Study of local habitat:
There are five major habitats in Hong Kong namely:
1. Grassland: found mainly on the hillside where it is too dry, too exposed, or the soil is too shallow to support shrubs and trees. Tai Mo Shan is a favourable site for the study of this habitat.
2. Stream: abundant in the N.T., but many of them dry up in winter and have been heavily polluted.
3. Mangrove: common in the north-west and north-east of N.T. where are sheltered from strong wind and wave actions.
4. Rocky shore: common on the south of Hong Kong Island, i.e. Shek O.
5. Urban area: city or town, e.g. Mongkok, Tsuenwan and Shatin, etc.

Habitat selected
Mangrove:
A. Introduction:
Mangrove communities are typically found in tropical regions and are specialized communities which can withstand high salinity, periodic flooding by incoming tides and exposure by the retreating tides, and which can make use of intertidal soil deposits. They are the primary colonizers of such deposits leading to a succession where tropical rain forest would be the climax community.

The mangrove refers to coastal, halophytic evergreen trees and shrubs which colonize sheltered intertidal areas in bays, lagoons or estuaries, growing on saline silt or sandy mud. Local mangrove communities can be found at Deep Bay, Mai Po Marsh, Sai Kung and Ting Kok Road along Tolo Harbour.

B. Physical conditions of the habitat:
1. Gradient of the slope
   - extremely gentle (from less than 1 in 200 on the seaward side to about 1 in 20 on the landward side), thus, great areas are affected by the tides
2. Nature of soil
   - it is composed of fine silt particles loosely packed together
   - the silt particles are easily washed away by water currents
3. Tidal movement
   - the ebb and flow twice a day make the substratum unstable
   - high tides bring nutrients and salts up the estuaries, this helps the mangroves to extend into inland areas
   - low tides allow freshwater from rivers or streams to remove salts from the substratum, this prevents the accumulation of salts to a lethal level
4. Salinity
   - as the habitat is in an estuaries area, the freshwater brought down by the river will make the salinity lower nearer to the landward side
   - so, there is a gradient of salinity occurs from the landward side to the seaward side and this is also responsible for the zonation pattern
5. Rainfall
   - provides freshwater to the habitat
   - a heavy rain will cause drastic changes in the salinity of the sea water and the soil, especially in the upper regions
   - only plants that can tolerate such sudden fluctuations can survive in the upper shore
6. Temperature
- the low winter temperature is responsible for the small size of the mangrove plants and the absence of some species in Hong Kong
- the temperature fluctuation is greater at the landward side as this area is exposed for a longer period of time
- when air temperature is high,
  a. soil temperature is also high, so only those organisms that can tolerate a high temperature can survive,
  b. amount of dissolved oxygen in soil water decreases
  c. water evaporates from soil faster, this may lead to desiccation and increase in salinity

7. Oxygen
- due to the extremely fine soil particle and the tide movement, the substratum is often waterlogged and with bad aeration
- this makes the soil with high hydrogen sulphide content that is produced by the sulphur bacteria under the anaerobic condition (they react with the mineral of the soil producing the grey or dark colour of the soil)

C. Zonation of marine life on muddy shore :-

1. The splash zone (mangrove zone)
- the upper part of the muddy shore
- often colonized by special trees known as mangroves

[Note] ‘Mangroves’ are group of plants belonging to several families which share a unique ability to grow in areas which, for some of the time, are submerged by the sea. In Deep Bay, the mangroves species commonly found are Kandelia candel(秋茄), Avicennia marina(白骨壤), Aegiceras corniculatum(桐花樹), and Acanthus ilicifolius(老鼠簕). Less common are Bruguiera gymnorrhiza(木欖), Lumnitzera racemosa(欖李) and Exoecaria agallocha(海漆).
- on the leaves of the plants, various periwinkles together with numerous terrestrial insects are found, whilst cemented to the stems will be barnacles and rock oysters
- nestling between the stems will be various bivalves and gastropods
- burrowing in the substrate between the roots will be various bivalves
- in the mud among these mangroves, the small shrimps which on detritus, mudskipper, crabs also occur

2. The intertidal zone (the burrowing animal zone)
- the middle shore of mud flats
- often characterized by long-legged wading birds delicately prowling the mud with their bills for food (e.g. polychaete worms, small crustaceans and small bivalves)
- very large worm casts on the mud surface mark the presence of the innkeeper which builds a very wide burrow in the mud which is shared by a group of commensals including crab, clam and polychaete worm
- peanut worm, lampshells are also occur and these are detritivores

3. The subtidal zone
- the lower shore of the mud flat
- bears a diversified seaweed that has small oval leaves and forms a mat on the surface of the mud among which many small animals live
D. Adaptation of mangrove plants:

The mangrove plants grow in saline, waterlogged mud which are unstable structurally, low in oxygen and high in hydrogen sulphide. In order to adapt such environment, the halophytes show following special features.

1. Viviparous droppers (occur in Kandelia, Bruguiera, Avicennia and Aegiceras)
   - the seed germinates inside the fruit when it is still on the parent tree
   - the dropper is nourished by the parent tree
   - germination is almost immediate without any period of rest
   - the radicle presses into the soft mud, keeping the plumule and cotyledons clear above the saline water, lateral roots are quickly formed for proper anchorage
   - the advantage is that the fruit cannot be easily swept away by tidal waves

Fig. 28 A dropper still attach on the stem.

2. Buttress root (板根), prop root(柱根) and cable root(纜狀根)
   - some plants with buttress roots which are aerial branch roots thickened unevenly to produce flattened blade-like structure for support
   - species like Avicennia develop a cable root system which spreads horizontally just beneath the surface to against the tidal action
   - in addition, prop roots (occur in Kandelia) are produced from the main stem and branches to support them

Fig. 29 Root system of Avicennia.

Fig. 30 Prop roots of Kandelia.

Fig. 31 Knee joint of Brugieria.
3. Pneumatophores and knee joint (occur in Kandelia and Bruguiera)
   - mangrove plant like Avicennia develop erected aerial roots called pneumatophores, it looks like so many conical spikes distributed all round the trunk of the tree, which extend upwards into the air at intervals from the cable roots
   - the prop roots of Aegiceras, Kandelia and Bruguiera form arches called knee joints which grow above the soil surface for gas exchange
   - they contain lenticels on their surface and aerenchyma in the upper part, through which exchange of gases take place, so they are also called respiratory root

4. Structures or properties against saline water / dehydration
   a. salt gland = present in leaves which can regulate the salts in the tissues and excrete the salts from the leaves, e.g. in Avicennia
   b. ‘salt excluders’ = the plants physiologically prevent the salt enter the root xylem and the excess salt is removed by active pumping mechanism, e.g. in Kandelia
   c. abscission = the plants stores salts in vacuoles or a crystalline form in their leaves so that it is physiologically inactive and will be lost at leaf fall, e.g. in Bruguiera
   [Note] Some use more than one method e.g. Aegiceras has salt glands and is also a salt excluder.
   d. xeromorphic = mangroves have water storage tissues in their leaves (fleshy leaves), small amount of stomata, trichomes (blunt hairs) and waxy cuticle on the leaves surfaces to reduce water loss

E. Economic importance of mangrove forests :-
   1. Reclamation of land
      - mangroves are the primary colonizers of sand and silt habitats leading to a succession where tropical rain forest is the climax
      - the continuous extending of the mangrove forests to the sea can develop new land
   2. Provide timbers
      - mangroves can be used as firewood, for making furniture and house building
   3. Provide spawning grounds (e.g. ‘Kei Wai’ at Mai Po Marsh)
      - the mangrove habitat linking the land with the sea, providing spawning grounds for some marine fish, shrimps, etc.
      [Note] The famous ‘Kei Wai shrimps’ are came from the ‘Kei Wai’ at the coast of Mai Po Marsh where is the major mangrove forests in Hong Kong.
      - the shrimps, fish and worms in the mangrove communities are the foods for the birds
   4. Provide accommodation for birds
      - such as the Mai Po Marsh, many birds live here and since there are plenty of food (fishes, shrimp and other aquatic organisms)
   5. As Chinese medicines
      - Acanthus can be used to cure some kinds of skin diseases.

F. Local Mangrove Animals :-
   A large variety of animals live in different parts of a mangrove, including both invertebrates and vertebrates. They are found in creeks, channels, water pools, mud surface, tree trunks, prop roots and also the tree canopy.
1. Invertebrates:
- the soft substratum provides an ideal habitat and the detritus found in the mud as the food source for the small ground-dwellers e.g. clam, gastropods and acorn barnacle (藤壺), snapping shrimp, soldier crab (玻子蟹) and fiddler crab (招潮蟹)
- the roots, stems and leaves of mangrove plants and the stones provide surfaces on which a number of mangrove animals encrust or attach e.g. gastropods (Periwinkle), rocky oyster (石蠔) and mussel (青口)
- Some large crustaceans hollow out the mud and live in large open burrows among the roots of mangroves, these allow them to react rapidly to changes in temperature and salinity during high tides and low tides; the holes or channels allow oxygen to enter more deeply into the substratum and provide refuges from predation and breeding places e.g. snapping shrimp and fiddler crab

2. Vertebrates:
- Mudskippers (彈途魚) are bony fishes, possess powerful pectoral fins that enable them to ‘walk’ and even ‘hop’ swiftly on mud surface; their gaseous exchange can take place when the tail fin dips in water
- over 400 species of birds in Mai Po, they usually nest in colonies on trees and obtain food from the gei wai (箕圍) and the mudflats

Rocky Shore:
A. Introduction:
Rocky shore exist where the effect of waves on the coastline is mainly erosive, allowing the wearing down of the softer materials and their removal exposing the hardest rock.
Most of the substratum is stable and permanent, forming a secure surface upon which a variety of organisms capable of attaching themselves to it can grow, e.g. large algae, barnacles, mussels and limpets.

B. Physical factors affecting the size and composition of rocky shore communities:
1. Wave action
- it is one of the major factors determining the amount and type of algal growth on the rocks
  = moderate wave: large algae cover the shore and give shelter to many small animals, e.g. coelenterates, sponges and small crustaceans, which cannot tolerate complete exposure to air
  = strong wave: prevent the growth of plants and rock surface then becomes covered mainly with barnacles and limpets, or sometimes at the lower levels by mussels
  = extreme strong wave: bare rock with lives restricted to fissures and crevices
2. Food sources
- the size of shore communities is determined by the abundance of food supply
- the rapid growth of seaweeds on rocky shore is favored by, besides mild wave action, excellent lighting conditions and good supply of nutrients well distributed by the movements of the water and continually released by wave disturbance of the sediments, weathering of the coastline or in fresh water flowing off the land
- where there are no large seaweeds, the surface of the beach may be covered by a film of microscopic algae
- in-shore water often contains a rich plankton on which many shore creatures feed
- plant materials torn from the sea-bed below low tide level become deposited on the shore
- various organic substances of terrestrial origin being stranded on the beach

C. Zonation:

- no organisms is equally well suited to every level of the shore, so different levels are occupied by different groups of organisms
- each species having its main abundance within a particular zone where conditions are most favourable for it, above or below this zone it occurs in reduced numbers, or is absent because physical conditions are too difficult to allow its survival
- organisms live in
  - Upper shore should be able to withstand conditions of prolonged drying, extremes of temperature and strong illumination
  - Lower shore should take risks of damage or dislodgement, and can withstand inadequate illumination during submergence
- generally, exposed rocky shore shows three major belts of zonation
  - Splash zone: the top part of the shore, seldom fully immersed even by the highest tides,
    - regularly visited by splash which brings a lot of nutrient far up the shore
    - few organisms are found, only those can withstand desiccation and high temperature can live
    - e.g. lichen and periwinkles dominant here
  - Littoral zone: or called intertidal zone which is the middle and broadest region in the shore
    - usually covered and uncovered by the tides twice daily and crashed by the strongest waves
    - only those can withstand strong wave action can inhabit there, e.g. barnacles and limpets
: various small and irregular pools are found there
: the rock pools are protected from strong waves, so create
   a lot of microhabitats for animals
   e.g. stalked barnacles are found at the crevices under the
   rocks while limpets are on the rock surface; inside the
   pool, mobile predatory gastropods, mussels and sea
   anemones are also found
= Sub-littoral zone: the lowest region which always submerged in the water
: organisms inhabiting this shallow water region can
   only tolerate exposure to air to a little extent, they are
   subjected to relatively greater changes in temperature
   than organisms inhabiting deep marine habitats
: abundant in algal distribution e.g. red algae
: sea urchins and chitons are major organisms found
   here
- although the tides exert a major influence on zonation, the distribution of
  organisms varied widely from place to place due to differences of geography,
  geology and climate
- factors which modify zonation include the intensity of wave action, the range
  of temperature and humidity, aspect of the shore with respect to the sun and
  prevailing wind, and the period of day or night when extreme low tides occur

D. Adaptation :-
I. Desiccation
   When the tide recedes, organisms are exposed to severe evaporation, in order
   to avoid dehydration, they will develop different adaptations
   (1) stay under stones e.g. crabs and shrimp
   (2) residing in sheltered parts (rock crevices) e.g. stalked barnacles, periwinkles,
   (3) develop flattened shape well suited for hiding in narrow spaces. e.g. chitons
   (4) live in rock pools e.g. sea anemones
   (5) develop protective covering to prevent excessive drying e.g.
      i. hard shell in topshells;
      ii. movable calcareous plates of barnacles kept shunt when animals are
          uncovered, opened occasionally for gaseous exchange
      iii. limpets pulling down their heavy shell close to the rock surface with
           only a very narrow gap left for gaseous exchange without too much
           evaporation
      iv. thick cuticles and mucilaginous secretion on algae
      v. slimy exudation coating the sea anemones
      vi. with their physiological change to tolerant desiccation e.g. littoral
           gastropods excrete uric acid instead of ammonia

II. Wave
   Strong waves may cause
   (1) danger of dislodgement which carry creatures to areas unsuitable for
       survival
   (2) difficulty for the settlement and attachment of spores and larva.
   [Note] unlike sandy shore inhabitants, most organisms cannot escape by burrowing into the
   substratum which is the rock
Thus, some of the ways to combat the problem of wave actions are
(1) retreating into sheltered places e.g. crabs and shrimps stay under stones
(2) presence of protective shells e.g. gastropods
(3) great power of adhesion
   i. larger seaweeds are anchored to stones by holdfasts with reduced and
dissected fronds to withstand rapid current e.g. Sargassum (brown algae)
   ii. barnacles and tube worms have shells or tubes cemented to rocks
   iii. with their large adhesive foot to grasp the smooth substratum and
pulling the shell down e.g. limpets and chitons
   iv. common mussels securing themselves to rocks and stones by strong
byssus threads
   v. Gobie fish having the pelvic fins specialized to form a ventral suckers
by which they can cling to a firm surface

III. Salinity
   ➢ Salinity in intertidal zone may fluctuate as a result of tidal effect, rain
water and run off water from land.
   ➢ In exposed areas, e.g. rock pools, evaporation may make the water more
saline.
   ➢ Body fluid of many organisms is isotonic to sea water or many of them are
able to make appropriated adjustment of their osmolarity of body fluid in
response to changes in their surrounding

IV. Temperature
   ➢ Because of tide, wide and rapid changes of temperature occurred on the
shore.
   ➢ Strong sunshine can produce high temperature on exposed shore surface.
   ➢ Few organism stay in direct light, except those which are capable of
running actively e.g. ants and sand hopper (水蟑螂).
   ➢ Many organisms are resistant to diurnal and seasonal temperature changes
by their shells or coverings that protect them away from direct rays.

V. Fluctuation of pH, dissolved substances (O₂, CO₂, etc.)
   ➢ In bright light, photosynthesis by dense algal vegetation in small pools
raises the O₂ content and the withdrawal of CO₂ from the water raises the
pH.
   ➢ Change of pH affect the enzymatic activities of the organisms.

VI. Range of illumination
   ➢ Light intensity decreases with depth and turbidity of water. Thus affecting
the quality of light received by plants.
   ➢ Red light is preferentially absorbed in the upper level of water, therefore
algae in deeper water often develop special pigments to meet the changes in
light quality.
   ➢ Inadequate light intensity is one of the factors limiting the downward
spread of some of the algae on the shore.

VII. Tides
   ➢ The higher the shore is, the greater will be the problem of water loss.
   ➢ The lower the shore is, the stronger will be the wave actions.
   ➢ Intermittent submergence often presents problems in connection with
respiration, feeding and reproduction. Animals develop appropriate
changes to meet different condition.
Respiration = majority of the shore-dwellers respire by gills which are kept moist inside the protective shell or carapace
= some amphibians are respire by gills which are protected by operculum that is derived from outgrowth at base of legs
= certain periwinkles have their gills reduced and the mantle cavity become modified as a lung
Feeding = many filter feeder e.g. barnacles, bivalve feed only when the tide is in,
= the herbivores, e.g. chitons, limpets and periwinkles, scraping algal film on the rocks with the radula
= the carnivores e.g. sea anemones, feed on zooplanktons during period of submergence or when water is splashed in
Reproduction = water brought in by the tide enables the external fertilization to take place but large number of eggs needed to be produced to increase the chance of fertilization
= some fishes deposit adhesive spawns to the surface of seaweeds,
= some may carry eggs, e.g. sea-horse, crabs, and develop the youngs on them until the early stages of development has passed
= for the sessile organisms, e.g. barnacles and mussels, they utilize sheltered places to lay eggs that are frequently develop into free swimming larva which may become widely dispersed in the water.
= however, the great losses of eggs and larva due to the wave actions may be overcome by settlement in groups or shorten even omitted the planktonic larval stage

Exercise: (91 II 4b-d)
With reference to a field study that you have carries out in a named local habitat:
(a) Briefly describe the effects of TWO major physical factors on the distribution of organisms in this habitat. [4 marks]
(b) Name FOUR organisms found in this habitat and outline their adaptations for life there [6 marks]
(c) With reference to this habitat, name examples of any TWO of the following biological inter-relationships and briefly describe the roles of the interacting organisms: i/ predation ii/ mutualism iii/ competition [4 marks]

Field Studies in Ecology
A Objectives:
1. to measure the abiotic factors and sample the biotic factors during field study
2. to study the effects of abiotic and biotic factors on the distribution and abundance of organisms
3. to learn how to respect life and the environment
B. **Preparation** :
1. Location - bring along a map for the site of study.
2. Weather - check the weather conditions and tidal time in advance for fixing the suitable date and time to go
3. Clothing - wear casually, preferably long-sleeves clothes (to guard sunshine), light or waterproof shoes
   - bring a waterproof jacket and a cap
4. Food and water - bring sufficient food and water
5. First aid - bring a first-aid kit and insect repellent
6. Books, reference material and stationery - bring pencils, markers, data sheets, a notebook and identification keys
7. Measuring sampling kits - knife, scissors, forceps, spades, collection bags, specimen bottle and labels, quadrat and transect line, thermometer, hygrometer, pH paper and environmental comparator (or Lux meter), etc.

C. **Safety** :
1. Never work alone in the site.
2. Never allow a wound to be exposed, cover the wound with a clean waterproof plaster.
3. Never carry too much, otherwise it will be difficult to walk through the site.
4. When anyone faces a problem (e.g. hurt by sharps or threatened by organisms), do not panic and do not make violent movements. Call for help as immediately as possible.

E. **Measurement of Physical and Chemical Factors** :

<table>
<thead>
<tr>
<th>Factor</th>
<th>Instrument / Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Thermometer</td>
<td>Alcohol or mercury</td>
</tr>
<tr>
<td>Light intensity</td>
<td>Environmental comparator or Lux meter</td>
<td>Meter exposed to the light in a location for recording the intensity</td>
</tr>
<tr>
<td>Turbidity of water</td>
<td>Visibility stick</td>
<td>A 1.3 m long stick with a straight wire at 3cm from one end and a wire loop at 1.2m from the wire; lowered down into water while viewing from the wire loop until the straight wire disappears.</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Wet and dry bulb hygrometer</td>
<td>2 thermometers mounted side by side, the bulb of one covered by an absorbent material dipped into a small water container while the other bulb is dry. Swirl the hygrometer for a while, say 30s, read out the reading on the 2 thermometers, calculate the absolute difference and from the index provided, the relative humidity can be found.</td>
</tr>
</tbody>
</table>
### F. Sampling of Organisms

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Instrument / Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
<td>Knife</td>
<td>For removing unwanted materials around the plants</td>
</tr>
<tr>
<td></td>
<td>Trowel</td>
<td>For excavating the whole plant</td>
</tr>
<tr>
<td>Aquatic animals</td>
<td>Hand net</td>
<td>For sampling swimming animals</td>
</tr>
<tr>
<td>Small land animals</td>
<td>Shaking method</td>
<td>Shaking branches of trees vigorously and collecting small animals on a pan</td>
</tr>
<tr>
<td>Small soil animals</td>
<td>Sieve</td>
<td>For sampling of small animals in soil</td>
</tr>
</tbody>
</table>

### G. Investigation Methodology

1. **Quadrat analysis** - a quadrat is a wooden or metal square used in ecological sampling  
   - it is used to estimate the population sizes of organisms in a confined area by random sampling  
   - also used together with a belt-transect to study the distribution and relative abundance of organisms  
   - but is not applicable to the sampling of highly mobile animals and aquatic habitats

2. **Transect analysis** - a transect is a line along which organisms are counted and measured  
   - usually set up across the area where there are transitions in populations and also abiotic gradients (e.g. gradual changes in temperature, moisture and light intensity)  
   - can also be used to determine the distribution of organisms along a selected area  
   - **(i) Line transect** = involves the selection of a straight line along the ground in the area of study; sampling is strictly confined to species actually touching the line.
(ii) Belt transect involves the selection of a strip of terrain with a fixed width along the habitat or to place quadrats continuously in regular intervals along a transect line; the distribution and relative abundance of organisms along the belt transect are studied.

3. Profile - the gradient between two points on a slope can be measured by using 2 ranging poles, a nylon thread and a spirit level
- the poles are held upright at two points X and Y on the slope
- the stick is attached at points X’ and Y’ respectively on the 2 poles
- the positions of X’ and Y’ are adjusted until the nylon thread (which is tied loosely on the 2 poles) is found to be horizontal by using the spirit level
- the distances XX’, YY’ and X’Y’ are then measured, and the gradient between points XY can be calculated.

i.e. Gradient between XY = \frac{YY' - XX'}{XY}

![Fig. 33 The set-up to measure the gradient between two points.](image)

- the cumulative horizontal distances of XY can be worked out as the table below:

<table>
<thead>
<tr>
<th>Positions of Poles</th>
<th>XY (m)</th>
<th>YY' - XX' (m)</th>
<th>Distance from A (m)</th>
<th>Height above I (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B</td>
<td>5</td>
<td>0.93</td>
<td>0</td>
<td>5.47 + 0.93 = 6.4</td>
</tr>
<tr>
<td>B, C</td>
<td>5</td>
<td>1.22</td>
<td>10</td>
<td>4.25 + 1.22 = 5.47</td>
</tr>
<tr>
<td>C, D</td>
<td>5</td>
<td>1.75</td>
<td>15</td>
<td>2.50 + 1.75 = 4.25</td>
</tr>
<tr>
<td>D, E</td>
<td>5</td>
<td>0.94</td>
<td>20</td>
<td>1.56 + 0.94 = 2.50</td>
</tr>
<tr>
<td>E, F</td>
<td>5</td>
<td>0.76</td>
<td>25</td>
<td>0.80 + 0.76 = 1.56</td>
</tr>
<tr>
<td>F, G</td>
<td>5</td>
<td>-0.73</td>
<td>30</td>
<td>1.53 - 0.73 = 0.80</td>
</tr>
<tr>
<td>G, H</td>
<td>5</td>
<td>0.88</td>
<td>35</td>
<td>0.65 + 0.88 = 1.53</td>
</tr>
<tr>
<td>H, I</td>
<td>5</td>
<td>0.56</td>
<td>40</td>
<td>0 + 0.65 = 0.65</td>
</tr>
<tr>
<td>I (low water level)</td>
<td>-</td>
<td>-</td>
<td>45</td>
<td>0</td>
</tr>
</tbody>
</table>
Exercise: (91 II 4a)

With reference to a field study that you have carried out in a named local habitat:
Describe TWO techniques for investigating the distribution of organisms in this habitat. [6 marks]