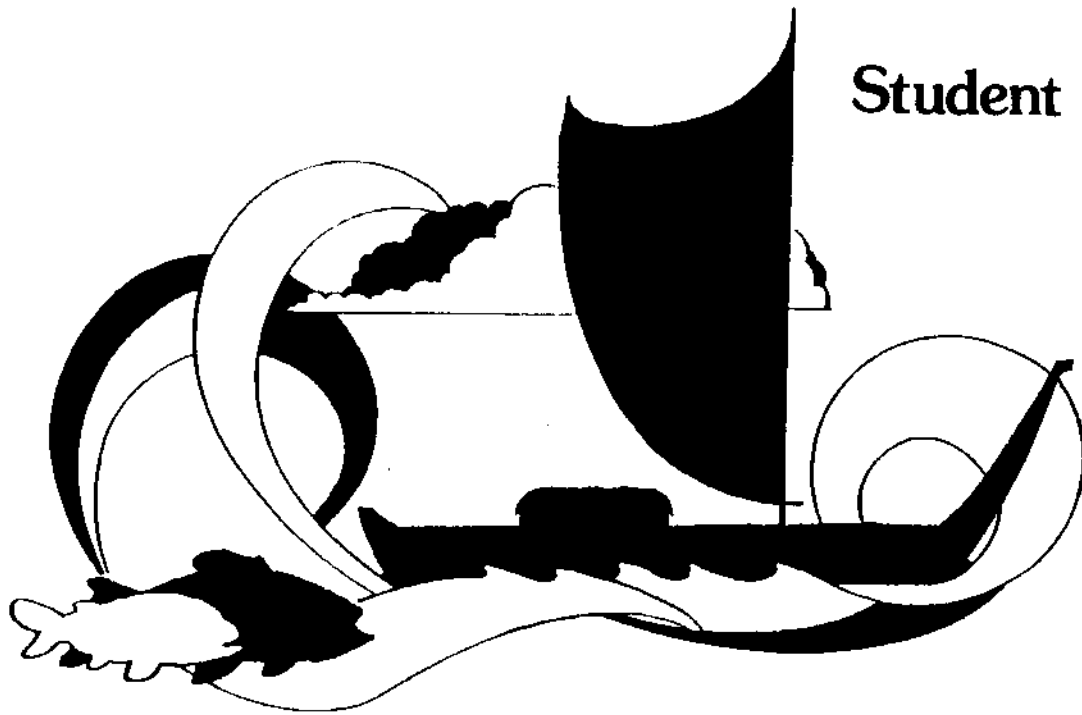


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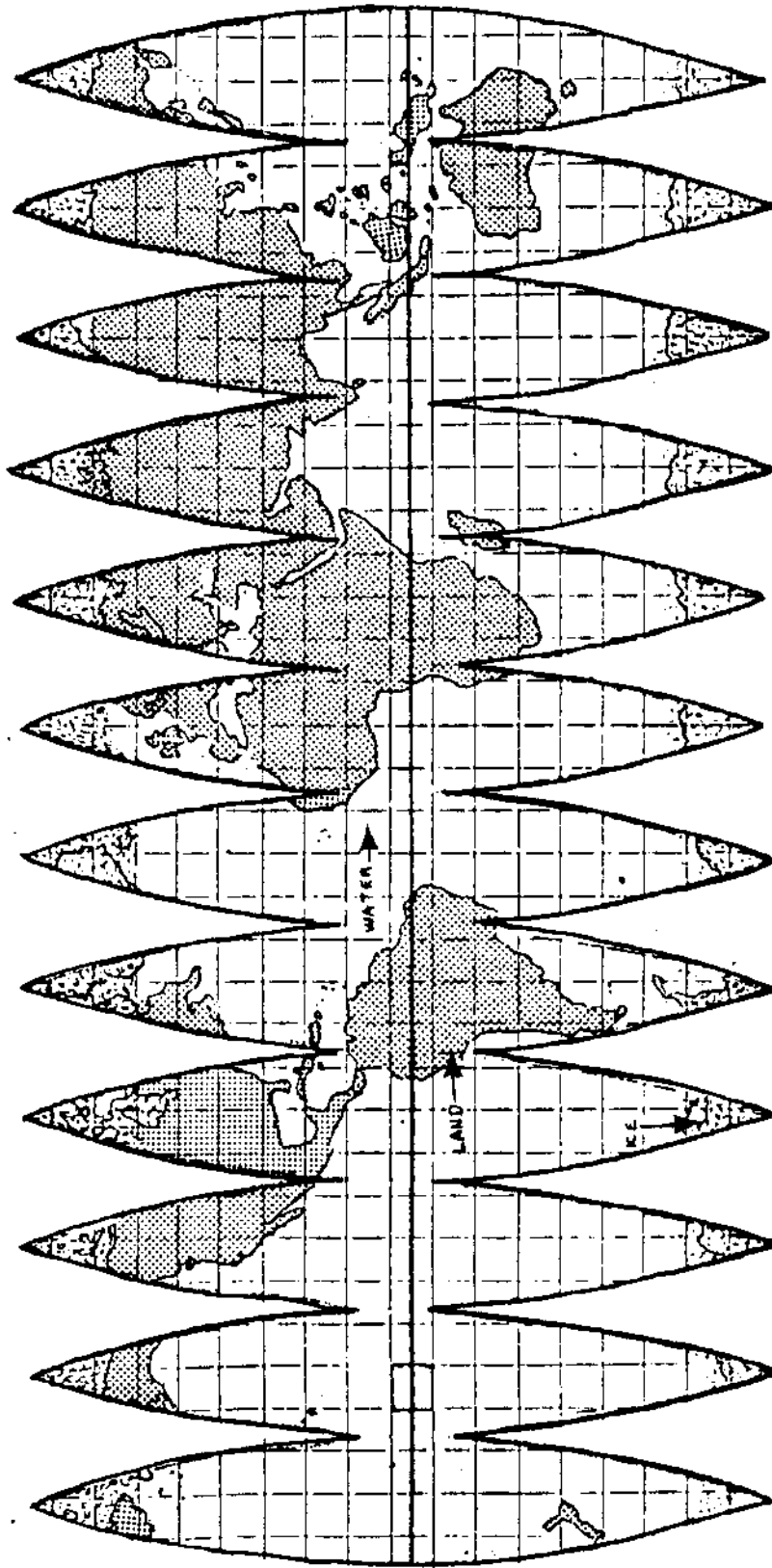
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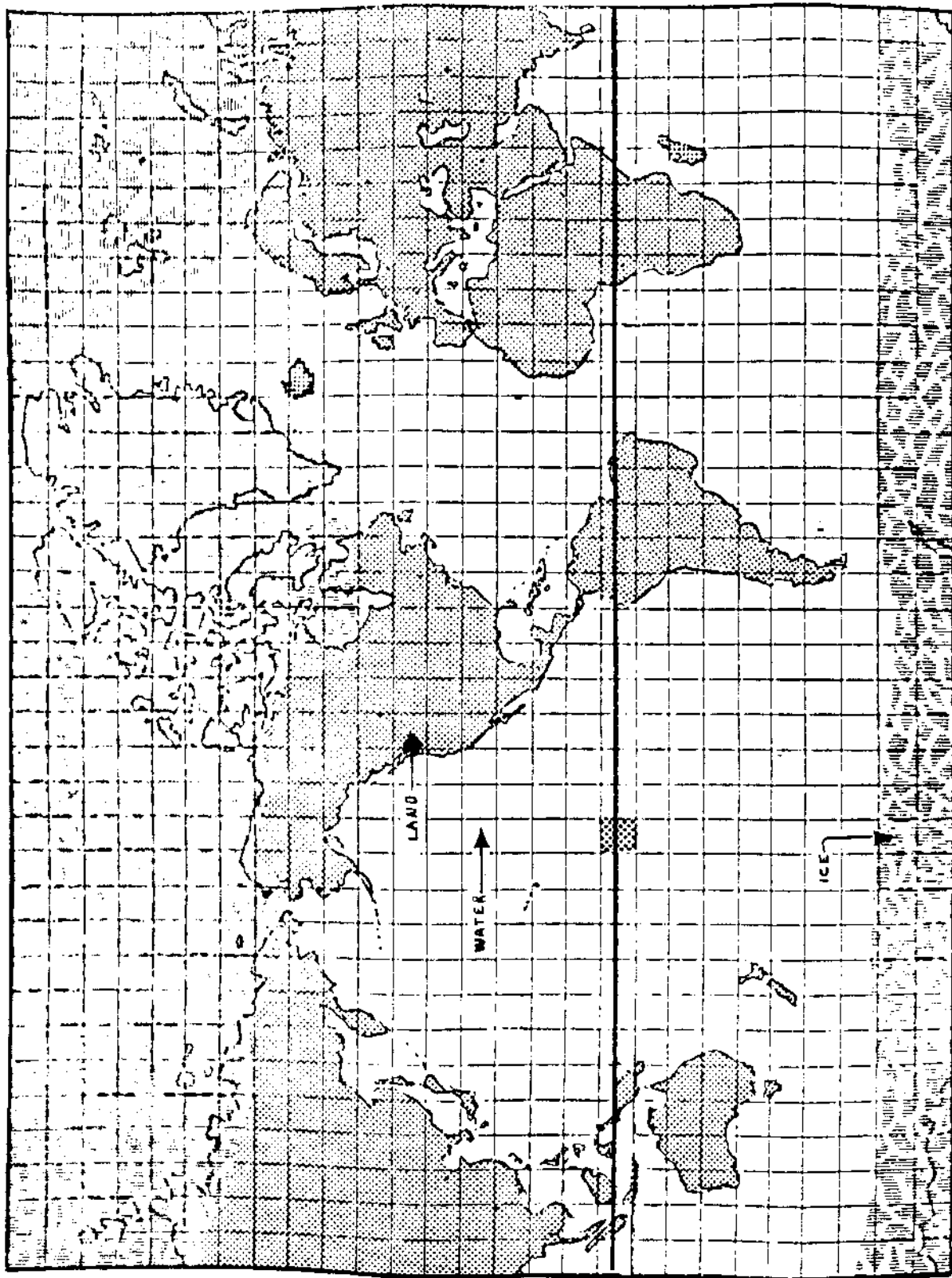
 $1.25 \times 10^6 \text{ km}^2$
(1,250,000 km^2)

Fig. 1-1. Equal-area projection map.



1,25 x 10⁶ km²
(1,250,000 km²)

Fig. 1-2. Mercator projection map.

Table 1-1. Area of the continents.

Continents	Number of Squares	Area	Rank	Accepted Area

Table 1-2. Area of the oceans.

Oceans	Number of Squares	Area	Rank	Accepted Area

Table 1-3. Comparison of area of land, liquid water and ice.

Material	Number of Squares	Area	Percentage	Accepted Percentage
Land				
Liquid water				
Ice				
Total surface area				

Table 1-4. Depth and volume of the major oceans.

Oceans	Area	Depth km	Volume	Rank	Accepted Volume
Arctic		1200			
Atlantic		3300			
Indian		3800			
Pacific		3900			

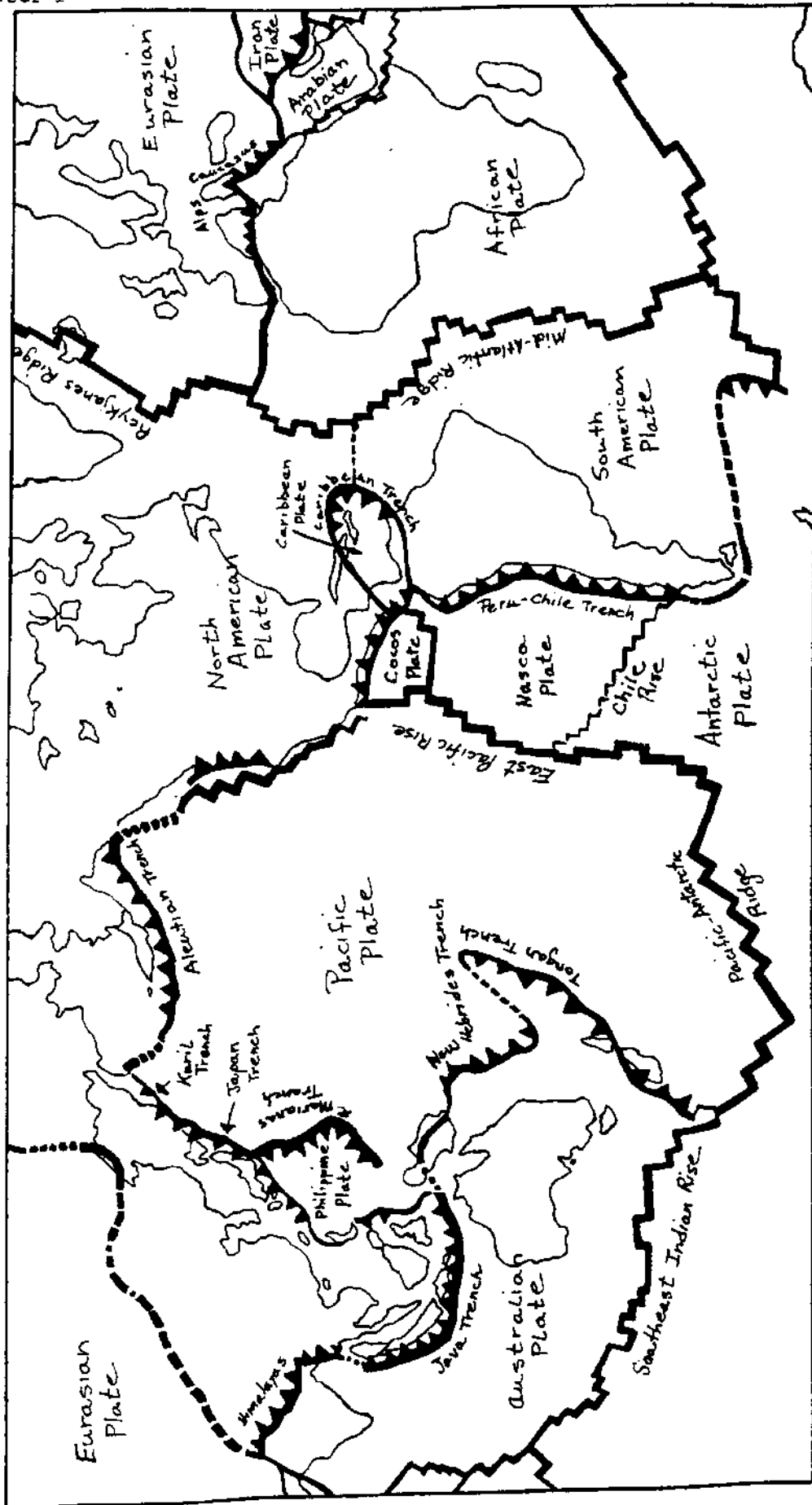


Fig. 4-2. Map of earth's plate system.

Table 3-1. Fish Spines, Rays, and Scales.

Name of Fish	First Spine in Dorsal Fin	First Ray in Dorsal Fin	Scale from middle of body

Table 3-2. Features of two fishes.

Feature	Soldierfish	Your fish
Dorsal fin (D1/D2)		
Pectoral fins (P1)		
Pelvic fins (P2)		
Anal fin (A)		
Caudal fin (C)		
Gill cover (G)		
Lateral line (LL)		
Anus (An)		
Eye (E)		
Mouth (M)		
Nostril (N)		
Scale		
Spine		
Ray		

Table 4-2. Fish counts and measurements.

Measurement	Fish 1	Fish 2
1. SL		
2. HL		
3. Caudal peduncle depth		
4. Eye width		
5. Pelvic to anal distance		
6. Body depth (Estimate)		
7. Lateral line scale count		

Fig. 4-4. Polygraph for comparing fish.

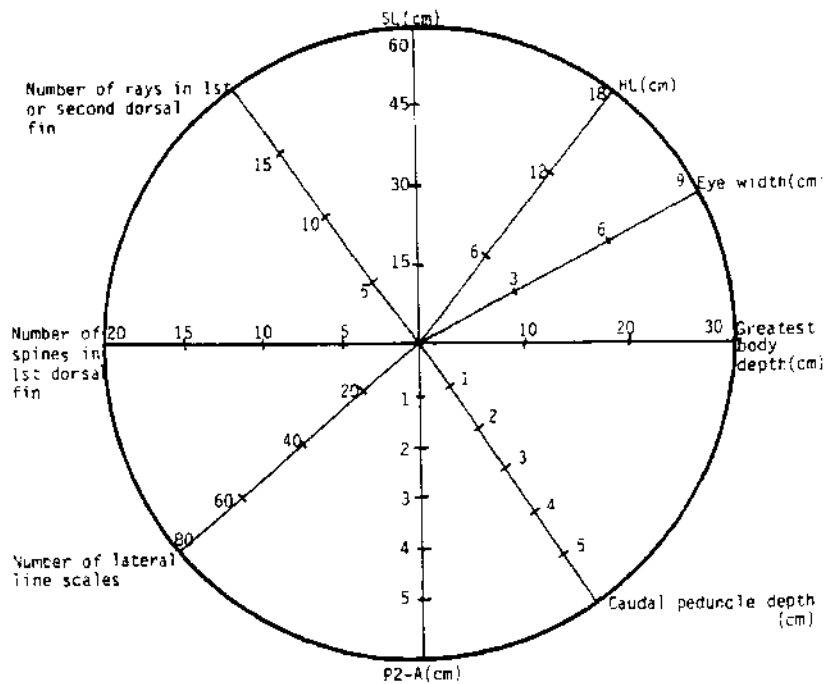


Fig. 5-1. Fish drawings.

	1	2	3	4	5
Largest tooth					
Mouth					
Body shape					
Paired fins					
Scale					
Special adaptations					

Table 5-1. Fish Description.

Part	Family				
	1	2	3	4	5
Eye size					
Write in function					
Largest visible tooth in jaws					
Write in function					
Mouth					
Write in function					
Body shape					
Write in function					
Paired fins (P1 and P2)					
Write in function					
Most specialized scales					
Write in function					
Special adaptations (other of Fig. 1.6-2c)					
Write in function					
Describe coloration					
Write in function					
List parts used for defense					

Table 5-2. Predicted behavior in habitat.

	Family				
	1	2	3	4	5
Food eaten (algae, soft animals hard animals, large animals, coral etc.)					
Habitat (midwater, in holes, on sand, etc.)					
Method of swimming					
Method of defense (how would it be- have when fighting)					
Most developed methods of sensing the world around it (eye, nose, touch, etc.)					

Table 6-2 Behavior and coloration of tilapia.

	Established Aquarium	Bare Aquarium
a. Respiration rate		
b. Coloration		
c. Dorsal fin		
d. Swimming		
e. Other behavior		
f. Slit tail		

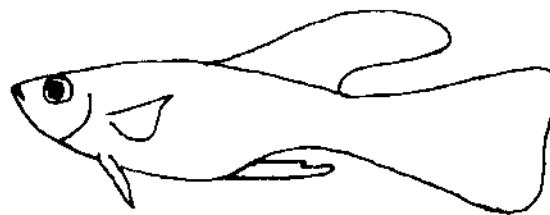


Fig. 6-3. Male guppy

Table 6-3. Guppy behavior.

Courting male	
a. Color change	
b. Fin action	
c. Body action	
d. Position with respect to female	
e. Preference of females	
f. Female responses	

Table 7-3. Muscles and their functions

Muscular System General Function	Muscles	Organ Functions
	Skeletal	
	Heart	
	Smooth	

Table 7-4. Organs and functions of the digestive system.

Digestive System General Function	Organs	Organ Functions

Table 7-5. Organs and functions of the respiratory system.

Respiratory System General Function	Organs	Organ Functions

Table 7-6. The circulatory system.

Circulatory System General Function	Organs	Organ Functions

Table 7-7. The excretory system of the fish.

Excretory System General Function	Organs	Organ Functions

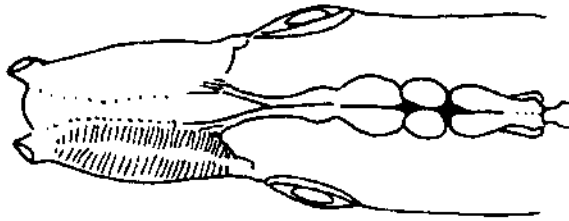


Fig. 7-7. Moray eel brain.

Table 7-8. Parts of the brain, spinal cord and nerves.

General Function	Organs	Organ Functions

Table 7-9. The sensory system of the fish.

Sensory System General Function	Organs	Organ Function

Table 7-10. The reproductive system of the fish.

Reproductive System General Function	Organs	Organ Functions

Table 7-11. Parts of the integumentary system and their functions.

Integumentary System General Parts	Parts	Function

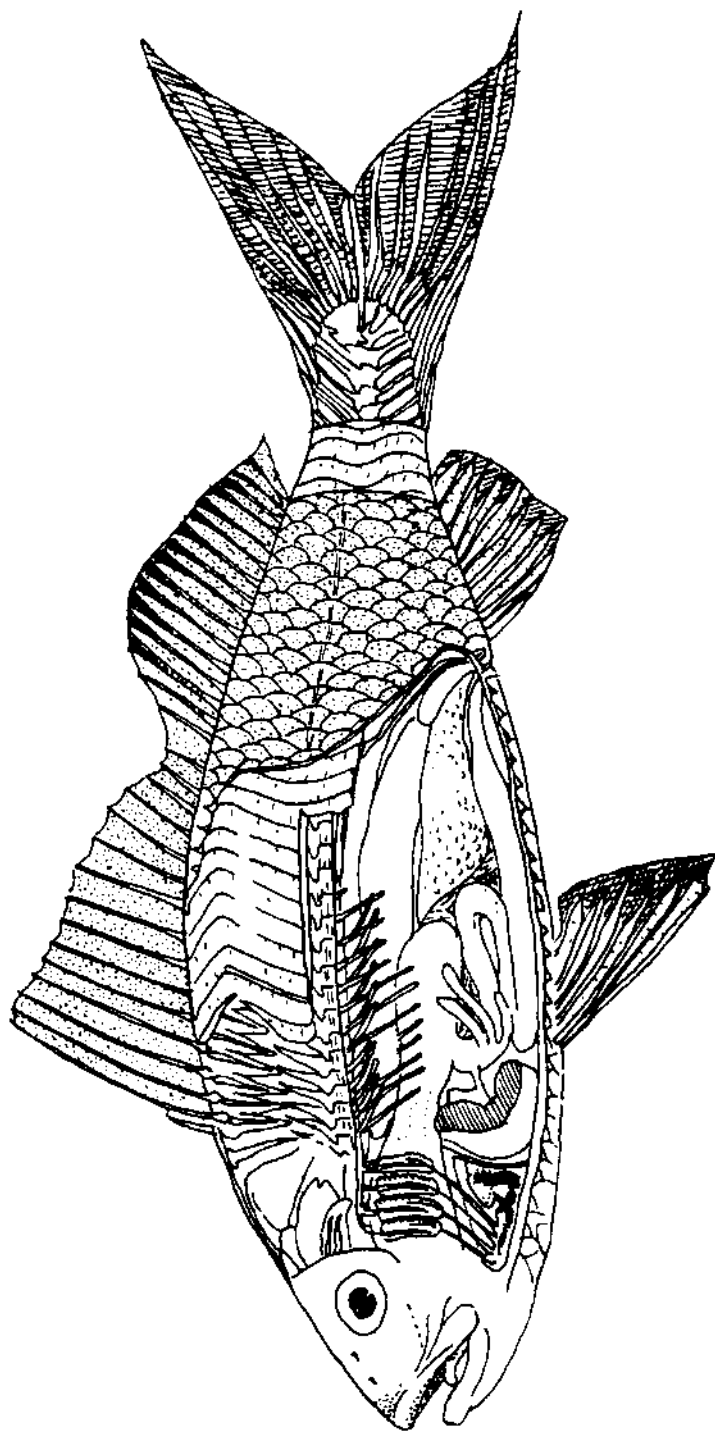


Fig. 7-12. Internal anatomy of a fish.

Fig. 9-2. Butterflyfish.

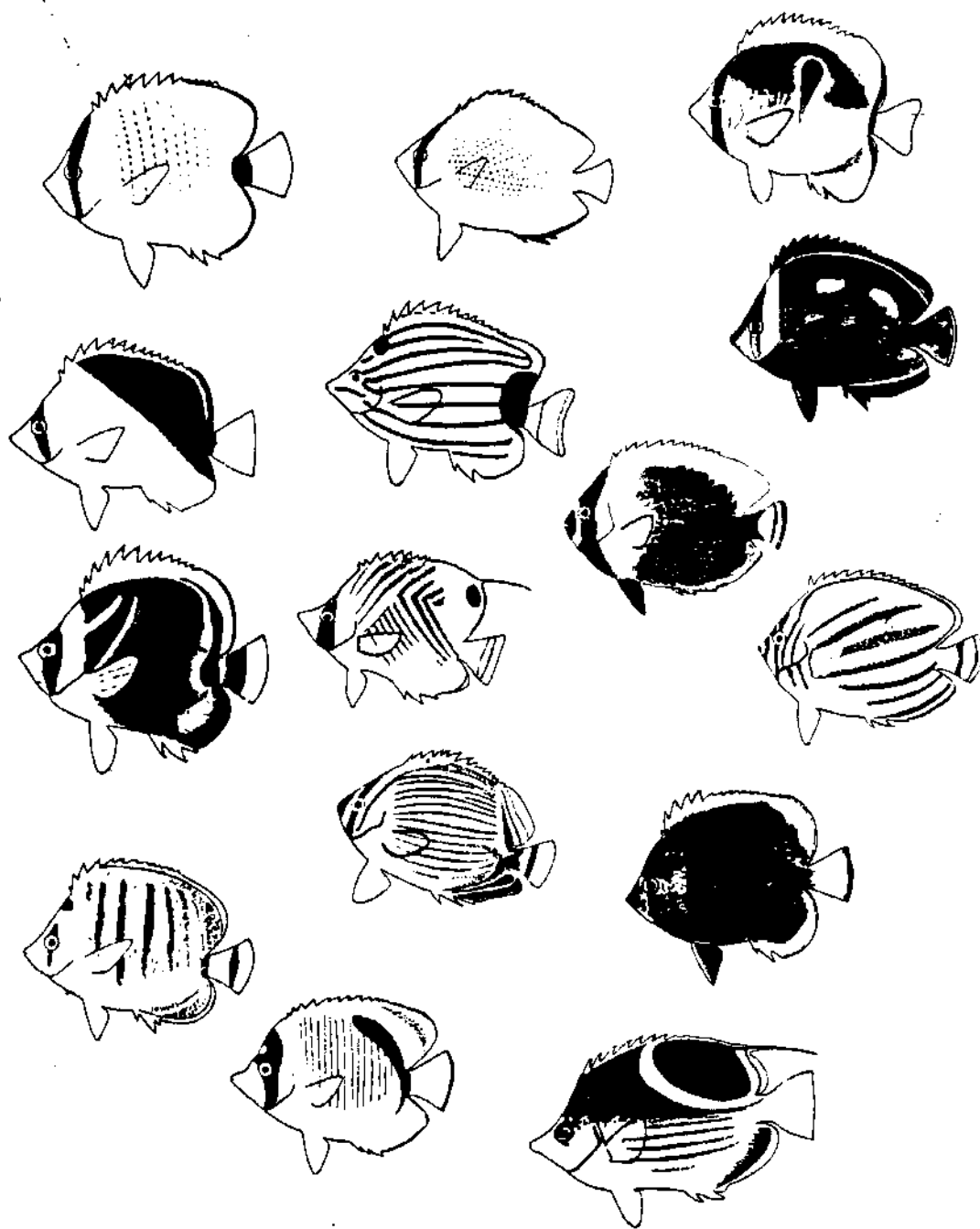


Table 9-2. Family of fishes.

Fish #	Family

Table 2-1. Volume of gas collected upon heating freshwater.

Measurements	Starting Conditions				
	Ice Cooled Aerated	Room Temp (25°C) Aerated	50°C Aerated	75°C Aerated	Room Temp Non-Aerated
1. Total Volume of Water in Funnel					
2. Starting Temperature					
3. Highest Temperature					
4. Volume of Gas in Funnel					
5. Volume of Gas Per ml of Liquid in Funnel #4 ÷ #1					

Table 2-2. Volume of gas collected upon heating seawater.

Measurements	Starting Conditions				
	Ice Cooled Aerated	Room Temp (25°C) Aerated	50°C Aerated	75°C Aerated	Room Temp Non-Aerated
1. Total Volume of Water in Funnel					
2. Starting Temperature					
3. Highest Temperature					
4. Volume of Gas in Funnel					
5. Volume of Gas Per ml of Liquid in Funnel #4 ÷ #1					

Table 3-1. Number of active *Daphnia* in test tube.

Temperature of water before cooling to 25°	Time						
	0'	5'	10'	15'	20'	25'	24hrs.
Room (25°)							
50°							
75°							
90°							

Table 4-1. Data on floating and sinking.

Kind of Data	A	B	C	D	E
1. Kind of Substance (Liquid-Object) in cup	Tap Water	Salt Water	Salt Water	Tap Water	Object
2. Mass of Cup and Contents					
3. Volume of Contents (Volume of Cup)					
4. Kind of Liquid in Container	Tap Water	Tap Water	Salt Water	Salt Water	Salt Water
5. Mass of Liquid Displaced					
6. Volume of Liquid Displaced					
7. Density of Cup and Contents (#2 ÷ #3)					
8. Circle Prediction - Cup and Contents (F) Floats (S) Sinks	ⓕ S	F S	F S	F S	F S
9. Circle Actual Observation, Cup and Contents (F) Floats (S) Sinks	ⓕ S	F S	F S	F S	F S
10. Mass of Cup					
11. Mass of Contents (#2 - #10)					
12. Density of Contents (#11 ÷ #3)					

Table 4-3. Object floats at surface.

Relationship	
Gravitational Force of Object Pushing Down	Buoyancy Force Pushing Up

Table 4-4. Object sinks.

Relationship	
Gravitational Force of Object Pushing Down	Buoyancy Force of Pushing Up

Table 4-5. Object floats above surface.

Relationship	
Gravitational Force of Object Pushing Down	Buoyancy Force Pushing Up

Table 4-6. Object floats at surface.

Relationship	
Density of Object	Density of Displaced Liquid

Table 4-7. Object sinks.

Relationship		
Density of Object		Density of Displaced Liquid

Table 4-8. Object floats above surface.

Relationship		
Density of Object		Density of Displaced Liquid

Table 4-9. Object floats at surface.

Relationship		
Volume of Object		Volume of Displaced Liquid
Mass of Object		Mass of Displaced Liquid

Table 4-10. Object sinks.

Relationship		
Volume of Object		Volume of Displaced Liquid
Mass of Object		Mass of Displaced Liquid

Table 4-11. Object floats above surface.

Relationship		
Volume of Object		Volume of Displaced Liquid
Mass of Object		Mass of Displaced Liquid

6. a. A water soaked log that just floats so that it is just seen at the surface will have a density that is _____ ($= > <$) 1.32 g/ml.
 - b. A boat that sinks so the bottom will have a density _____ ($= > <$) 1.32 g/ml.
 - c. A boat that floats high above the surface of the liquid has a density _____ ($= > <$) 1.32 g/ml.
 - d. A 10,000 Kg vessel that floats in the liquid displaces _____ Kg of liquid.
 - e. A 10,000 Kg object that sinks will displace a mass of liquid _____ ($= > <$) 10,000 Kg.
 - f. An object that floats above the surface will have a volume _____ ($= > <$) the volume of the liquid displaced.
 - g. An object that just floats will have a volume _____ ($= > <$) the volume of the liquid displaced.
 - h. An object that sinks will have a volume _____ ($= > <$) the volume of the liquid displaced.
 - i. A 10,000 Kg object that floats in the liquid has a gravitational force of _____ Kf.
 - j. A 10,000 Kg object that floats in the liquid is supported by a buoyant force of _____ Kgf.
7. a. The volume of the object is _____ ($= > <$) 10 ml.
 - b. The buoyant force is _____ ($= > <$) 10 gf.
 - c. The density of the object is _____ ($= > <$) 1.0 g/ml.
 - d. If the volume of the object were 5 ml the buoyant force would be _____.
 - e. If the volume of the object were 5 ml the unbalanced gravitational force tending to sink the object would be _____.
 - f. If the volume of the object were 5 ml its density would be _____.
 - g. If the volume of the object were 5 ml it would displace _____ of liquid.

Table 5-1. Standardizing the hydrometer.

Solution	Scale Reading of Hydrometer	Standard Density
1.		
2.		
3.		
4.		
5.		

Table 6-1. Hydrometer data.

Solution	Standard Density	Hydrometer Reading	Hydrometer Error
#1			
#2			
#3			
Total			
Average			

Table 6-2. Temperature and density ice water - 10°C.

Measurement	Fresh Water			Salt Water		
	Temp	Density		Temp	Density	
Start		Uncorrected	Corrected		Uncorr.	Corrected
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Table 6-3. Temperature and density 10⁰C - boiling.

Measurement	Fresh Water			Salt Water		
	Temp	Density		Temp	Density	
		Uncorr.	Corrected		Uncorr.	Corrected
Start						

Table 6-4. Temperature and density at boiling.

Time	Fresh Water			Salt Water		
	Temp	Density		Temp	Density	
		Uncorrected	Corrected		Uncorrected	Corrected
Start						
1 min						
2 min						
3 min						
4 min						

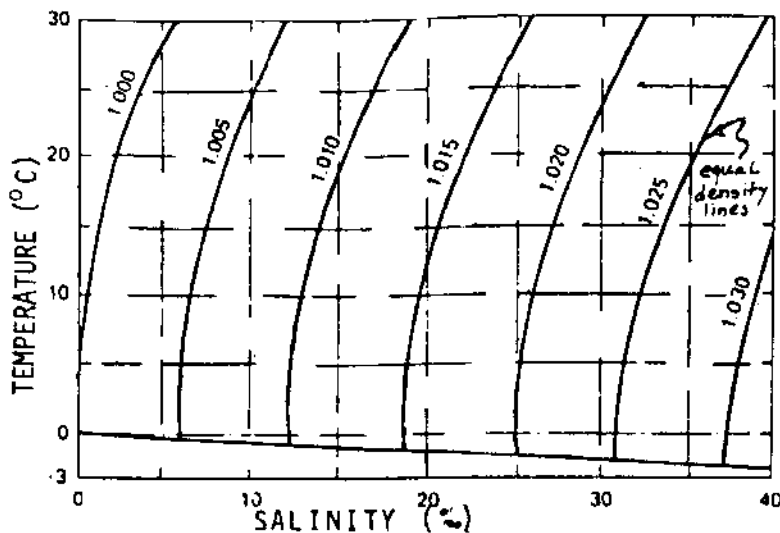


Fig. 6-1. Temperature, density and salinity

Table 6-5. Corresponding densities-salinities and temperatures.

Salinity (‰)	Temperature (°C)	Density (g/ml)
20	10.0	
	20.0	1.005
30		1.020
20	27.5	
	15.0	1.005
25		1.015
25	12.5	
	30.0	1.0075
28		1.0175

Table 7-1. Data on contents of system after operation.

	Fresh Water	Salt Water
Temperature of Content in Pan (Final)		
Temperature of Water Content in Beaker (Final)		
Density of Content in Pan (Start)		
Density of Content in Pan (Final)		
Density of Content in Beaker (Final)		
Taste of Content in Beaker (Final)		
Taste of Content in Pan (Final)		

Table 7-2. Data on moving air and evaporation.

		Fresh Water		Salt Water	
		Moving Air	Staitonary	Moving Air	Stationary
Temperature	Start				
	Final				
	Change				
Volume	Start	25 ml	25 ml	25 ml	25 ml
	Final				
	Change				
Density	Start				
	Final				
Time Exposed					
Rate of Volume Change					

Table 7-3. Data on surface area and evaporation.

		Fresh Water		Salt Water	
		Petri Dish	Beaker	Petri Dish	Beaker
Size	Diameter				
	Surface Area				
Temperature	Starting Temperature				
	Final Temperature				
Volume	Start				
	Final				
	Change				
Density	Start				
	Final				
Time Exposed					
Rate of Evaporation					

Table 7-4. Data on agitation and evaporation.

		Fresh Water		Salt Water	
		Agitated	Not Agitated	Agitated	Not Agitated
Temperature:	Start				
	Final				
Density:	Start				
	Final				
Volume:	Start				
	Final				
	Change				
Time Exposed					
Rate of Evaporation					


Table 8-1. Data on freezing liquids.

	Salt Water	Fresh Water
Volume of Liquid Start		
Volume of Liquid Final		
Volume of Liquid Change		
Distance to Surface Start		
Distance to Surface Final		
Distance to Surface Change		
Density at Melting Top 1/3		
Density at Melting Mid 1/3		
Density at Melting Bottom 1/3		

Table 8-2. Temperature during melting.

Minutes	Top 1/3		Middle 1/3		Bottom 1/3	
	Fresh	Salt Water	Fresh	Salt Water	Fresh	Salt Water
Start						
1						
2						
3						
4						
5						

Key to Symbols

$=$ $a=b$ a equals b
 $>$ $a>b$ a greater than b
 $<$ $a<b$ a less than b
 Colored water

①




start	prediction	act
hot fresh		
cold fresh		

density hot fresh || density cold fresh

②

start	prediction	act
cold fresh		
hot fresh		

Completed Example

Start	Prediction	Actual
 a		
b		

density a < density b

③

start	prediction	actual
low salinity		
high salinity		

density low saline || density high saline

④

start	prediction	actual
high salinity		
low salinity		

⑤

start	prediction	actual
hot saline		
cold fresh		

density hot saline || density cold fresh

⑥

predicted cool → actual cool

predicted cool	actual cool

density cool saline || density cold fresh

⑦

start	prediction	actual
fresh		
fresh		

density fresh || density fresh

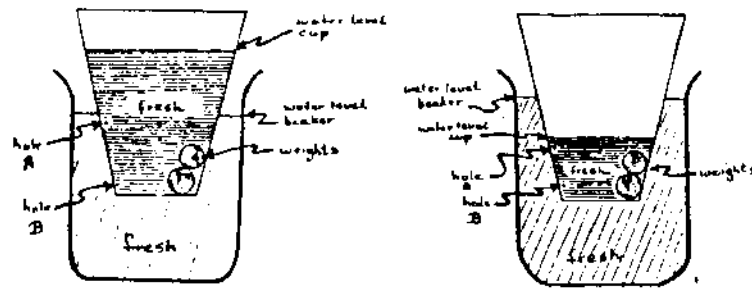


⑧

start	prediction	actual
aerated		
fresh		

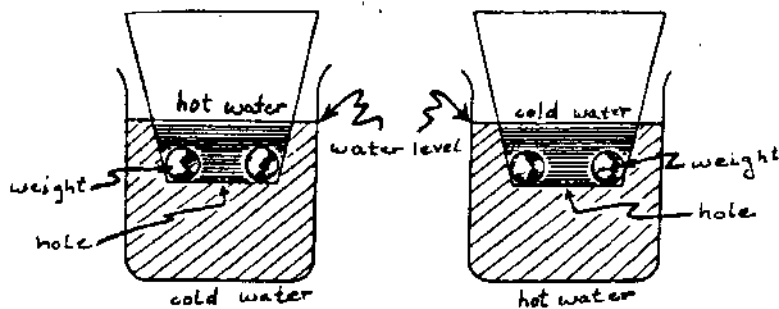
density aerated fresh || density fresh

Table 9-1. Gravitational response of different water samples.



Predicted		Predicted	
force hole A	force hole B	force hole A	force hole B
↑	↑	↑	↑
Actual		Actual	
force hole A	force hole B	force hole A	force hole B
↑	↑	↑	↑
Predicted direction of flow		Predicted direction of flow	
cup ↓ beaker	cup ↓ beaker	cup ↓ beaker	cup ↓ beaker
Actual direction of flow		Actual direction of flow	
cup ↓ beaker	cup ↓ beaker	cup ↓ beaker	cup ↓ beaker

Fig. 9-2. Movement of water at different heights.



Predicted direction of flow		Predicted direction of flow	
hot water	cold water	hot water	cold water
↑	↑	↑	↑
Actual direction of flow		Actual direction of flow	
hot water	cold water	hot water	cold water
↑	↑	↑	↑

Fig. 9-3. Movement of water through a single hole when water is at different densities.

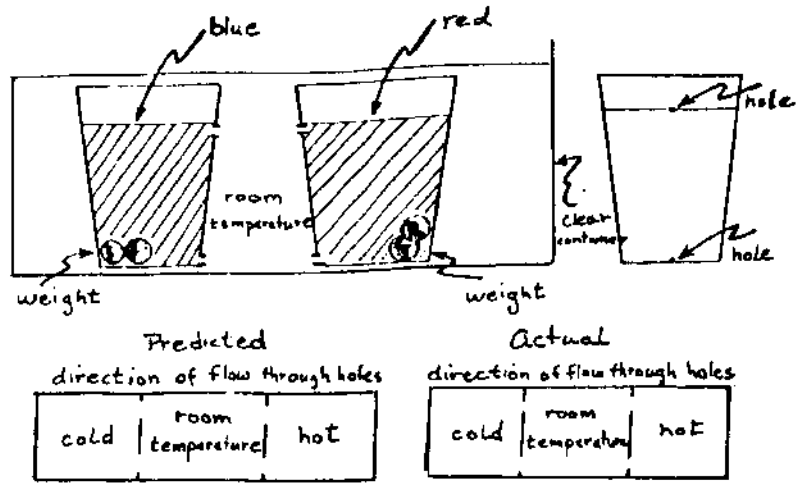


Fig. 9-4. Equipment to study the interaction of hot and cold water.

2. Wind can blow water out to sea creating a hill in offshore waters. Use the results of Procedure 2. Which of the diagrams below would best describe expected water movement in response to such winds? Explain your selection. This process is called upwelling.

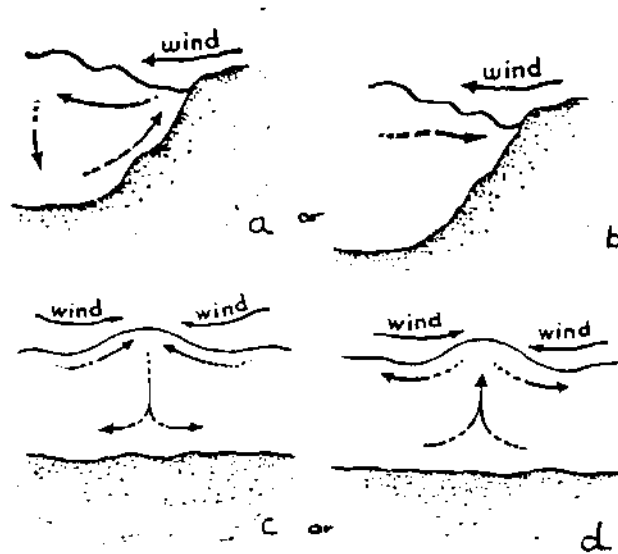
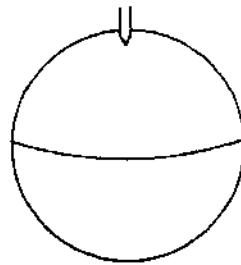
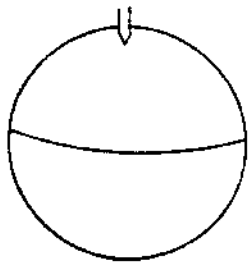
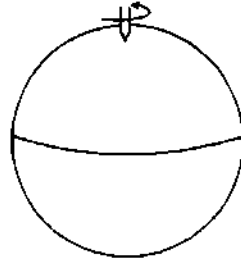
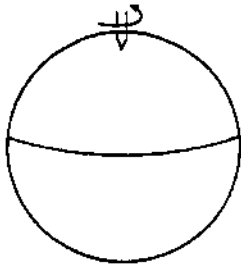


Fig. 9-5. Effect of wind on water movement.



- a. Predicted path of current when flask is at rest. b. Actual path of current when flask is at rest.



- c. Predicted path of current when flask is rotating. d. Actual path of current when flask is rotating.

Fig. 10-1. Diagram of the path of currents.

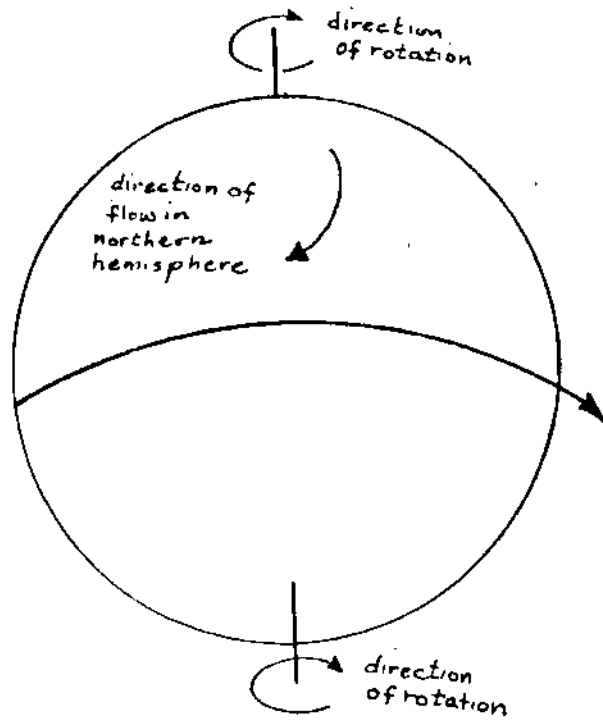


Fig. 11-3. Coriolis effect showing that direction of flow in the opposite direction of rotation.

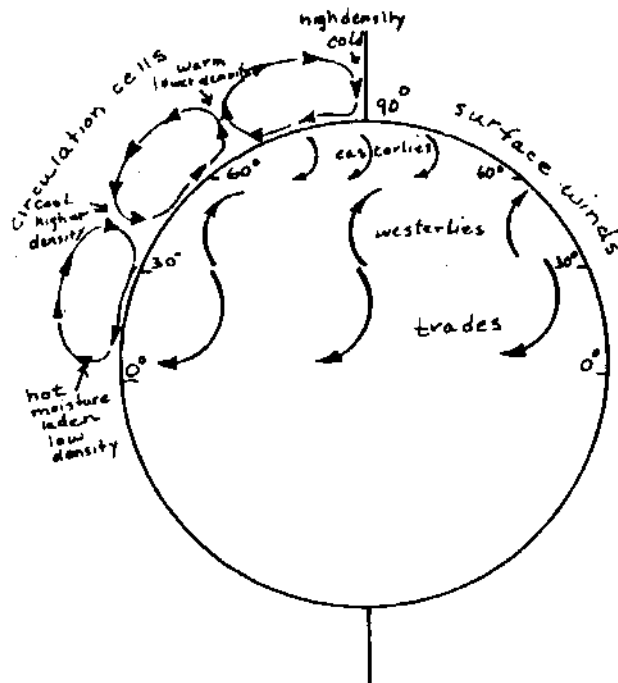


Fig. 11-4. Prevailing winds on an ideal model of the earth showing major circulation cells.

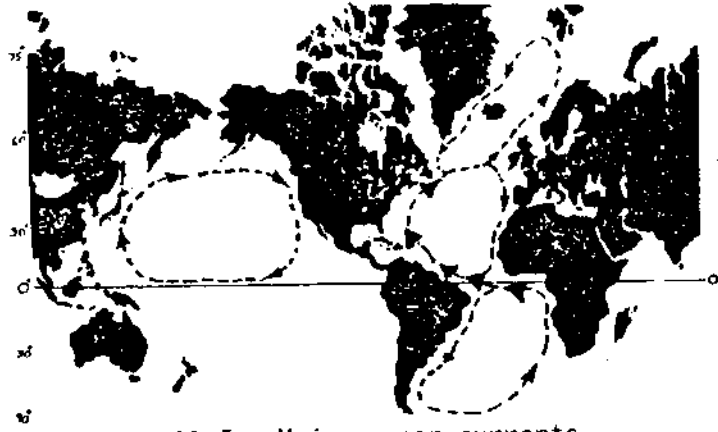


Fig. 11-5. Major ocean currents.

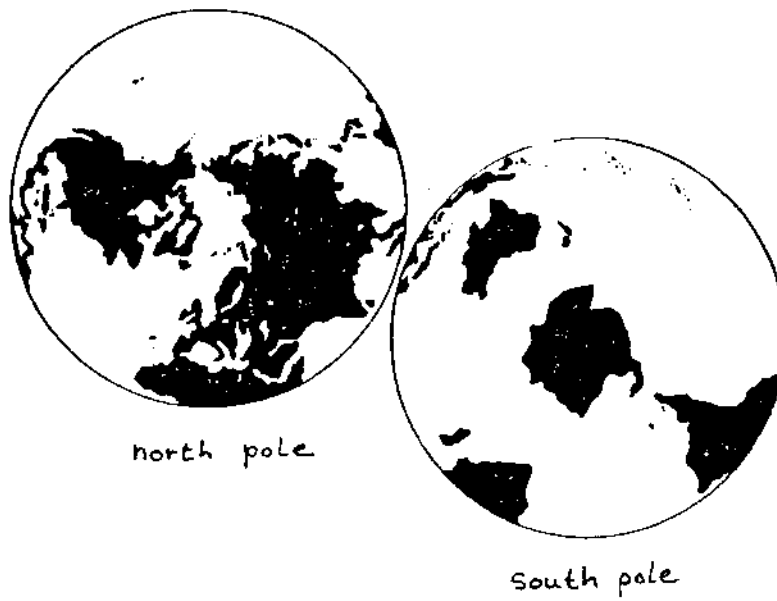


Fig. 11-6. Maps of the world from the poles.

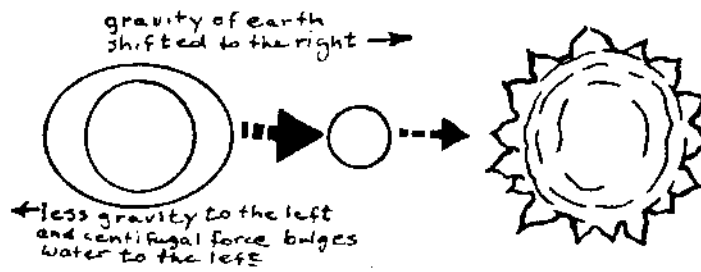


Fig. 11-8. Spring tide.

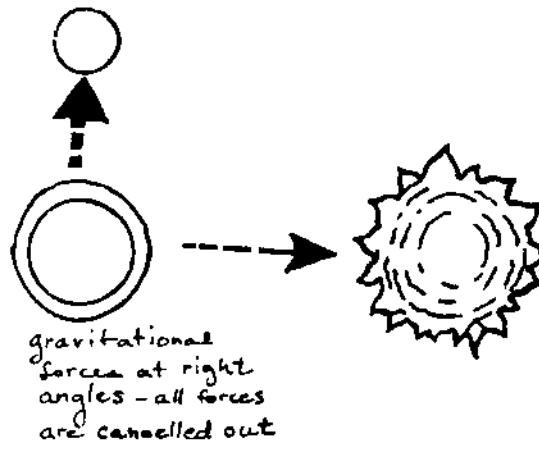


Fig. 11-9. Neap tide.

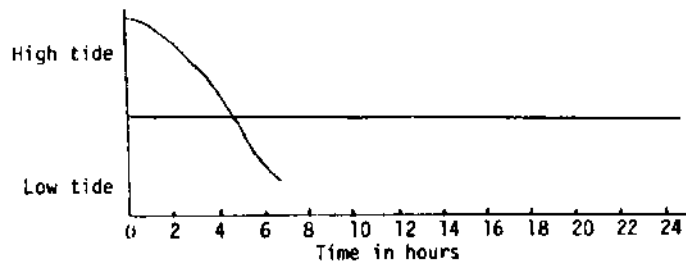


Fig. 11-10. Graph of tides.

Table 11-1. Calendar showing spring tide on first day of month.

1 Spring	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Table 1. Common Hawaiian multicellular animal
phyla comparison sheet.

Phylum	Chordata	Porifera	Cnidaria (Coelenterata)	Annelida	Echinodermata	Mollusca	Arthropoda
Body Symmetry							
Body Segmentation							
Type of Digestive Tract							
Type of Nervous System							
Method of Respiration							
Unique Anatomy							
Economic Importance							

Table 2-1. Coral cup features.

Data		Drawing
	A. Cup's diameter in mm B. Gap between cups (present or absent) C. Septa 1. number of septa/cup 2. entire/porous/reduced 3. join/do not join other cups D. Cup (elevated/non-elevated)	
	A. Cup's diameter in mm B. Gap between cups (present or absent) C. Septa 1. number of septa/cup 2. entire/porous/reduced 3. join/do not join other cups D. Cup (elevated/non-elevated)	
	A. Cup's diameter in mm B. Gap between cups (present or absent) C. Septa 1. number of septa/cup 2. entire/porous/reduced 3. join/do not join other cups D. Cup (elevated/non-elevated)	
	A. Cup's diameter in mm B. Gap between cups (present or absent) C. Septa 1. number of septa/cup 2. entire/porous/reduced 3. join/do not join other cups D. Cup (elevated/non-elevated)	
	A. Cup's diameter in mm B. Gap between cups (present or absent) C. Septa 1. number of septa/cup 2. entire/porous/reduced 3. join/do not join other cups D. Cup (elevated/non-elevated)	

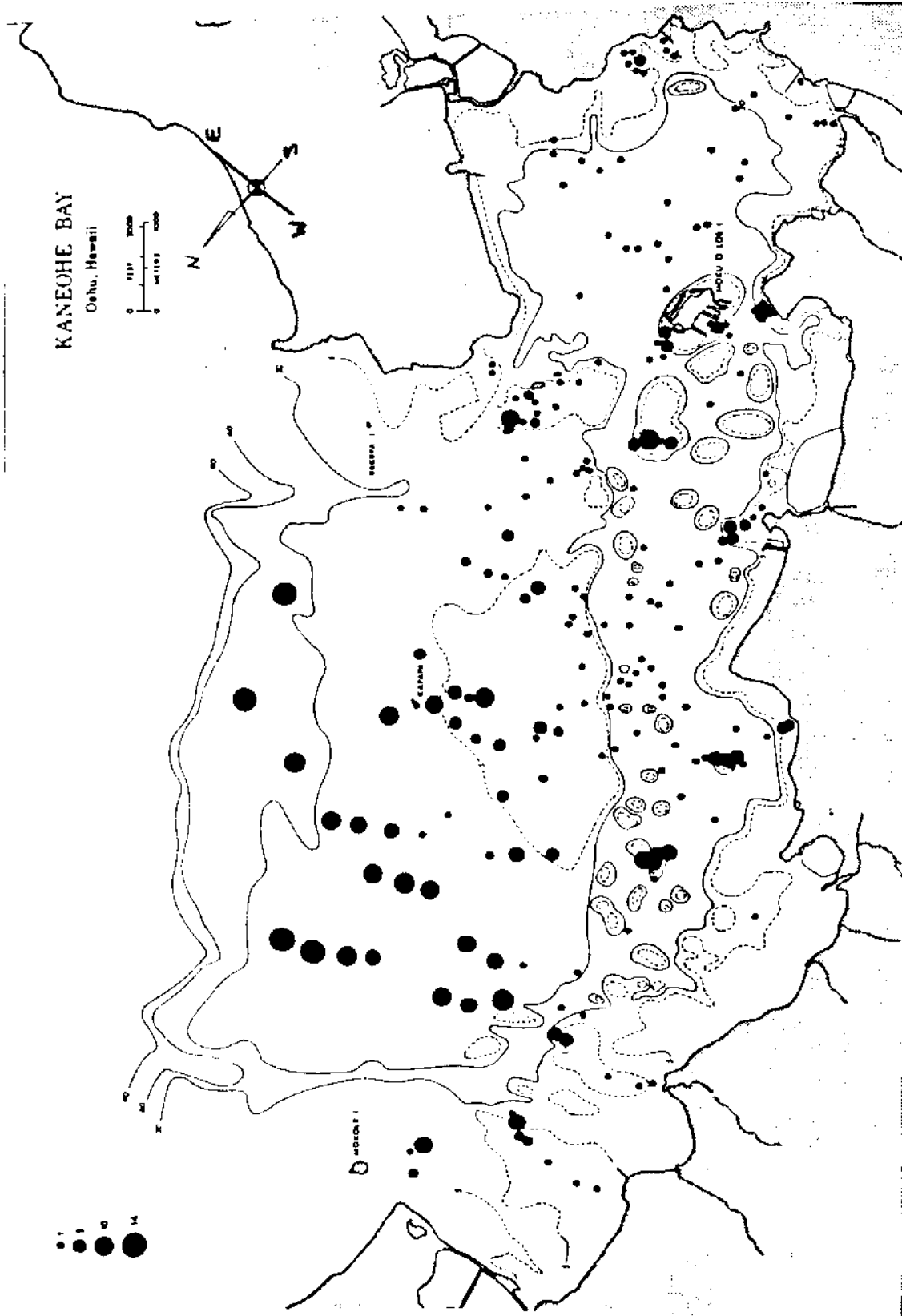


Fig. 4-2. Number of species of coral at each station in Kaneohe Bay.

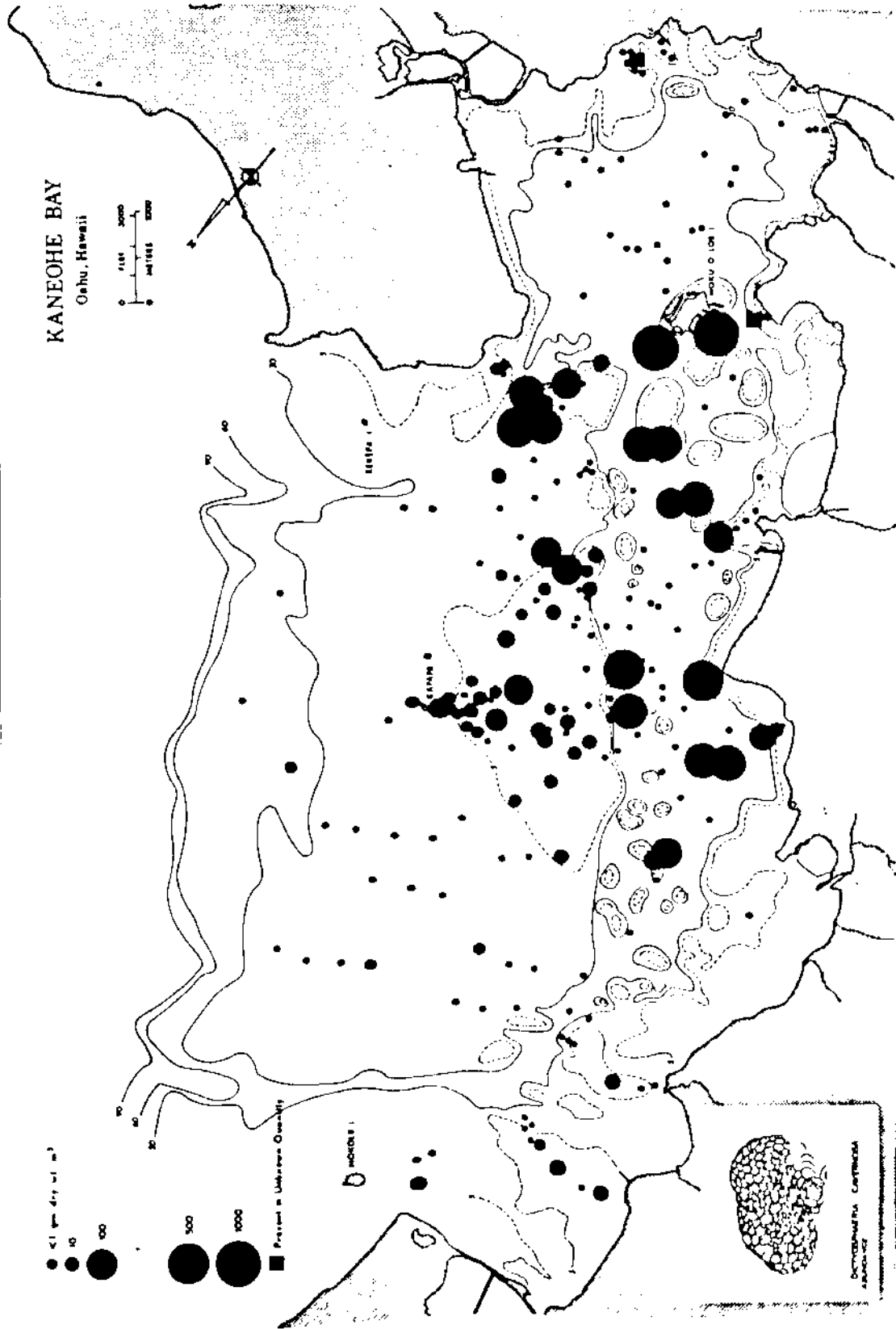


Fig. 4-3. Abundance of *Dictyosphaeria cavernosa* in Kaneohe Bay.

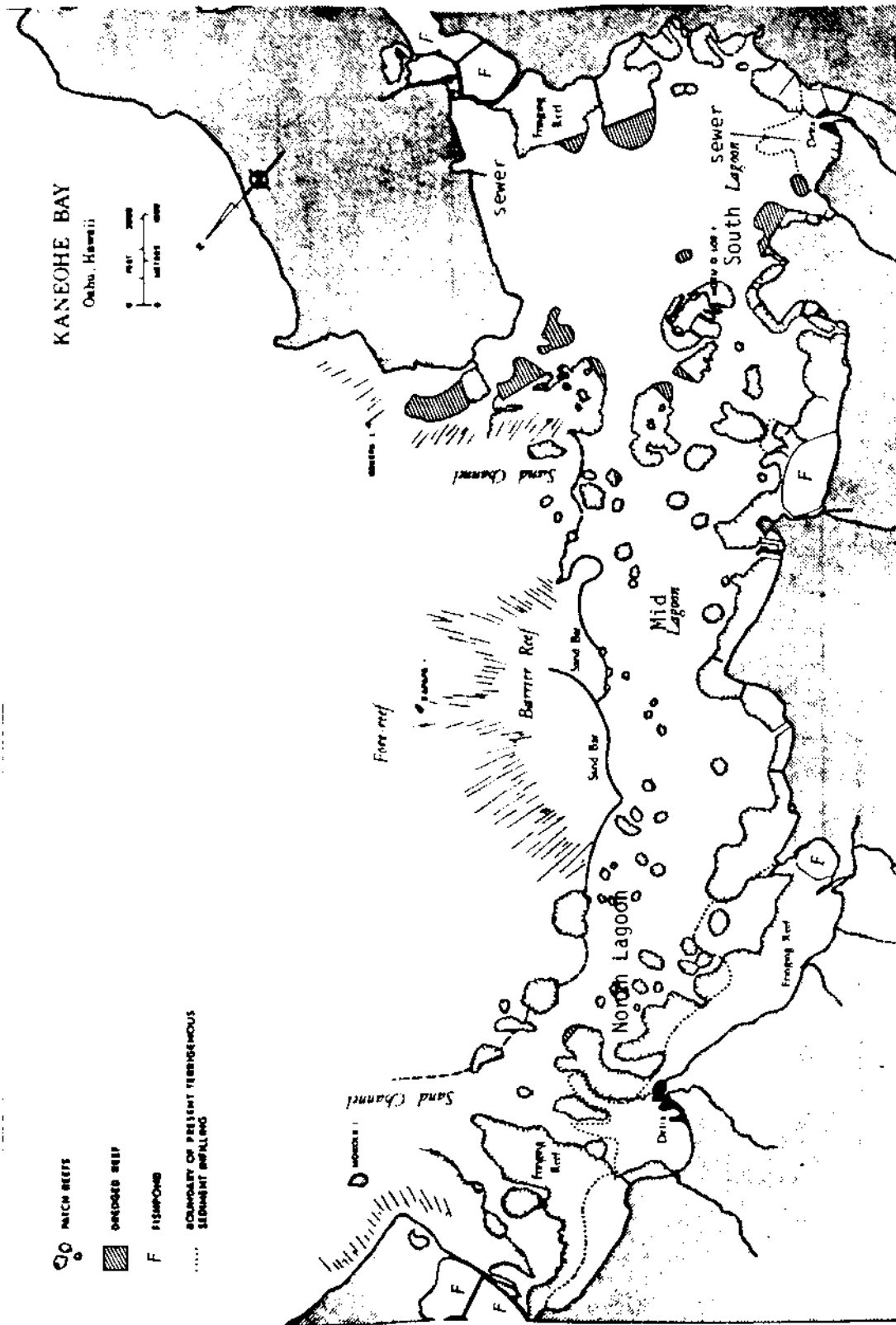


Fig. 4-4. Kaneohe Bay.

Table 5-1. Sea anemone response.

Disk Material	Positive Response	Negative Response
clam juice		
shrimp juice		
saliva		
plain disk		
fish food solution		
hair root		
clean tweezers		
grease from skin		
vinegar		
plant juice		

Table 6-1. Sea anemone regeneration.

Date	Cut A		Cut B		Cut C	
	beaker 1	beaker 2	beaker 3	beaker 4	beaker 5	beaker 6

Table 7-1. Comparison chart for sponges and tunicates.

	Sponge	Tunicate
Touch test		
External covering		
Internal structures		
Number of large openings		

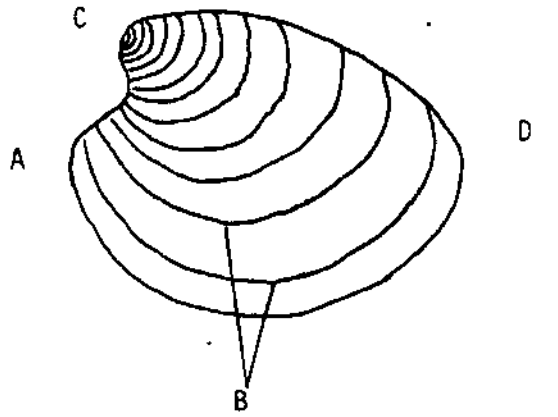
Table 8-1. Comparison of sponge characteristics.

Sponge	Color	Texture	Shape
A			
B			
C			
D			

Table 9-1. Sponge resident chart.

Animal	Number
Total	

Umbo
Anterior
Posterior
Lines of growth



A. _____ C. _____
B. _____ D. _____

Fig. 11-1. Clam external features.

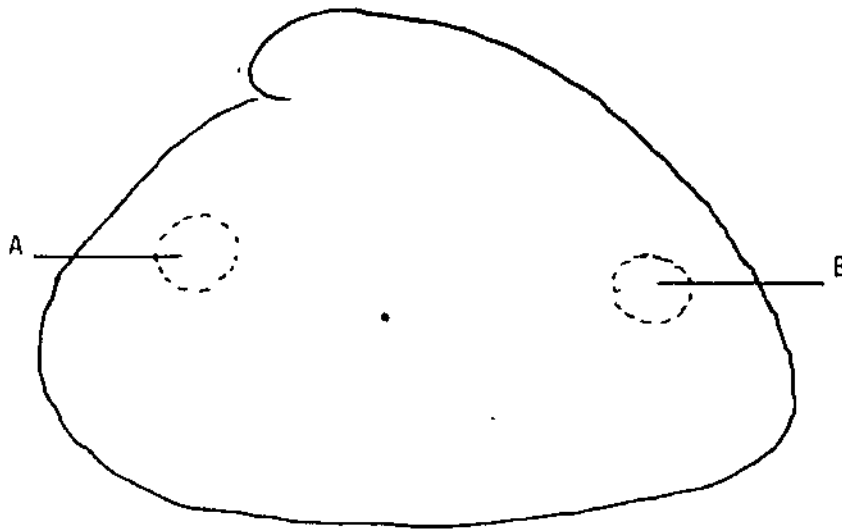


Fig. 11-2. Clam - internal features.

sketches of shells	shell shape	aperture			
		length	shape	margins	visible features
	slipper-like				
	turriiform				
	fusiform				
	globose				
	bulloid				
	conical				
	cap-shaped				
	1/4 shell length				
	1/2 shell length				
	3/4 shell length				
	length of shell				
	narrow				
	oval				
	round				
	square				
	no teeth				
	lip teeth				
	callus teeth				
	teeth on lip and callus				
	no canal				
	canal				
	notched				
	no notch				
	umbilicus				
	no umbilicus				
	callus				
	no callus				
	varices				
	no varices				
	shoulders				
	no shoulders				
	sutures				
	no sutures				
	spires				
	no spire				

Table 13-1. Data sheet for gastropod shell identification.

Fig. 14-1. Growth of embryo chart.

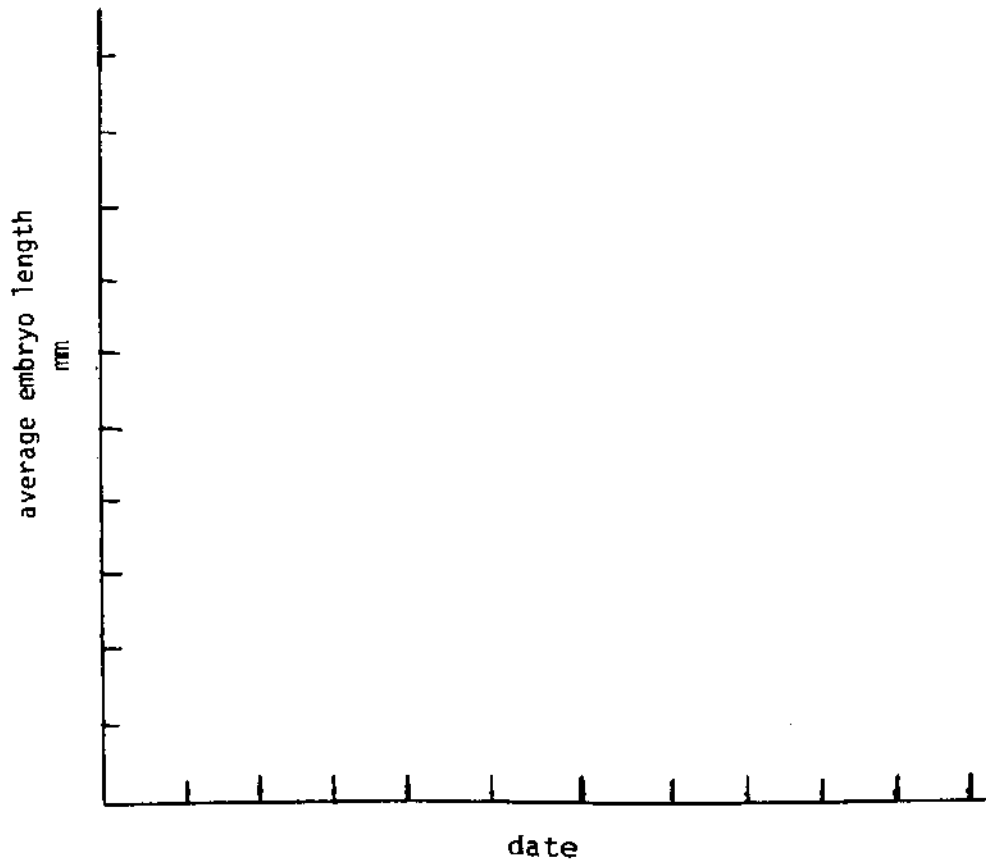


Table 15-1. Behavior of intertidal snails.

Average Time To Reach Marker	pipipi		pupu		drupe	
	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
25 ml						
50 ml						
75 ml						
100 ml						
Average Height In 15 Minutes						

Table 15-2. Position and adhesion strength.

Mollusk	Position	Adhesion strength
pipipi		
pupu		
drupe		

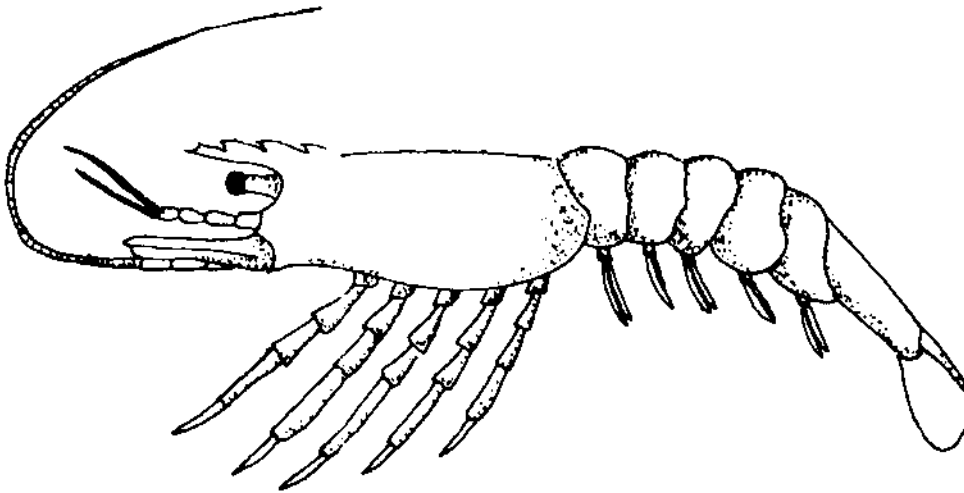


Fig. 16-2. Diagram of a generalized crustacean.

Table 16-1. Shrimp behavior

Structure	Behavior
antennae	
antennules	
feeding (mouth bait movement)	
walking legs	
abdomen and telson	
swimmerets	

Table 17-1. Behavior of hermit crabs with and without shells.

# minutes		
hermit crabs	contact between animals	no contact between animals
with shell		
without shell		

Table 17-2. Behavior shell-less hermit crabs.

hermit crab	In shell at end of test X	Tally number of attempts to capture shell
1		
2		
3		
4		

Table 17-3. Behavior shell-less hermit crabs.

Enters Shell #

Hermit Crab	1	2	3	4	5	6
1						
2						
3						
4						

Table 17-4. Behavior of snapping shrimp.

Snapping Shrimp	Observations
2 animals	
1 tube and 2 animals	

Table 17-5. Number of shrimp in each tube.

Separated tubes	Number of shrimp
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table 17-6. Number of shrimp in each tube.

Tubes in circle	Number of shrimp
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table 18-1. Sea urchin behavior.

	Response
Area touched	
-tube feet	
-single spine	
-test	
-several spines	
Rapid light changes	
-spines	
-tube feet	
Inverted animal	
-spines	
-tube feet	
Water Current	
-spines	
-tube feet	

Table 18-2. Debris selection.

Kinds of Objects	Size	Selection (+ or -)
algae		
coral rubble		
sand		
paper towel bits		
sticks		

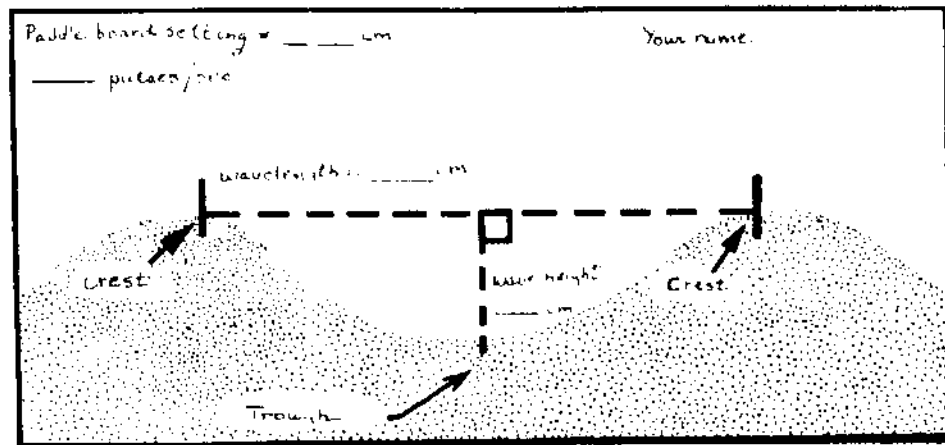
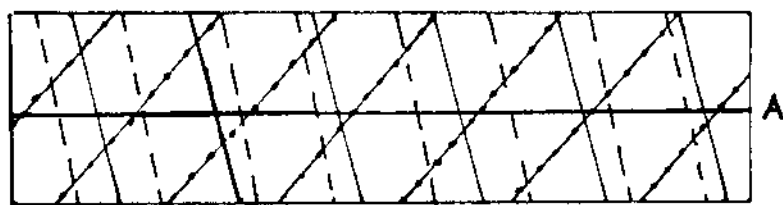


Fig. 4-4. Length and height analysis of water-marked wave picture.

Table 4-1. Effects of pulse rate and paddle guard setting on wave length and height.

		PULSE RATE (pulses/second)	
		2	4
PADDLE Guard Setting (cm)	4	wave length (L) = ___ cm	L = ___ cm
		wave height (H) = ___ cm	H = ___ cm
	8	L = ___ cm	L = ___ cm
		H = ___ cm	H = ___ cm



long swell ———
short swell - - -
cross swell ·····

Fig. 5-6. Superimposition of local swell on distantly generated long swell.

Table 1-1. Stomate patterns and numbers at 100X magnification.

<u>Plant</u>	<u>Upper Epidermis</u>	<u>Lower Epidermis</u>	<u># of Stomates in microscope field</u>
Land Plant			
Fresh Water Plant			
Sea Water Plant			

Table 1-2. Comparison of cuticle in land, marine and fresh water plants.

<u>Plant</u>	<u>Drawing of Cross-Sections</u>
Land plant	
Salt water alga	
Fresh water plant	

Table 1-3. Cross sections of land, fresh water and marine plants.

Land plant	Alga	Fresh water plant

Table 1-4. Characteristics of plants.

Plant	Stomates		Cuticle	Lignin
	Upper	Lower		
Alga				
Land plant				
Fresh water plant				

Table 3-2. Scientific names of seaweeds.

Seaweed Group	Genus, Species	Written Description
Green		
Brown		
Red		
Blue-green		

Table 6-1. Animals found in seaweed beach drift quadrat # _____.

Group # _____		Area of Quadrat (m ²) _____	
Location _____		Volume of Bucket _____	
Animal Phyla		Sketches and descriptions of animals	
Protists (Foraminifera, Protozoa)			
Porifera (sponges)			
Cnidaria (coelenterates)			
Platyhelminthes (flatworms)			
Annelida (segmented worms)			
Echinodermata (spiny-skinned)			
Mollusca (seashells, octopus)			
Arthropoda (jointed legs)			
Chordata (backbones)			

Table 6-2. Seaweed beach drift in quadrat (bucket) # _____.

Group # _____	Area of Quadrat (m ²) _____	
Location _____	(or) Volume of Bucket (gal) _____	
Date _____	Total wet weight of seaweeds (g) _____	
Genus (or species)	Wet mass (g)	% Composition
Total Mass (g)		100%

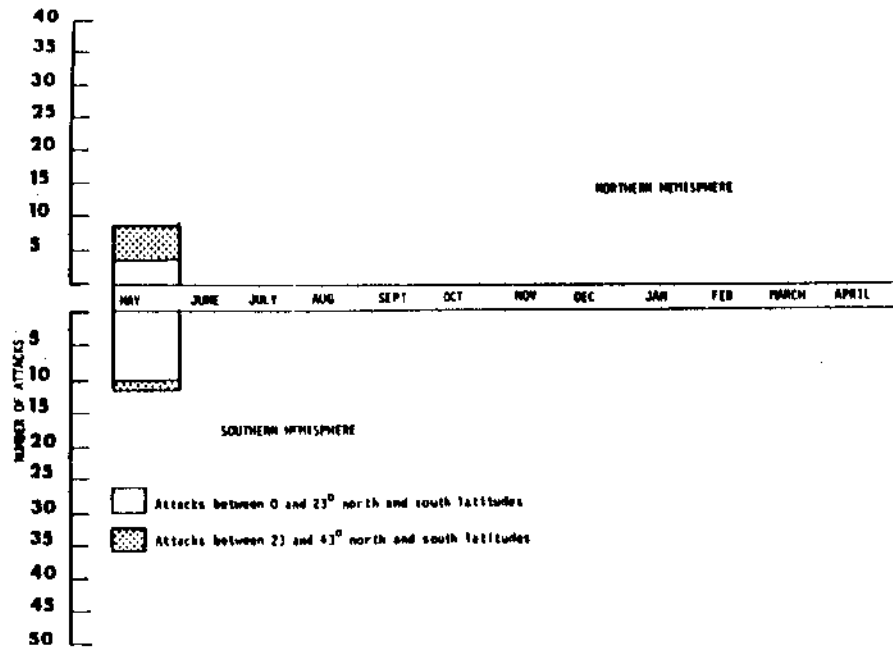


Fig. 1-3. World distribution of shark attacks.

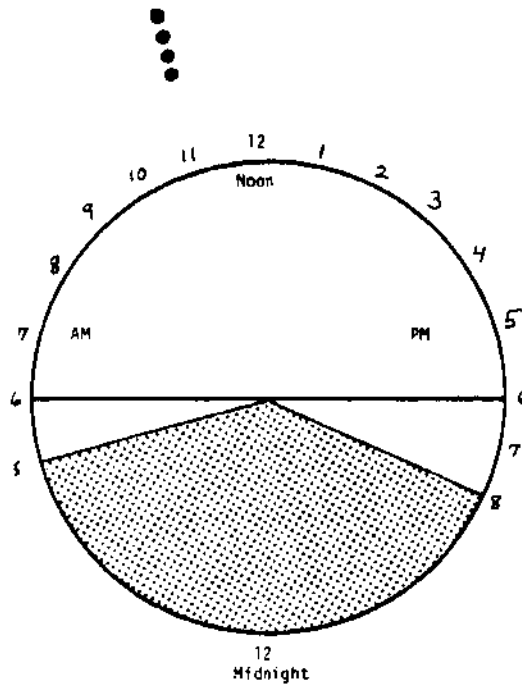


Fig. 1-4. Time of shark attack.

Table 1-3. 1971 Shark Control Program Catch Log for Oahu

area #	tiger	sandbar	black tip	grey reef	galapagos	mako	shark total
15					1		
16		3					
1		5	1		1		
2	9	10			2		
3	2	2	1				
4	5	1					
5		1			1		
6	4	1					
7	1	3					
8		1	1		1		
9	2					1	
10	3	3	1				
11	1	4	1		1		
12	NOT	FISHED					
13							
14		3	1				
Total							

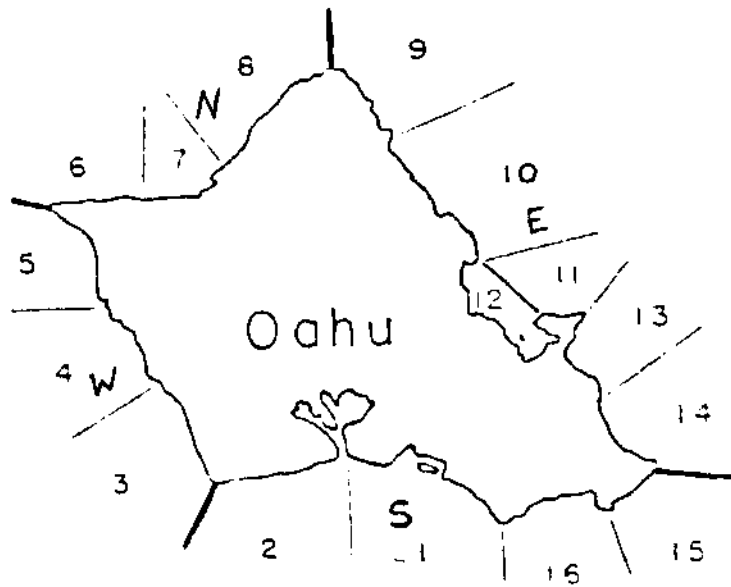


Fig. 1-5. Map of Oahu showing fishing areas 1-16 and divisions (E = east coast, N = north coast, W = west coast, S = south coast). Divisions are separated by heavy black lines. Area 12 is Kaneohe Bay.

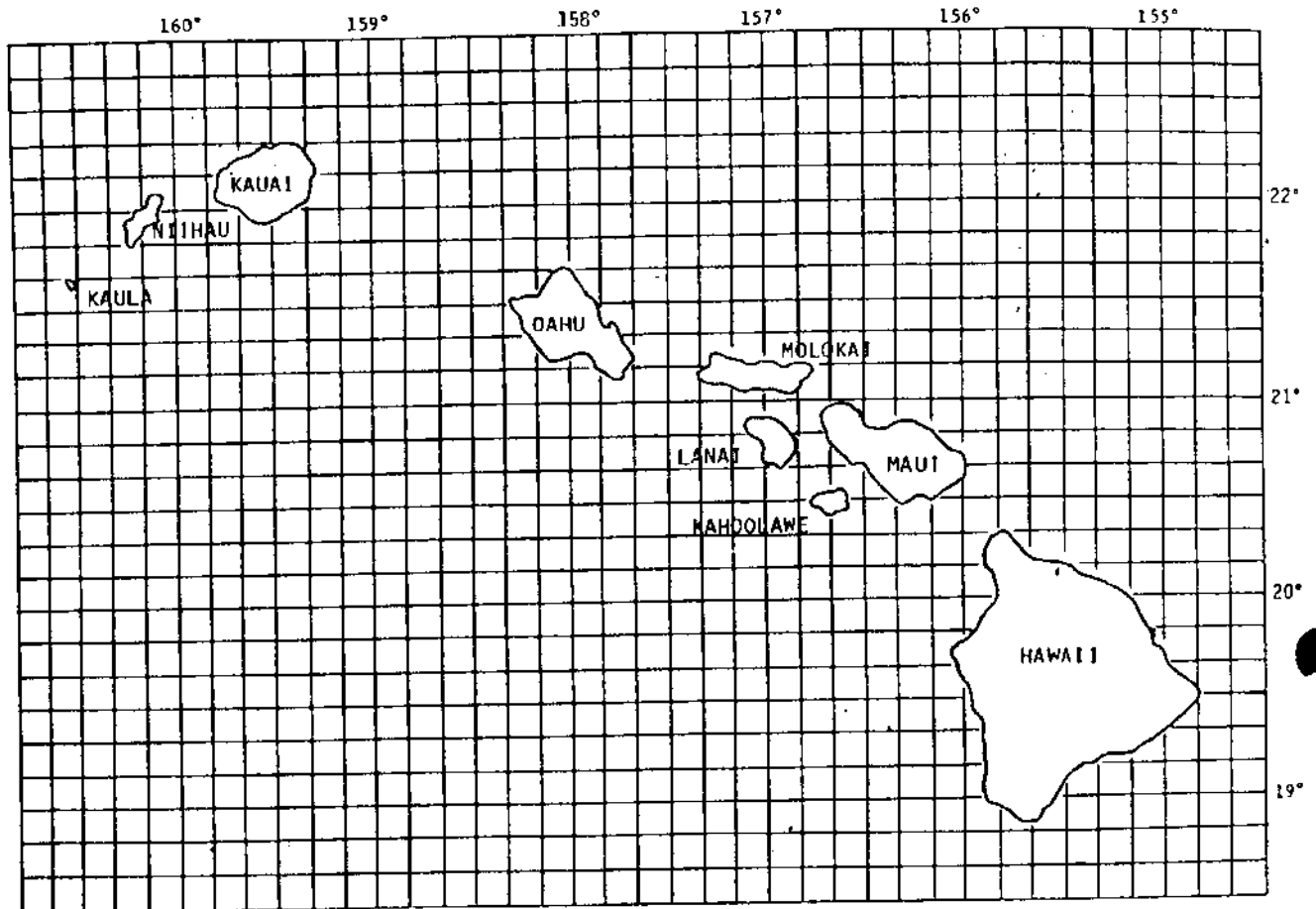


Fig. 3-2. Locations of whale sightings in Hawaii, February, 1977.

Table 3-3. Prawn farm statistics.

1. # eggs carried by one female	
2. mortality rate (50% of all stages)	
3. size of pond in m ²	
4. optimum density of juveniles	
5. Life table	
# juveniles	
# adults	
6. weight of harvestable adults	
7. sale value of prawns	
8. maintenance costs	
9. net	

Table 1-1. Net Buoyant Force.

Object	Floats or Sinks	Weight of Object (a) (gf)	Weight of Displaced Water (b) (gf)	Net Buoyant Force (b) - (a) (gf)
clay sphere				
metal				
wood				
clay boat				

Table 1-2. Hull design and carrying capacity.

	Sketch of Hull Shape	Carrying Capacity
Your Hull		
Class Hull with the Greatest Carrying Capacity		

Table 5-1. Boat sketches and speeds.

<p><u>My Boat</u> Distance (cm) _____ Time (sec) _____ Speed (cm/sec) _____ Boat Weight (gf) _____ Force, cup + weight (gf) _____</p>	<p>Boat #2 Distance (cm) _____ Time (sec) _____ Speed (cm/sec) _____ Boat Weight (gf) _____ Force, cup + weight (gf) _____</p>
<p>Boat #3 Distance (cm) _____ Time (sec) _____ Speed (cm/sec) _____ Boat Weight (gf) _____ Force, cup + weight (gf) _____</p>	<p>Boat #4 Distance (cm) _____ Time (sec) _____ Speed (cm/sec) _____ Boat Weight (gf) _____ Force, cup + weight (gf) _____</p>

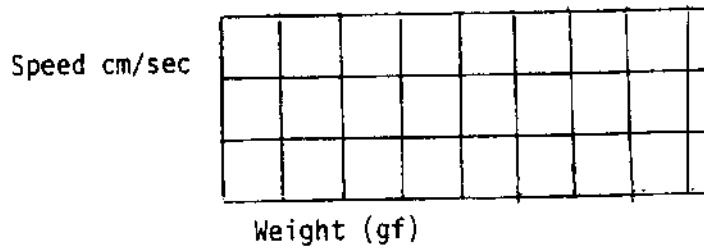


Fig. 5-2. Ship speed plotted against boat weight.

Table 5-2. Powering force and ship speed.

Powering Force (gf) (weight in cup)	Distance (cm)	Time (sec)	Boat Speed (cm/sec)
2			

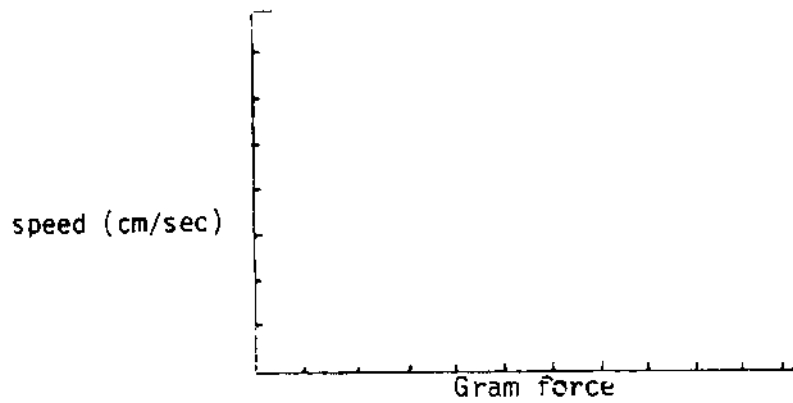


Fig. 5-3. Ship speed plotted against powering force.

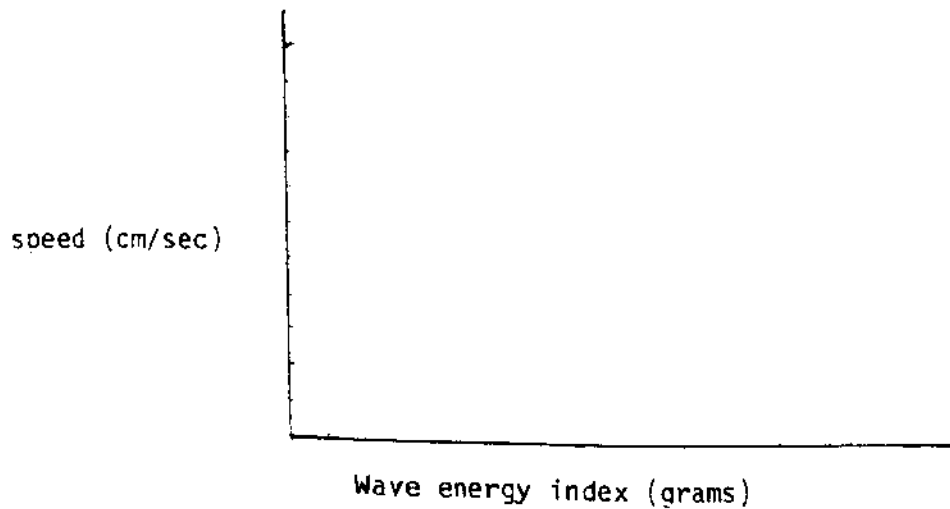


Fig. 5-5. Ship speed plotted against wave energy index.

Table 1-1. Interaction of charges.

	surface charged (+)	surface charged(-)
surface charged(+)		
surface charged(-)		

Table 2-3. Electron dot formulas for elements of Groups I-VIII.

Period	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	H	He						
2	Li	Be	B	C	N	O	F	Ne
3	Na	Mg	Al	Si	P	S	Cl	Ar
4	K	Ca	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra						

Table 2-4. Some elemental ions.

Li ⁺	Be ²⁺	B ³⁺		N	O ²⁻	F ⁻
Na ⁺	Mg	Al		P	S ²⁻	Cl
K	Ca				Se	Br
Rb	Sr					

Table 4-3. Periodic table showing elements essential to biological processes.

Groups IA ↓ IIA																		IIIA	IVA	VA	VIA	VIIA	VIIIA																
Periods →	1																	1	2																				
	1																	H	He																				
	2	3	4																	5	6	7	8	9	10														
		Li	Be																	B	C	N	O	F	Ne														
	3	11	12																	13	14	15	16	17	18														
		Na	Mg																	Al	Si	P	S	Cl	Ar														
	4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																				
		K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																				
	5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																				
		Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																				
	6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																				
		Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																				
	7	87	88																																				
		Fr	Ra																	57	58	59	60	61	62	63	64	65	66	67	68	69	70						
																				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb						
																				89	90	91	92																
																				Ac	Th	Pa	U																

Table 4-4. Periodic table showing major, minor, and trace elements of seawater.

Groups IA ↓ IIA																		IIIA	IVA	VA	VIA	VIIA	VIIIA																
Periods →	1																	1	2																				
	1																	H	He																				
	2	3	4																	5	6	7	8	9	10														
		Li	Be																	B	C	N	O	F	Ne														
	3	11	12																	13	14	15	16	17	18														
		Na	Mg																	Al	Si	P	S	Cl	Ar														
	4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																				
		K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																				
	5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																				
		Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																				
	6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																				
		Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																				
	7	87	88																																				
		Fr	Ra																	57	58	59	60	61	62	63	64	65	66	67	68	69	70						
																				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb						
																				89	90	91	92																
																				Ac	Th	Pa	U																

Table 4-5. Periodic table showing major, minor, and trace elements in the earth's crust.

Groups IA ↓ IIA																		IIIA	IVA	VA	VIA	VIIA	VIIIA																
Periods →	1																	1	2																				
	1																	H	He																				
	2	3	4																	5	6	7	8	9	10														
		Li	Be																	B	C	N	O	F	Ne														
	3	11	12																	13	14	15	16	17	18														
		Na	Mg																	Al	Si	P	S	Cl	Ar														
	4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																				
		K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																				
	5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																				
		Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																				
	6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																				
		Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																				
	7	87	88																																				
		Fr	Ra																	57	58	59	60	61	62	63	64	65	66	67	68	69	70						
																				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb						
																				89	90	91	92																
																				Ac	Th	Pa	U																

Table 4-6. Examples of data to calculate residence time.

Element	Amount now in Ocean $\times 10^{21}$ g	Amount added to Ocean/Year $\times 10^{13}$ g/y	Residence Time	Concentration Ion ‰
Sodium (Na^+)	14.4	20.7	69 million yrs.	
Magnesium (Mg^{2+})	1.9	13.3		
Potassium (K^+)	.5	7.4		
Calcium (Ca^{2+})	.6	48.8		
Silicon (SiO_2)	.008	42.6		
Chlorine (Cl^-)	26.1	25.4		
Sulfur (SO_4^{2-})	3.7	36.4		
Iron (Fe^{3+})	.0000014	2.2		
Copper (Cu^{2+})	.0000014	.007		

Table 5-1. Density and hydrometer reading.

	standard density	hydrometer reading
1		
2		

Table 5-2. Data on aquarium water.

Temperature _____			
Density _____			
Salinity _____			
Concentration		Concentration	
Cl ⁻		SO ₄ ²⁻	
Na ⁺		K ⁺	
Mg ²⁺		Ca ²⁺	

Table 6-1. Data table for seawater and stream water.

Item	Sea Water	Stream Water
1 Mass of beaker and water		
2 Mass of beaker		
3 Mass of water (1)-(2)		
4 Mass of beaker and concentrate		
5 Mass of beaker		
6 Mass of concentrate (4)-(5)		
7 Mass of beaker and remaining concentrate		
8 Mass of beaker		
9 Mass of remaining concentrate (7)-(8)		
10 Mass of concentrate on watch glass A (6)-(9)		
11 Decimal fraction of concentrate on watch glass A (10):(6)		
12 Mass of mineral and watch glass A		
13 Mass of watch glass A		
14 Mass of mineral (12)-(13)		
15 Mass of mineral in original seawater sample (14):(11)		
16 Salinity of water $[(15):(3)] \times 1000\text{g}/1000\text{g}$		
17 Mass of watch glass A and mineral on outer ring		X
18 Mass of watch glass B and mineral in inner circle		X
19 Mass of watch glass B for inner circle		X

Table 7-2. Elements forming covalent compounds showing valence bond notation.

			H-
-C-	-N-	O	F-
-Si-		S	
	As	Se	
			I
			At

Table 8-2. Degree of conductivity measured by light intensity.

Compound	Bright	Dim	No light
Alcohol			
Oil			
Hexane			
Sea Water			
Water			

Table 8-3. Conductivity and mutual solubility of liquid pairs.

Compound	Water		Oil		Hexane	
	Volume Lower Layer	Conductivity	Volume Lower Layer	Conductivity	Volume Lower Layer	Conductivity
Alcohol						
Hexane					X	X
Oil			X	X	X	X

Table 8-4. Relative solubility and conductivity of solutions.

Compound	Sodium Chloride (NaCl)		Wax		Detergent	
	Volume of Undissolved Solid	Conductivity	Volume of Undissolved Solid	Conductivity	Volume of Undissolved Solid	Conductivity
Alcohol						
Hexane						
Water						
Oil						

Table 9-3. Reactions of different chemicals in different pH solutions.

2 ml Solution	Limestone (CaCO ₃)	Iron (Fe)	2 ml Base (pH 13)	2 ml Acid (pH 1)
pH 1				--
pH 4				
pH 10				
pH 13			--	

Table 9-4. pH change or reaction of water and sea water with solution of known pH.

	1 Drop pH 1	1 Drop pH 4	1 Drop pH 10	1 Drop pH 13
pH () fresh water 9 drops				
pH () sea water 9 drops				

Table 9-5. pH of gases dissolved in water.

	CO ₂	SO ₂	NO ₂
Fresh water			
Sea water			

Table 10-1. Light and mass of algae.

	full light	2 layers partial light	4 layers partial light	no light
Mass of filter paper and algae				
Mass of filter paper				
Mass of algae				

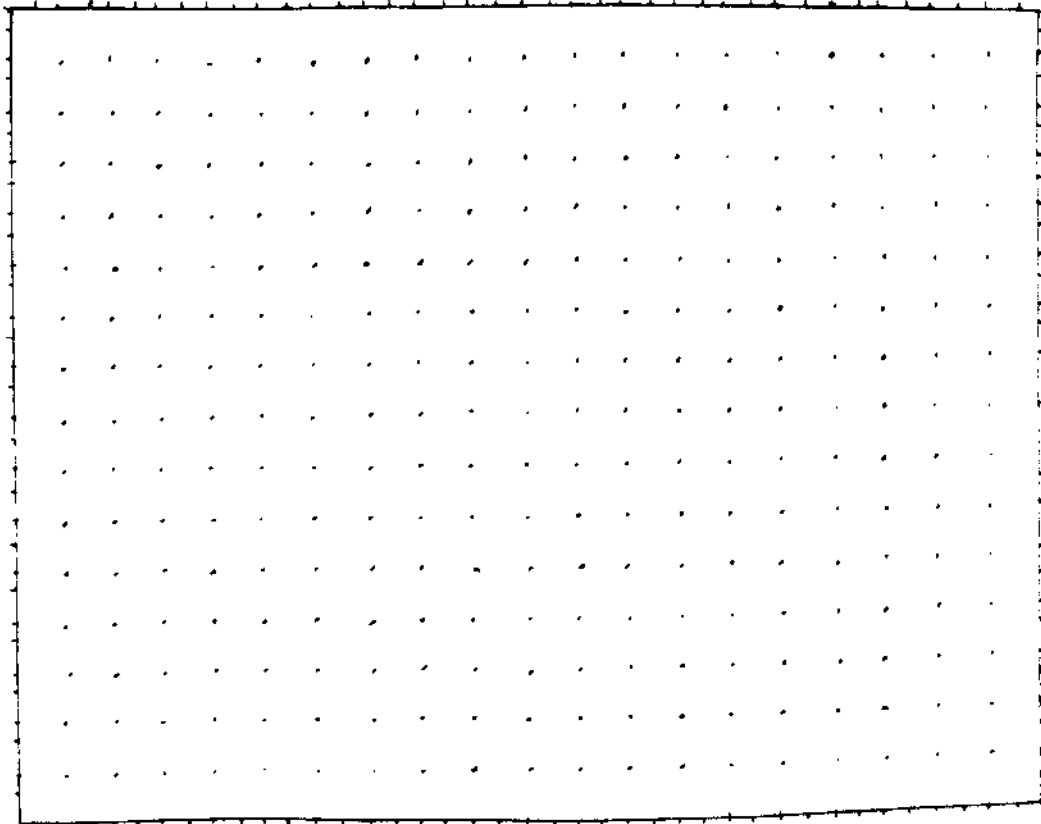
1. Maps

Fig. 1. Aerial view map.

Team no. _____ Location _____ Date _____ Time _____ Tide (m) _____

Cartographer(s) _____

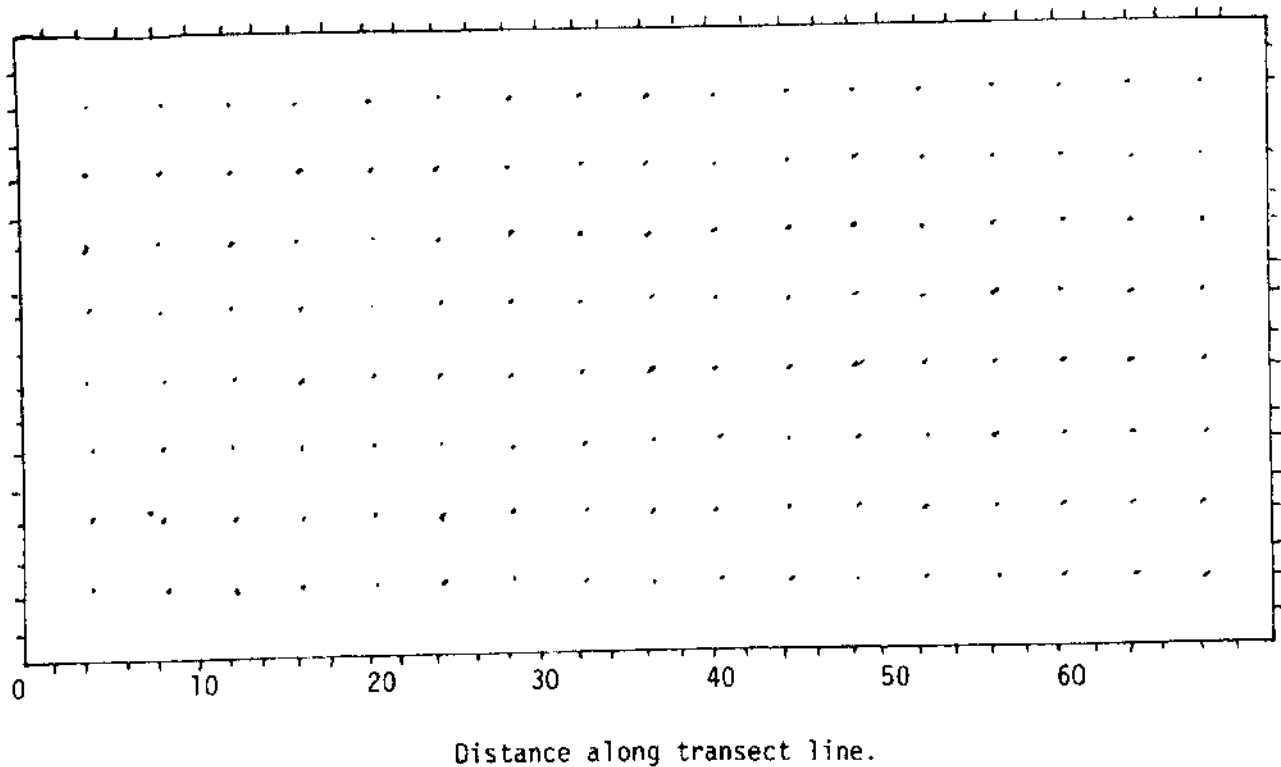
Indicate north, scale, boundaries, major features, transect and quadrat locations, wave zones, and objects in the beach area that can be used to relocate transect line positions at a later date.



Team no. _____ Location _____ Date _____ Time _____ Tide (m) _____
Cartographer(s) _____

1. Using a meter stick line, measure the water depth along the transect line. Plot depths on map below.
2. Indicate type of substrates observed along transect line (coral, coral rubble, loose sand, rocks, basalt bench, etc.).

Fig. 2. Profile (bathymetric) map.



2. Water Conditions

Table 1. Water conditions.

Study Area: _____ Transect Line/Sampling Station # _____
 Date: _____ Time: _____ Recorder(s): _____

WATER FACTORS	LOCATION OF SAMPLING STATIONS (either distance in meters along transect line, or sampling stations identified by number)			
A. TEMPERATURE (°C) <u>1. In Water Column</u> <u>Surface</u> <u>Mid-Column (meters)</u> <u>Bottom (meters)</u> <u>2. Air</u>				
B. DENSITY (g/cm ³) (Hydrometer reading)				
C. SALINITY (o/oo)				
D. TURBIDITY <u>Vertical Secchi(in meters)</u> <u>Horizontal Secchi(in meters)</u> Forele-Ule Scale				
E. pH				
F. OTHER: (Specify)				

Table 2. Wind, waves and currents.

Study Area: _____

Team No. _____

Date: _____ Time: _____

Physical Condition	Transect Lines				
	1	2	3	4	5
WIND CONDITIONS					
Speed					
Direction (gusty, steady, etc.)					
WAVE EXPOSURE					
Protected or exposed?					
From which direction?					
Height (meters)					
Period (seconds)					
Rolling or breaking?					
Primary or secondary?					
CURRENTS					
Approx. speed (m/sec.)					
Longshore direction					
Offshore/onshore direction					
TIDE					
Height					

Fig. 3. Density-temperature-salinity relationships at one atmosphere.

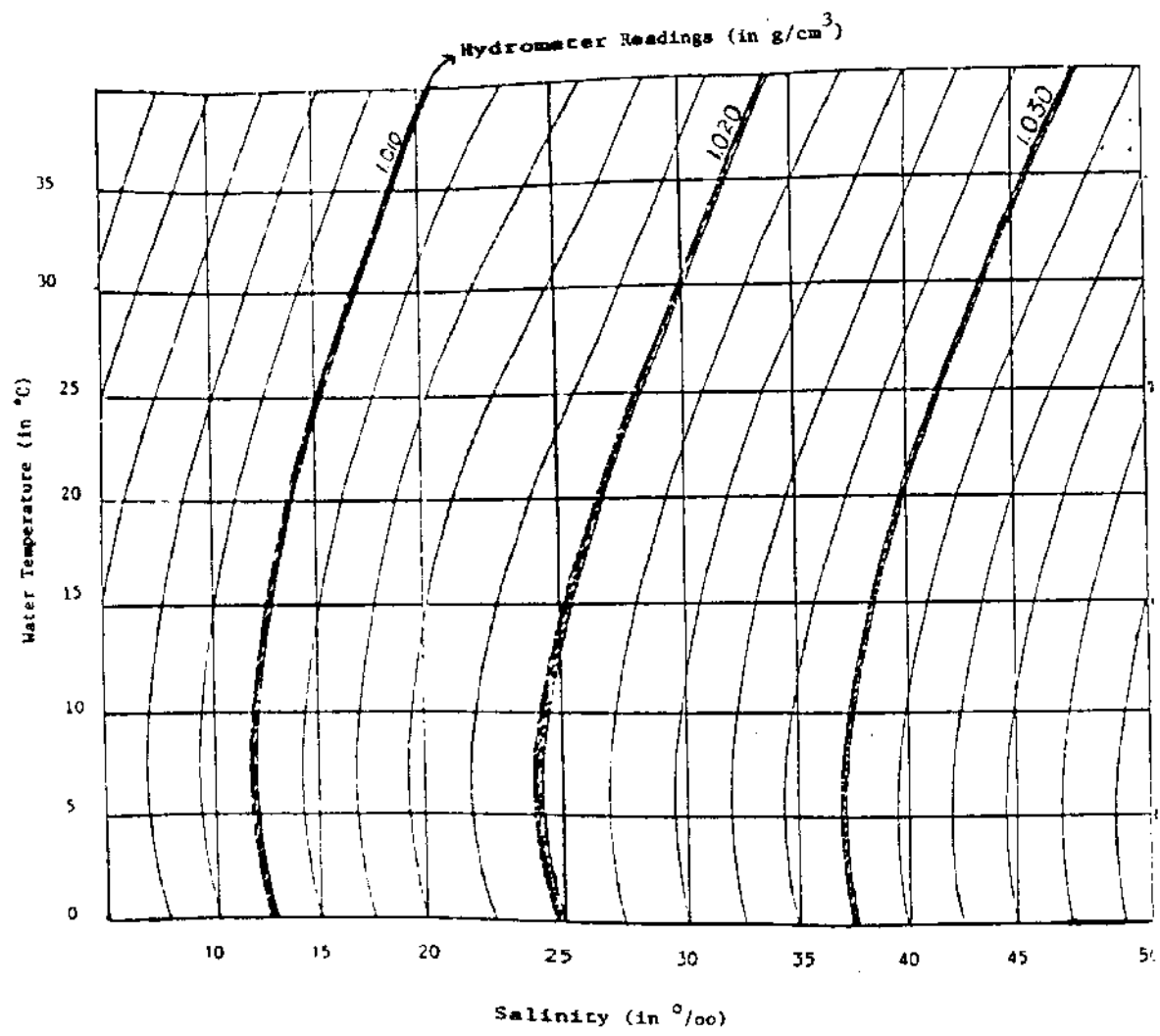


Fig. 4. Visual estimates of winds, waves, and sea conditions.

BEAUFORT FORCE	SEA STATE	DESCRIBED SEA CONDITIONS	ESTIMATED WAVE HT. (m)	ESTIMATED WIND SPEED DESCRIPTION (knots)
0	still	Sea smooth and mirror-like.	.08	Calm (0 - 1)
1	ripples	Scale-like ripples without foam crests.	.15	Light air (1 - 3)
2	ripples	Small, short wavelets; crests have a glassy appearance and do not break.	.61	Light breeze (4 - 6)
3	Chop	Large wavelets; some crests begin to break; foam of glassy appearance. Occasional white foam crests.	1.22	Gentle breeze (7 - 10)
4	Chop	Small waves, becoming longer; fairly frequent white foam crests.	1.82	Moderate breeze (11 - 16)
5	Small	Moderate waves, taking a more pronounced long form; many white foam crests; there may be some spray.	3.05	Fresh breeze (17 - 21)
6	Small	Large waves begin to form; white foam crests are more extensive everywhere; there may be some spray.	4.27	Strong breeze (22 - 27)
7	Small	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind; spindrift begins.	5.49	Near gale (28 - 33)
8	Small	Moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks along the direction of the wind.	7.01	Gale (34 - 40)
9	Storm waves	High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble, and roll over; spray may reduce visibility.	8.84	Strong gale (41 - 47)
10	Storm waves	Very high waves with long overhanging crests. The resulting foam in great patches is blown in dense white streaks along the direction of the wind. On the whole, the surface of the sea is white in appearance. The tumbling of the sea becomes heavy and shock-like. Visibility is reduced.	11.28	Storm (48 - 55)
11	Storm waves	Exceptionally high waves that may obscure small and medium-sized ships. The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility reduced.	13.72	Violent storm (56 - 63)
12	Storm waves	The air is filled with foam and spray. Sea completely white with driving spray; visibility very much reduced. (Courtesy National Weather Service)		Hurricane (64 - 71)

3. Substrates

A. Beach Observations

1. Observe and describe substrates found along the transect line. Record in Table 3.
 - a. Describe dominant substrates at each location. Use abbreviated terms such as those listed below Table 3.
 - b. Indicate approximately what per cent of the bottom is covered with each substrate.
 - c. Record other observations about the substrate at each location. Create your own abbreviations for things like attached seaweeds, broken glass, etc.

Table 3. Dominant substrate by composition.

Description	Location Along Transect Line (m)							
a. Dominant substrate -general composition								
-approximate size								
b. Dominant substrate -covers approx. % quadrat								
c. Other observations								

- B Lava rock (basalt)
- L Limestone reef (calcium carbonate)
- R Limestone rubble (coral rubble, calcium carbonate)
- O Other rubble, including shingles, pebbles and gravel
- S Sand
- SM Sand/mud
- M Mud
- C Cement
- W Wood
- BR Beach rock (shoreline bench)
- MP Metal pipes
- Other (specify)

Table 4. Dominant substrate by size.

Name	Dimension	Comments
Boulders	200 mm (8 in)	Usually lava or coral. Good evidence of original unweathered source of sand. What's eroding?
Cobbles	76-200 mm (3-8 in)	
Gravel		Includes shingles and pebbles
Coarse	76-79 mm	
Medium	19-79 mm	
Fine	5-19 mm	
Sand		Note color, shape. Particles this size are true sand. Wet samples will not stick together, feel gritty. Compacted (pressure, temperature, chemical,) forms sandstone. Often red. Sticky, slippery, may be shaped by rolling between fingers
Coarse	2-5 mm	
Medium	0.4-2.0mm	
Fine	0.07-0.4mm	
Silt or Clay	0.04 to 0.7 um	

B. Analysis of Sand by Sieving

1. Collect at least 100 ml sand from various quadrats along transect line. Place in a plastic bag and label.
2. Dry. Sieve 100 ml sand, beginning with largest sized mesh sieve. Shake sand onto clean white paper. Pour sand from paper into graduated cylinder. Note volume that came through largest sieve. Record in Table 5. Code your answers (e.g. cs - coarse sand).
3. Repeat procedure using medium and small sieve.

Table 5. Analysis of sand grain size.

Volume (ml)	Location Along Transect Line (m)							
Sieve 1 (largest)								
Sieve 2								
Sieve 3								
Sieve 4								

C. Microscopic Analysis of Sand

Using Table 7, identify components of sand samples collected along transect lines in Table 8.

Table 6. Microscopic identification of sand components.

Components of sand	Location Along Transect Line (m)								
<u>A. Inorganic components</u>									
Olivine									
Magnetite									
Volcanic glass									
Basalt									
Plagioclase									
Other									
<u>B. Organic Components</u>									
Coral									
Foraminifera									
Sea urchin spine									
Halimeda plates (algae)									
Sponge spicules									
Seashells, puka shells									
Other/unknown									

Table 7. Inorganic and organic components of sand.

1. Olivine Olivine is a green mineral which is broken from oceanic basalt (lava).
2. Magnetite Magnetite is an iron ore which forms a black crystal resembling a double pyramid. It shines like a metal.
3. Garnet Garnets are amber or beer bottle color usually, some are light pink. Look for a grain with twelve faces. Perfect crystals are rare because the ocean waves round off the edges rapidly.
4. Basalt Black lava flows are basalt. As they erode, they may form dull red, black or grey colored grains of gravel and sand.
5. Quartz Quartz grains are clear or transparent resembling small pieces of broken glass. Quartz comes from granite and sandstone erosion. It is the most abundant mineral found in mainland sand.
6. Feldspar Feldspar is clear, yellow or pink squarish crystals broken from lava.
7. Other: "Beach glass" is formed when broken shards of glass are founded and ground by wave action. Metals and other man-made substances can also be found on the beach.

Organic Components

8. Coral Fragments of coral rubble are common in Hawaiian sand. Even when worn smooth, coral may be identified by its many small rounded holes where individual coral polyps used to live.
9. Foraminifera Called "Forams" for short, these are the skeletons of one-celled animals (protozoans). They may be white and shiny, clear or covered with sand grains. They look like tiny shells except their apertures are small and slit-like or pore-like. Forams have a small hole where the living animal extended false feet to catch food.
10. Sea Urchin Spines Spines may be white, purple, black or beige. These needle-like structures may appear to have designs.
11. "Puka" Shell "Puka" is Hawaiian for "hole." These "shells" appear like shiny pearl-like discs with a puka in the center. They are the tops of cone shells.
12. Sponge Spicules Usually clear and transparent, sponge spicules may resemble tiny jacks (from the ball and jack game) or other geometric shape.
13. Micromolluscs Tiny shells of all types with large apertures.
14. Other Fish scales, teeth and earbones; platelets from *Halelida* (a coralline alga), crab claws.

4. Seaweeds

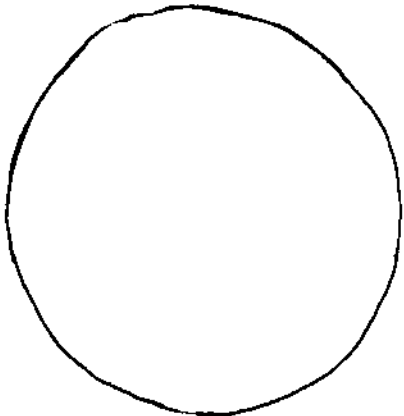
Table 3. Dominant seaweed species

Location _____

Quad Size _____

Date _____

Species	Wet Weight					Total	% Composition
	Quad 1	Quad 2	Quad 3	Quad 4	Quad 5		



% Composition of seaweed species

Table 9. Seaweed distribution along transect lines.

Name of Seaweed	SUBSTRATE TYPE	Location Along Transect Line (m)									
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											

Substrate Types: 1. Lava Rock, 2. Reef, 3. Coral Rubble, 4. Rubble/Sand, 5. Sand, 6. Sand/Mud, 7. Mud/Sand, 8. Mud, 9. Cement, 10. Wood

5. Animals

Directions

1. Look for and collect one of each species found along transect line. Animals may be burrowed in substrate on the bottom surface or hidden in seaweeds.
2. Carefully place each organism in a separate plastic bag containing seawater and air. Label bag. (Be sure water is kept cool and animal has sufficient air. For longer periods of time, place organism in aerated, insulated container.)
3. Count how many of each species you find in each quadrat. Record in Table 10.
4. Identify the animal by common name if you can. Then, using Fig. 5, identify each animal by phylum.
5. Complete an organism data sheet Table 11 for each animal you collect.

Table 10. Animal tally sheet.

Name of Animal	Location Along Transect Line										Location in Habitat	
	0m	5m	10m	15m	20m	25m	30m	35m	40m	45m		50m
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												

*Location in habitat: (1) in substrate, (2) on substrate, (3) among seaweed, (4) open water, (5) other (specify)

**Motion (if any): (1) sessile (attached), (2) crawling, (3) swimming

Fig. 5. Marine invertebrates.



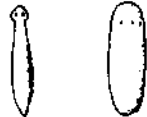





SKETCHES OF TYPICAL ORGANISMS	PHYLUM
<p>Sponges</p> 	<p><u>PORIFERA - Sponges</u></p> <p>Spongy, soft, pliable, (spicules inside): bright colors; blue, orange, yellow, etc; many holes in body; <u>upright & branching</u> or <u>attached & encrusting</u>.</p>
<p>Sea anemones, corals, jellyfish, hydroids</p> 	<p><u>CNIDERIA - corals, etc.</u></p> <p>Body radically symmetrical with tentacles spaced evenly around top rim (radially symmetrical) with stinging cells.</p> <p><u>Solitary</u>: sea anemone, <u>Fungia</u></p> <p><u>Colonial</u>: most corals; <u>Branching</u>: hydroids;</p> <p><u>Free swimming</u>: (bubble with tentacles) jellyfish</p>
	<p><u>ANNELIDA - Segmented Worms</u></p> <p>Bilaterally symmetrical, segmented:</p> <p><u>Polychaetes</u> with hairs or spines along sides; <u>tube dwellers</u> with tentacles or fans at heads for food gathering, oxygen exchange.</p>
<p>Fireworms, bristle worms, tube worms</p> 	<p><u>ANNELIDA - Segmented Worms</u></p> <p>Bilaterally symmetrical, segmented:</p> <p><u>Polychaetes</u> with hairs or spines along sides; <u>Tube dwellers</u> with tentacles or fans at heads for food gathering, oxygen exchange.</p>
<p>Starfish, sea urchins, sea cucumbers, brittle stars</p> 	<p><u>ECHINODERMATA - starfish, sea urchin, etc.</u></p> <p>Spiny or bumpy skin, tube feet for locomotion or attachment, radial symmetry.</p>
<p>Slugs, cowries, clams, squid, octopus</p> 	<p><u>MOLLUSCA - shells and nudibranches</u></p> <p>Soft body usually protected by shell; muscular foot for locomotion;</p> <p>Without shell, sea slugs; <u>Single shell</u>, snails, etc.; <u>Two shells (hinged)</u>, clams, oysters. (bivalves); <u>Free-swimming</u>, octopus (8 tentacles), squid (10).</p>
<p>Crab, shrimp, lobster, barnacles</p> 	<p><u>ARTHROPODA</u></p> <p>legs jointed; exoskeleton,</p> <p><u>Free moving</u>: crabs, shrimp, lobster</p> <p><u>Attached</u>: barnacles</p>
<p>Tunicates - Sea Squirt</p> 	<p><u>CHORDATA</u></p> <p>Nerve chord down back;</p> <p>Tunicates - have nerve chord only when larvae;</p> <p>Adults - <u>Solitary & attached</u> with dull colors and 2 large holes, or <u>colonial & encrusting</u>, brightly colored and mottled.</p>

Table 11. Organism data sheets.

Fill in
after
field trip

1) Phylum _____	Date _____
2) Order of Family _____	Site _____
3) Common Name _____	Name of Reporter _____
4) Scientific Name _____	_____
5) Name & Location of Shoreline Area _____	_____

Fill in
on the
beach

Circle: Common, Uncommon _____	Tide _____
Coloring _____	Weather _____
Length _____	_____
<p><u>SKETCH</u> If ANIMAL, label eyes, mouth, appendages and anus. Do both a dorsal (top) and side view is possible. If PLANT, a pressing is suitable. Use back of this sheet if more space is needed.</p>	

Fill in
while
observing
and
collecting

TRANSECT OR QUADRAT NO. _____	COLLECTION NO. _____	TIME _____
Circle: free, attached _____	to what _____	
Circle: stationary, propelled by what _____	_____	
<u>LOCATION</u> _____	WATER TEMP. _____	
DEPTH _____	SECCHI LIGHT PENETRATION _____	
SUBSTRATE _____	Illumination around organism light _____ dark	
<p>Description of the immediate environment of the organism, or <u>habitat</u>, including: 1. associated organisms 2. coloring of substrate 3. protective structures 4. other features.</p>		

