SEMEP
SOUTH EASTERN MEDITERRANEAN SEA PROJECT

EXPERIMENTAL ENVIRONMENTAL INVESTIGATION
THE SEA AND THE SHORELINE

SUPPORTING INFORMATION

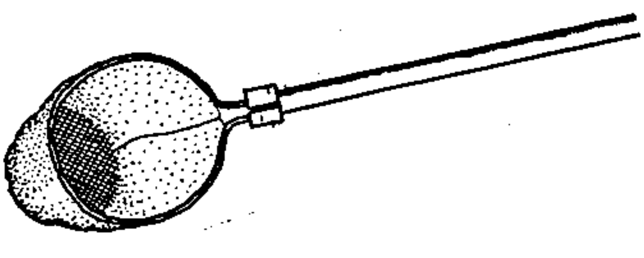
The instructions accompanying the worksheet describe experimental procedures for investigating the environment, either using tests in the laboratory, or carrying out investigations on the seashore. The instructions indicate what equipment and chemicals are required, but sometimes there is a need to improvise the equipment. The solutions required need to be prepared. And calculations need to be performed The purpose of this document is to assist in these areas.

Teacher may wish to give this document to the students so that they can use it in an appropriate manner. Alternatively, teachers may wish that equipment will be provided for the students; and teachers may prefer students to think out the calculation procedures for themselves. In the latter cases, this document is obviously meant as a reference for the teacher.

IMPROVISATION OF EQUIPMENT

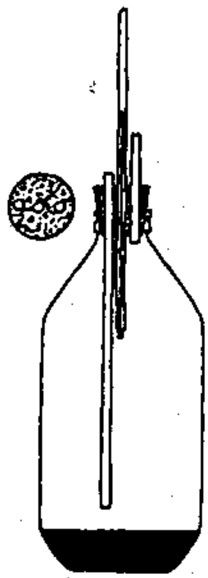
Making a Water net

In order to make a water net you need a double metal ring made of flat - iron (20 mm wide, 3 mm thick and 900 mm long). Fasten a cloth bag with poppers between the metal rings. The cloth should be coarse (e.g. canvas). Cut out the bottom and sew on a metal netting bottom. The net should have a diameter of approx. 200 mm and a mesh size of approximately 2 mm.



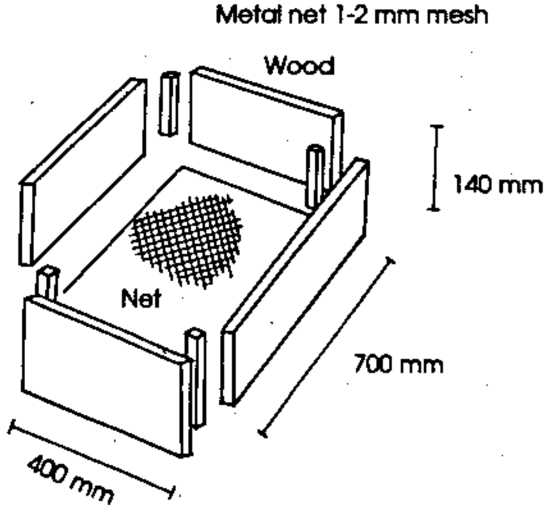
Making a Water Sampler

You can make a water sampler with a plastic bottle. Make three holes in the cork of the bottle: a tube for outgoing air, a tube for incoming water and one for a thermometer. In order to fill the bottle with water up to the bottom edge of the tube for outgoing air, place the top edge of the tube as close to the cork as possible. Place the thermometer so that you can read it without removing it. The most difficult part of making the water sampler is getting the right weight at the bottom of the bottle (over 1 kg in a one-dm^3 bottle). You need to attach the weight properly, for example with glue, so that it will remain in place even when the bottle is turned upside down to empty it.



Making a Sieve

A suitable rectangular sieve can be made by fixing a sheet of 1-2mm metal mesh to make the bottom of a wooden box. The sides can be made by piece of wood 14 cm wide, two being 70 cm in length and the other two, 40 cm. If the wood is not sufficiently thick to be nailed or screwed together, additional pieces of wood 2 cm square and 14 cm long can be fixed in each corner (see diagram).

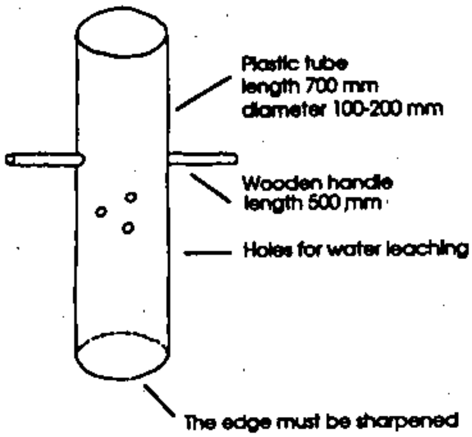


Making a Cylinder Sampler

Small samples can be obtained by taking an old tin can, making a few holes in the end to allow water to pass through. The cylinder is simply put into the sea bottom to be tested and pushed by standing on it.

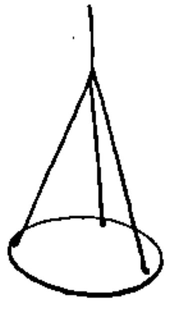
If the bottom is not hard, longer samples can be obtained by using a plastic drink bottle (1 dm^3) with the bottom cut off.

For bigger samples, a cylinder can be made by taking a length (about 70 cm) of plastic piping (10-20cm diameter). Drill a hole in the pipe about 20cm from one end just large enough to allow a broom handle to pass through. The broom handle needs to be approximately 50 cm in length. The edge of the pipe to be pushed into the bottom can be sharpened with the aid of a knife.



Visibility Disk

This is simply a white disk 25 cm in diameter. It can be made of plastic, metal or be ceramic (a plate). A plastic disk can be cut from a plastic bucket or other container. The plastic container is weighted by, for example, filling with sand. Fix the disk so as to be the lid of a plastic container that is 20-25 cm in diameter Using nylon rope with at least 3 strands twisted together, fix the strands separately to the edge of the disk using screws or clips, or to the plastci container underneath). Adjust the strands so that the disk is horizontal when the rope is held vertically. Tie knots in the rope at 1 metre intervals.



ADDITIONAL INFORMATION ON MOLLUSCS

GASTROPODA

Most gastropods have protective shells produced by the mantle. The soft part of the body is mainly composed of a foot which may produce a horny operculum for protective purposes when the animal is withdrawn into the shell. The head has a pair of sensory tentacles and two eyes.

FAMILY APORRHAIDAE

Shells thick-walled with an outer lip resembling a foot. Aperture closed by a small operculum.

Aporrhais pes-pelecani

Up to 45mm. Outer lip resembling pelican's foot. Shell yellow-brownish. Found buried in sand.

FAMILY CERITHIIDAE

Generally elongated with many whorls. Siphon canal short. Surface always sculptured. Operculum horny.

Cerithium vulgatum

Up to 55mm. Shell thick-walled with many whorls. Found on rocky shores.

Cerithium rupestre

Up to 20mm. Found on rocky shores.

Bittium reticulatum

Up to 10mm. Shell light to dark brown. Surface with very small bumps.

FAMILY LITTORINIDAE

Shells mostly small to medium; surface ornamented with spiral cross. Umbilicus general absent. Aperture closed by a horny operculum. Found on rocky shores.

Littorina neritoides

Up to 11mm. Dark colours (black-blue, brownish). On rocky shores.

FAMILY MURICIDAE

Whorls with varices or nodules ornamented with several projections. Operculum thick, horny.

Bolinus brandaris

Up to 95mm. Shell yellowish. Siphon canal long. Surface with long strong spines. (This mollusc was used by the early Phoenicans, Greeks and Romans to make a purple dye).

Hexaplex trunculus

Up to 95mm. Shell brown, grey or yellow. Surface striped with many swellings. Found on rocky shores.

Muricidea blainvillei

Up to 33mm. Shell brown, grey or yellow. Surface with many stripes and spines. Outer lip toothed. Aperture brightly coloured. Found on rocks.

Thais haemastoma

Up to 65 mm Shell grey with brown lines. Surface ribbed with small humps. Aperture brightly coloured (red-brown) outer lip toothed. Found on rocks.

Ocenebra aciculata

Up to 10mm. Shell yellow, light brown-greyish. Surface ribbed with samll bumps. Outer lip toothed. Siphon canal short. Beach collection.

FAMILY NASSIDAE

Shells globos to oval; spire high and pointed. Surface usually striated or reticulate. The animal have a characteristic forked projecting foot.

Nassa mutabilis

Up to 18mm. Shells grey to yellow-whitish with light brown lines.

Nassa gibbosa

Up to 21mm. Shell grey-pink with dark spots; white base; thick-walled.

Nassa neritea

Up to 8mm. Shell yellow-whitish with dark spots; white base; thick-walled. Aperture brown. Found on sand.

Nassa clathrata

Up to 23mm. Shells light brown to white. Whorls separated. Outer lip thickened, toothed.

Nassa incrassata

Up to 11mm. Shell white to yellow with brown lines. Outer lip thickened. Found on sand.

Nassa recticulata

Up to 11mm. Shell white to brown. Surface reticulate.

FAMILY PATELLIDAE

Shells are open, conical with the point directed forwards. Surface usually ribbed. They live on the rocky shores between tidal marks

Patella caerulea

Up to 45 mm. Shell whitish with an irregular edge. Pearly interior. Found on rocky shores.

Patella lusitanica

Up to 22mm. Ivory-white inside. brown stripes on the outside and dark rim on the edge. Found on rocks.

FAMILY PYRENIDAE

Shells with a small spire; body whorl large. Aperture like a narrow slit, closed by a small, horny operculum. Shells usually brightly coloured.

Pyrene scripta

Up to 12mm. Shell white to yellow. Aperture narrow, ouer lip toothed. Found on rocks

Pyrene rustica

Up to 17mm Shell yellow with white spots to white with red-brown flashes. Body whorl large; aperture narrow; outer lip toothed.

FAMILY TROCHIDAE

Shells small to medium, thick-walled; conical and spiral. Interior pearly. Operculum horny, multispiral.

Clanculus corallinus

Up to 10 mm. Coral red. Two teeth present on base of spindle. Found on rocks in shallow waters.

Monodonta turbinata

Up to 24mm. Yellow with dark (black or brown-red) dots in stripes. Tooth on base of spindle. Found on rocks in shallow waters.

Monodonta articulata

Up to 10mm. Grey with white-grey longitudinal stipes. Tooth on base of spindle. Found in shallow waters

Calliostoma zizyphinus

Up to 10 mm. Yellow and red with longitudinal stripes. Umbilicus absent. Beach collection.

Cantharidus striatus

Up to 8 mm. Red and white stripes. Umbilicus absent.

Gibbula adansoni

Up to 10mm. Reddish-brown with white markings. High cone shape with six humped whorls. On rocks and stones in shallow waters.

Gibbula divaricata

Up to 10mm. Shell greenish with red spots. Umbilicus absent. On rocks and under stones in shallow waters.

Gibbula Varia

Up to 10 mm. Shell whitish with brownish patches. Umbilicus present.

SCAPHOPODA

The mulluscs of the group have a tubular, usually white shell, open at both ends. The shell is tapering towards the apex and its surface is usually sculptured, but withour whorls. The animal has a conical digging foot. They live just beneath the surface of the sea bottom.

FAMILY DENTALIDAE

Shells strongly curved (like an elephant's tusk). Surface smooth or scuptured, usually exhibits longitudinal ribs.

Dentalium vulgare

Up to 36mm. Shell white, storngly curved. Surface with longitudinal ribs.

Dentalium dentale

Up to 25mm. Shell whitish in colour. Surface with high longitudinal ribs.

Dentalium rubescens

Up to 23mm. Shell whitish in colour. Surface with low longitudinal ribs, almost smooth. Beach collection.

LAMELLIBRANCHIATA

The bivalve mulluscs are protected by a double shell hinged together and closed by strong internal muscles. They lack a head and radular teeth, though some species have eyes on the edge of the body mantle.

FAMILY ARCIDAE

Shells vary in size. Mostly elongate, equivalved. Surface radially ribbed. Muscle impressions equal. Hinged with a long series of small teeth.

Arca noae

Up to 65mm. Shell brown with dark brown stripes.

Arca barbata

Up to 55mm. Shell light brown with dark brown stripes and short thick hairs. Valves inflated.

Arca lactea

Up to 10mm Shell similar to A.barbata but smaller, white and without hairs.

FAMILY CARDIIDAE

Shells mostly oval. Surface radially ribbed. Muscle impressions unequal. Hinge with two main teeth and two lateral (on each valve).

Cardium tuberculatum

Up to 46mm. Shell white to brown. Surface with about 22 ribs; small nodules present on larger specimens. Found on sandy shores.

Cardium echinatum

Up to 47mm. Shell usually white-yellow. Surface with about 20 ribs, ornamented with small truncated spines. Found in deep waters.

Cerastoderma edule

Up to 43mm Shell white, often with brown stripes. Surface with about 24 ribs. Shallow waters. Found on rocky shores.

Laevicardium oblongum

Up to 33mm Shell white and red-brown, elongate. Surface with many ribs. Found in deep waters.

FAMILY DONACIDAE

Shells rather small, triangular in shape, equivalved. Hinge with two main teeth under the umbo; two lateral teeth on each valve. Most of the species are edible

Donax venustus

Up to 12mm. Shell covered with white, yewllow and brown stripes and bears four white or yellow rays. Found in sand.

Donax semistriatus

Up to 25mm. Shell white, brown or light red. Surface finely ribbed at the centre. Found in sand.

Donax trunculus

Up to 25mm. Shell whitish, brown or violet. Inner surface violet-white. Found in sand.

FAMLY GLYCYMERIDAE

Sehlls medium to large in size, thick, subcircular, equivalved. Surface sculptured by radial ribs or smooth and covered by a periostracum. Hinged with a curved row of small teeth. Found on sandy shores.

Glycymeris pilosa

Up to 45mm. Shell brown-violet, radially ribbed. Surface covered by a dark brown periostracum; periostracum with very short hairs.

Glycymeris violescens

Up to 45mm. Shell violet, similar to G.pilosa Periostracum dark brown, usually absent.

FAMILY MYTILDAE

Shell equivalved, trigional or elongate oval in shape.

Modiolus barbatus

Up to 27mm. Shell brown-orange; periostracum hairy, brown. Found on rocks.

Modiolus adriatica

Up to 12mm. Shell similar to M.barbatus but very thin; periostracum absent

Mytilus edulis

Up to 13mm. Shell dark violet. Inerior covered with a thin pearly layer. Xylophagou

Lithiphaga lithophaga

Up to 45mm. Shell white. Surface with concentric growth lines; periostracum brown, thin, Shallow water.

FAMILY TELLINIDAE

Shell equivalved, thin, flattened and oval. One or two small teeth on each valve.

Tellina planata

Up to 62mm. Shell usually white with a brown edge. Shallow waters. Found in sand.

Tellina incarnata

Up to 34mm. Shell red-orange. Found in sand.

Tellina pulchella

Up to 16mm. Shell violet. Found in sand.

Gastrana fragilis

Up to 31mm. Shell white, thin. Found in sand.

GUIDELINES FOR PREPARING SOLUTIONS

1. *Manganese chloride solution*: 43.5g crystalline manganese chloride is dissolved in 100 cm^3 distilled water.
2. *Sodium hydroxide solution*: 32 g sodium hydroxide dissolved in 100 cm^3 distilled water. (Take care, solution becomes hot)
3. *Alkaline iodide solution*: 32 g sodium hydroxide is dissolved in 100 cm^3 distilled water, the solution is cooled down and 60 g sodium iodide is added.
4. *0.0100 M sodium thiosulphate solution*: 2.48g crystalline sodium thiosulphate is dissolved in 1 dm^3 distilled water. It is possible to add 0.02 g sodium carbonate to the solution as a preservative. The solution will keep for several weeks in a coloured glass bottle.
5. *1% starch solution*: 1.0 g starch is dissolved in 100 cm^3 cold water, after which the solution is heated almost to boiling point. Let the solution cool. 0.1g salicylic acid can be added as a preservative.

6. *0.100M silver nitrate solution*: 17.00 g silver nitrate is dissolved in 1 dm^3 distilled water.
7. *0.25M potassium chromate solution*: 5 g of potassium chromate is dissolved in 100 cm3 distilled water.
8. *Phosphoric acid*: concentrated (85%).

DETAILS OF CALCULATIONS REQUIRED

1. Number of Benthos Animals per Square Metre

Measure the diameter of the cylinder sampler (in metres) you used to extract sediment from the bottom. Calculate the area of the tube (in square metres). Multiply this by 5 (if this number represents the number of testing sites). In this way you calculate the total testing surface which has been investigated.

Example Calculation

Diameter of cylinder sampler:	0.10 m
Area of cylinder sampler:	0.0079 m^2
Number of testing sites:	5
Surface of total testing area:	0.0079 x 5 = 0.040 m^2
This gives you the factor	1/0.040

which is then be multiplied by the number of specimens found.

If the number of any retrieved species = 1
Then number per square metre = 10 x 1/ 0.040 = 250.
This figure is recorded in the column marked "In bottom samples: No/m^2"

2. Oxygen Content Determination - Simplified Method

By adding Mn(II) ions and hydroxide ions to a water sample you get a precipitate of manganese(II) hydroxide. The oxygen which is dissolved in the water sample will oxidise the manganese(II) hydroxide precipitate into manganese(IV) oxide hydroxide. At the same time the precipitate will turn brown. The intensity of the brown colour depends on the oxygen content in the water.

The colour of the precipitate indicates the oxygen content as follows:

white precipitate	-	very little oxygen
ivory-coloured precipitate	-	2-3 mg oxygen dm^{-3}
light chocolate-coloured	-	4-7 mg oxygen dm^{-3}
dark rust-coloured	-	8-14 mg oxygen dm^{-3} (oversaturated)

3. **Oxygen Content Determination by Titration**

Again a brown precipitate is formed first. This precipitate, which consists of manganese(IV) oxide hydroxide, dissolves when the water sample is mixed with sodium iodide solution, acidified with phosphoric acid. At the same time iodine is formed, which corresponds to the amount of dissolved oxygen. Tthe sample turns yellow. The yellow colour comes from the triiodide ions that are formed from iodine and iodide ions in an equilibrium reaction. By adding thiosulphate ions of a known concentration which reacts with the tri-iodide ions, the concentration of iodine can be determined.

Reactions

$2Mn^{2+} + 2OH^- + O_2 \rightarrow 2MnO(OH)_2(s)$	-	brown precipitate
$MnO(OH)_2 + 4H^+ + 3I^- \rightarrow Mn^{2+} + I_3^- + 3H_2O$		yellow solution
$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$	-	colourless solution

Example Calculation

If the sodium thiosulphate added during titration is taken as 10.0 cm^3, then the oxygen concentration, in mg dm^{-3}, can be calculated as.

$O_2 =$ 0.25 x 10.0/1000 x 0.0100 x 2 x 1000/100 x 1000
1/4 x (vol. $Na_2S_2O_3$ in dm^3) x (conc. of $Na_2S_2O_3$) x (molar mass for O_2) x (1000/volume of sample) x 1000 = 8 mg dm^{-3}

4. **Salinity**

The Salinity is calculated using the formula

$$S = 0.03 + 1.805 \times Cl\ (\%).$$

Theory

The concentration of chloride ions in the water can be determined by adding silver ions.

$$Ag^+ + Cl^- \rightarrow AgCl\ (s)$$

If chromate ions are also present and the concentration is adapted (in a mixture of chloride ion and chromate ion solution) so that the silver chromate starts to precipitate when all the chloride ions have been precipitated. The solution then becomes red in colour because of the silver chromate.

$$2Ag^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4\ (s)$$

In practice you cannot actually see the reddish brown colour until an excess of about 1 cm^3 has been added. This amount can be determined with "blank test". A solution containing chromate ions and no chloride ions is titrated until the red colour appears. The pH value should be between 6-10, otherwise the silver chromate will not precipitate.

Example Calculation

If the silver nitrate solution added during titration is taken as 16.9 cm^3 and the adjusted volume is 16.9 - 0.5 = 16.4 cm^3 (volume of silver nitrate minus volume of silver nitrate at blank test titration), then the chloride concentration can be calculated as.

Cl = 16.4/1000 x 0.100 x 35.46 x 1000/20
(vol. $AgNO_3$ in dm^3) x (concentration of $AgNO_3$) x (molar mass for Cl) x (1000/volume of sample) = 2.91 g dm^{-3}

Salinity (S) measured per thousand is calculated according to the formula below:

$$S = 0.03 + 1.805 \times 2.91 = 5.3\%$$

5. Water Content

$$x = \frac{1000\,(a - b)}{c}$$

where
x = dry substance in g/kg sediment
a = weight of the dish with solid after evaporation, g
b = the weight of the empty dish, g
c = the selected sample amount, g

6. Organic Content

$$\text{Organic content} = \frac{100\,(a - b)}{a}$$

where a is the mas of sediment before incineration, and
b is the mass of sediment after incineration