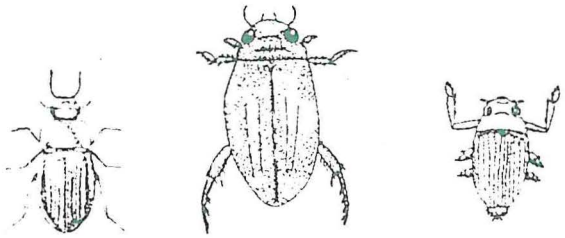
BEETLE LARVAE [4]

*Beetle larvae may be confused with other animals. They are segmented, have three distinct pairs of legs, are never found in cases, but have a wide variety of forms. They are very active, aggressive predators with large mouth parts, and are found in all habitats. **



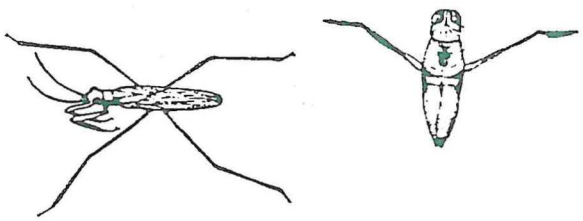
BEETLES (COLEOPTERA) [3]

Beetles have hard front wings folded side by side along the centre of the back. From above, they have a more oval shape than bugs. Beetles have biting mouthparts. They are found on plants, or swimming in or on the water at all levels. +



BUGS (HEMIPTERA) [3]

Bugs tend to be shield shaped when viewed from above. Their soft front wings are folded and overlap to leave a small triangle on the back, and they have sucking mouthparts. They are found among the aquatic plants on the water's surface, or swimming freely at all levels of slowly flowing water. Water boatmen and backstriders are bugs. +

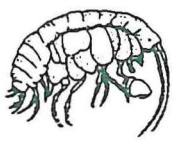


WATER FLEA (DAPHNIA) [3]

Water fleas are only just visible and can be very numerous. They are free swimming organisms +

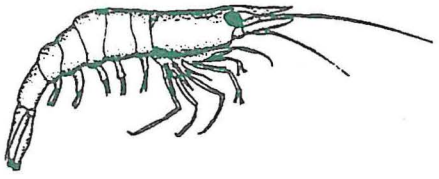
AMPHIPOD [3]

*Amphipods are small, narrow, free-swimming crustaceans found in a range of conditions.**



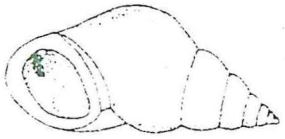
FRESHWATER SHRIMP [3]

*Shrimp are familiar small crustaceans with slender legs and claws - found among aquatic plants and loose stones. **



WATER SNAILS [3]

Aquatic snails are similar in form to land snails, but smaller. They are found on plants and on rocks +

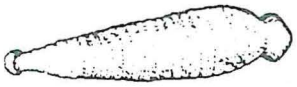


FLATWORMS (PLANARIA) [3]

Planaria are small flattened worm-like creatures with two distinctive eye spots. They move in a gliding fashion.+

LEECHES [3]

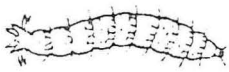
*Leeches are segmented worms with a sucker on one or both ends. They are found free swimming in the water, as well as on plants in water or on land, or on the bottom. They move in a looping manner. **



Very Tolerant Macroinvertebrates

FLY LARVAE [2]

*There are many types of fly larvae. They are worm-like creatures with no legs, or stumpy unjointed legs, and may have a sucker on the abdomen and a brush on the head. They occur in all sorts of aquatic habitats; swimming, on rocks, or on the bottom. **

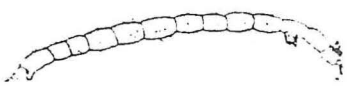


AQUATIC EARTHWORM [1]

These are segmented worms with rounded ends and no suckers. They can be opaque or flesh coloured, and many are red and called bloodworms. They often live in tubes in the sediment.+

MIDGE LARVAE [2]

Midge larvae are slender worm-like creatures, sometimes red, with no legs, or stumpy unjointed legs, and bristles. They are found in all sorts of aquatic habitats; swimming, on rocks, or on the bottom. +



For more information contact:

WATER AND RIVERS COMMISSION

Level 2, Hyatt Centre
3 Plain street
EAST PERTH WA 6004
Telephone: (08) 9278 0300
Facsimile: (08) 9278 0301
or your regional office

This Water Facts sheet is one in a series providing information on water issues of interest to the community. It has been produced in consultation with Ribbons of Blue. Revised and reprinted September 1997.

RIBBONS OF BLUE

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