Wonderful Water

An Environmental Education Programme

A Watery World

Mangrove Ecosystems in TCI

2. Adaptations of Mangrove Species

Teachers' Guide



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Target Age Group - 9-11 years

This environmental education programme has been produced by the UK Overseas Territories Conservation Forum (UKOTCF) and the Turks and Caicos Department of Education.

It was part-funded by the Overseas Territories Environment Programme (OTEP) of the UK Department for International Development and the Foreign and Commonwealth Office.

The project was developed from an original idea by Mr Edgar Howell, Director of Education, Turks and Caicos Islands, and these materials developed by a team co-ordinated by Ann Pienkowski, Environmental Education Co-ordinator, UKOTCF. It is hoped that through the teaching materials developed for this project, students in TCI will gain a greater understanding of the importance of the water ecosystems in TCI, and the need to conserve these.

As a possible model to assist environmental education in other areas of the Caribbean (especially UK Overseas Territories) these materials will be made available to a wider audience.

Contents

Introduction

In devising these teaching materials, reference was made to the TCI Science Curriculum for Grade 5 and 6, and the science teaching materials currently being used in primary schools in TCI.

A curriculum framework has been developed, which links the Wonderful Water themes to curriculum requirements. As part of the curriculum framework, expected levels of achievement for a particular stage in a students' education have been developed into statements of competency which can be used to assess the levels students have reached. The purpose of these statements of competency is to support teachers in their review of students' progress. The objectives given in the pupils' materials relate to these statements of competency.

Assessment criteria / Statements of competency

These level statements relate to levels of attainment given in the Science National Curriculum for England, but are compatible with such statements about expected attainment in many other curricula.

This table gives the level (L) a child is expected to achieve at a particular stage in their schooling:

End of grade:	Expected attainment related to curriculum levels (from National Curriculum for England)		
	Slower progress	Most pupils	Faster progress
4	L2	L3	L3/4
5	L2/3	L3/4	L4/5
6	L3	L4	L5

2 - Adaptations of Mangrove species: statements of competency

The assessment criteria / statements of competency, which relate to the unit on Adaptations of mangrove species are given below. These can be used to guide progression.

How animals and plants in different [mangrove] ecosystems are suited to their environment.

L2: Recognise that different living things are found in different places, and with help say why a plant or animal is suited to a place [mangrove]
L3: Identify ways in which an animal or plant is suited to its environment [mangrove].
L4: Provide simple explanations for animal and plant behaviour that helps them survive and cope with change (eg changing physical conditions on the coast)
L5: Explain how more complex features help animals and plants survive in a named ecosystem [mangrove]

The pupils' text provides key information for pupils.

The teachers' guide contains further information and resources for teachers, suggested activities for pupils, and example pupil worksheets.

The suggested pupil activities and worksheets can be carried out by individuals, pairs or small groups.

These materials are a working draft, and any suggestions for further activities, amendments and improvements are welcome.

Any comments / suggestions should be sent to the UKOTCF Environmental Education Co-ordinator, Ann Pienkowski. Email apienkowski@ukotcf.org

What is an Adaptation? Overview

Anything that helps an organism survive in its environment is an adaptation. It also refers to the ability of living things to adjust to different conditions within their environments.

Types of adaptation can be summarised as:

Structural adaptation involves some part of an organism's body. In plants this could be the leaf structure, presence of thorns or spines, ability to withstand drought, the way it produces and disperses its seeds, etc. In animals this could be the size or shape of the teeth, the animal's body covering.

Protective colouration (camouflage) allows an animal to blend into its environment.
Natural camouflage is one of the most widespread and varied adaptations. While colour and pattern play important roles in camouflage, so does its behaviour. Animals can use camouflage to help them remain hidden from predators, and hidden from prey that they are trying to catch.

Mimicry allows one animal to look, sound, or act like another animal to fool predators into thinking it is poisonous or dangerous.

Behaviour adaptations

Migration is the behavioural adaptation that involves an animal or group of animals moving from one region to another and then back again.
Animals migrate for different reasons:

- better climate at some seasons
- better food at some seasons
- safe place to live at some seasons
- safe place to raise young

Hibernation is a deep sleep in which an animal's body temperature drops to about the temperature of the environment. Body activities, such as heartbeat and breathing are slowed causing the animal to need very little food.

Adaptations of plants in the mangrove zone

Mangrove plants have very specialised structural adaptations that allow them to deal with a high salt concentration environment.

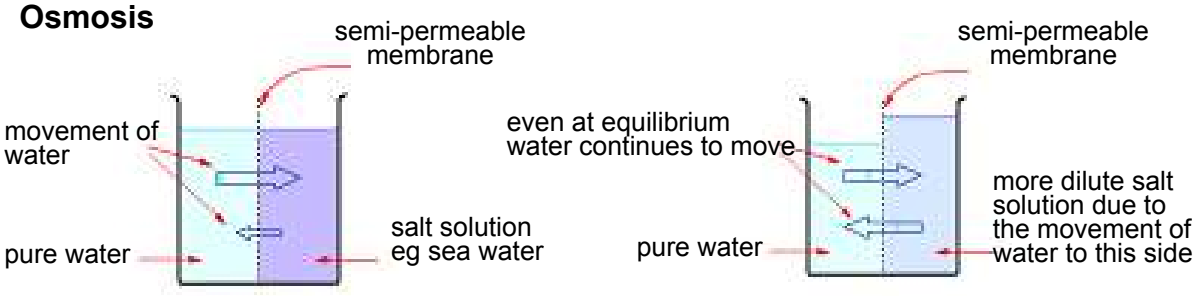
The prop roots of the Red Mangrove exclude salt by **reverse osmosis**. This is the same process which is used in water de-salination, where fresh drinking water is obtained from sea-water.

To explain reverse osmosis, an understanding of **osmosis** is needed first.

Osmosis is the passage of water from a dilute solution through a **semi-permeable membrane** to a more concentrated solution. A semi-permeable membrane is a membrane that will allow some

atoms or molecules to pass through but not others.

So normally freshwater will pass into a plant cell by osmosis, because the cell contents are a more concentrated solution than freshwater



Reverse osmosis is the opposite. Water passes through a semi-permeable membrane from the more concentrated solution into the less concentrated solution. So fresh water passes from the sea water into the Red Mangrove by reverse osmosis, leaving the salt behind. The Red Mangrove prop root has a semi-permeable membrane which keeps the salt out, and lets fresh water pass through for the plant to use. How does this work? It is caused by pressure reversing normal osmosis. This is a complex process. Put simply transpiration (water loss) at the leaf surfaces produces high negative pressure in the xylem tissue. [The xylem of a plant is the system of tubes and transport cells that circulates water and dissolved minerals. Water is absorbed in the roots, and is needed in the leaves. The xylem consists of vessels that are connected end to end to move water around. Tree rings in seasonal environments are the remains of old xylem tissue, one ring for every year the tree was alive.] This negative pressure in the xylem causes fresh water to pass from the salt solution (sea water) into the root, leaving the salt behind. Otherwise, normal osmosis would mean that water would pass from the Red Mangrove into the salty sea water.

Salt deposit on a Black Mangrove leaf. This is how the Black Mangrove gets rid of excess salt. This is why if you lick a Black Mangrove leaf it tastes salty

In contrast to the salt exclusion observed in Red Mangroves, other species such as Black Mangroves, White Mangroves and Buttonwoods each use salt excretion to get rid of excess salt. The take in salty water through their roots. Salt concentrations in the sap of these species may be up to ten times higher than in species that exclude salts. They then excrete excess salts using specialized salt glands located in the leaves. In the Black Mangrove this is done in the leaf. In the Buttonwoods, it is done by salt glands at the base of the leaf.

Buttonwood salt glands at the base of the leaf

If possible, collect some examples of Buttonwood leaves showing the salt glands at the base of the leaves and take these into the classroom for students to examine.

Summary Table of Adaptations of Animals in the Mangrove Ecosystem

Animal	Body parts or structural adaptations	Behavioural adaptations
Silversides fish	Silvery colour – makes it more difficult for predators to pick them out camouflage Long narrow shape – important for a small fish as it reduces water resistance as it moves quickly through the water.	Live in large shoals. By keeping together as a group, they make it more difficult for a predator to pick one out. And if they are in a large group the chances that any one individual will be caught are smaller than if they were one of a small group. The shoal moves together as if it were one unit, to confuse predators. The shoal moves and changes direction quickly, to get out of the way of predators.
Needlefish	Streamlined shape for low water resistance and mobility. Very sharp teeth to hold prey once they have caught it. Translucent grey colour blends in with background - camouflage	Swim near the surface where the surface ripples hide them from their prey. Catch prey with a sideways sweep of the head.
Aquatic Blue Crab and Blue Land Crab	Hard shell to protect soft internal body. Eyes on protruding eyestalks, so that the crab can see front, back and sideways. The crab's antennae can sense vibrations, smell and taste chemicals in the water to help detect prey or predators. The land crab's antennae detect smells in the air. Pincers for feeding and defence against enemies. Gills so that it can get oxygen from the water, like fish do.	The Aquatic Blue Crabs are lie-and-wait predators. They hide buried in the sand, then reach up at passing fish lightening fast. You wouldn't think a crab would be able to move that fast, but they can. The Blue Land Crab can also move fast to grab prey as it goes by its burrow. The land crabs live in deep burrows, which protect them from predators, and keep them hidden from their prey. The burrows help keep their gills moist, because they get oxygen from the air through their gills, just like the Aquatic Blue Crabs. Gills need to be moist to do this. Blue Land Crab migrates to sea to release eggs.
Yellow-crowned Night Heron	Heavy bill to cope with eating crabs. Large eyes, so that it can spot its prey well, and can see to hunt at night. Long legs to wade in water Wings and feathers so it can fly to move to another place or get away from danger.	Stands motionless and waits (sometimes for several minutes), until food (like crabs) appears, then lunges to seize prey in its bill. Or slowly wades in water stalking its prey. (Feeding method depends on what prey it is after.) Hunt on their own, away from other birds.

A useful video of Silversides is available to view on YouTube:
http://www.youtube.com/watch?v=xqs4imGVxew

Adaptations of animals in the mangrove ecosystem

Although the **Introduction** mentions hibernation as a behavioural adaptation, this is not relevant for tropical species.

The structural and behavioural adaptations of the species' accounts in the pupils' text are summarized in the table on the previous page.

Suggested Consolidation and Follow-up Activities

Activity to show students one of the important structural adaptations they have.

Ask who can tie shoelaces. Get a volunteer (or several) to come and tie the laces of a pair of shoes provided.
Then ask students to tuck thumbs into palms and try to tie shoelaces.

Discuss this.

It is very difficult to tie shoelaces without using thumbs. Humans have thumbs opposite their fingers, which we use to tie shoes, pick up food or play games. Not all animals have thumbs. Thumbs are a body adaptation that humans (and other primates such as monkeys) have that help us survive.

Ask students for any other suggestions as to adaptations humans have. They might come up with:
eyes to see,
ears to hear,
legs and feet to walk,
a large and complex brain, for problem solving and creative thinking
special vocal cords and throat structure for talking.

Activity to show a behavioural adaptation humans have.

You will need balloon and / or large book (one which you can drop without damaging it)

Explain that you will pop the balloon / drop the book. Students should pay careful attention to how they react. Ask students to close eyes and quietly count to ten.

When they get to any number you like pop the balloon or drop the heavy book on the floor. Once the students have calmed down, ask how they reacted to the noise (jumped, shouted, ...)

Discuss how their reactions to the noise could help them. (avoiding danger by running, scaring a predator by shouting ....)

Discussion to reinforce learning about adaptations and how they help plants and animals survive

Use the photo resource material to discuss adaptations of plants and animals found in the mangrove ecosystem – include both structural and behavioural adaptations.
Summary table can assist here.

Students can follow the discussion up by:

- making their own drawings and labelling the animal's adaptations on their drawings,
- listing the animal's adaptations
- making their own table of adaptations.

Finally, discuss with students similarities and differences they see in the adaptations of the animals.

Activity: What adaptations would you want if you were a mangrove animal?

Ask students to create a new animal that lives in the mangroves. Ask them to think about the adaptations that this organism would need to survive. Encourage them to think of a least two body parts, or structural adaptations, and one behavioural adaptation.

They could draw their new mangrove animal, and label its adaptations. Or they could make a model of their new mangrove animal.

Ask them write a story about the new mangrove animal and how its adaptations enable it to live and survive in the mangrove. The stories can be made into a class book, shared with other classes, with parents. If the school has a website or Facebook page, the stories and photographs of artwork can be uploaded.

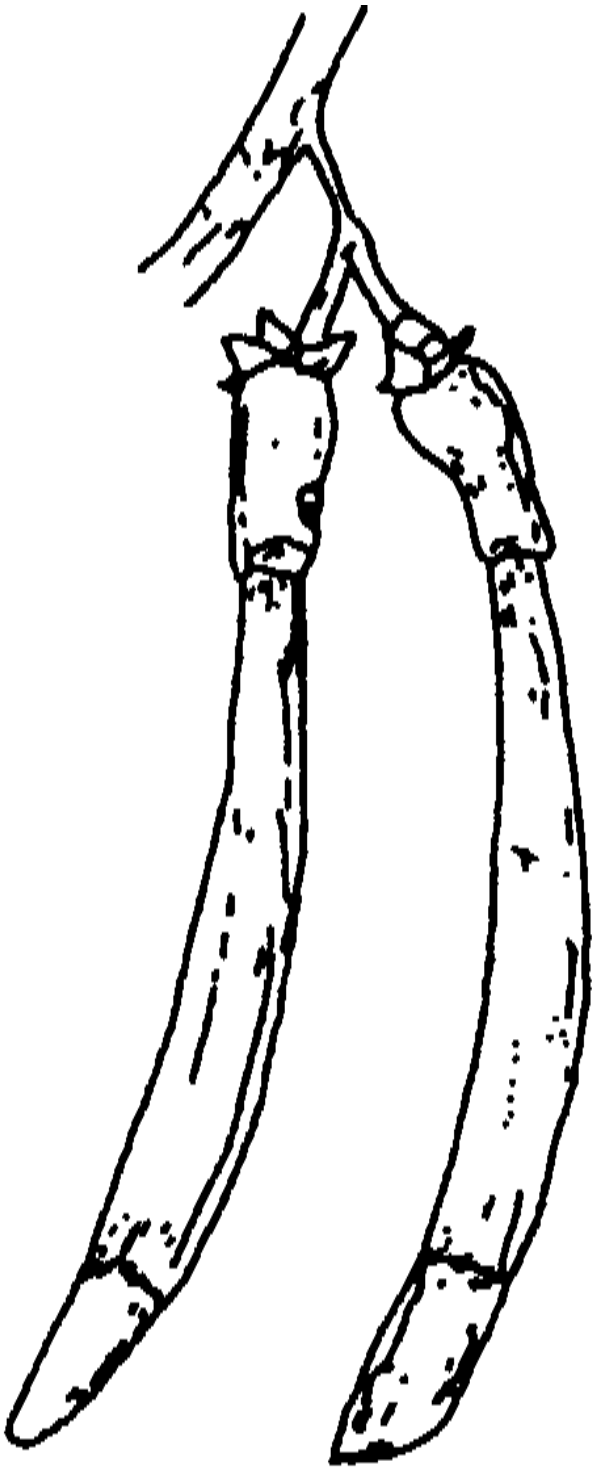
The **language activities** suggested in the Teachers' Guide for Section 1 can all be used to support learning about adaptations in the mangrove ecosystem. Some examples are given here.

Relevant information and activities from the **Wondrous West Indian Wetlands** Teachers' Resource Book:- (Chapter 2 pp 32, 33); Fill the Bill – finding out how bird bills are adapted to different ways of feeding 2-F p50

Mathematics Activity

In learning about probability the example can be used of the different chances of an individual animal being caught by a predator it if is in different sized groups.

Example Student Activity Sheets



Red Mangrove Propagules (Sea Pencils)

What do you know about adaptations of living organisms in the mangroves in TCI?

Answer these questions, in complete sentences if you can. Use the information about mangroves in the book to help you.

1. Name two adaptations which the Red Mangrove has, which lets it live the salt water.

2. Explain how the Black Mangrove gets oxygen to its roots.

3. Why is a Silverbuttonwood leaf hairy?

4. How can an Aquatic Blue Crab catch a fish?

5. What does camouflage mean?

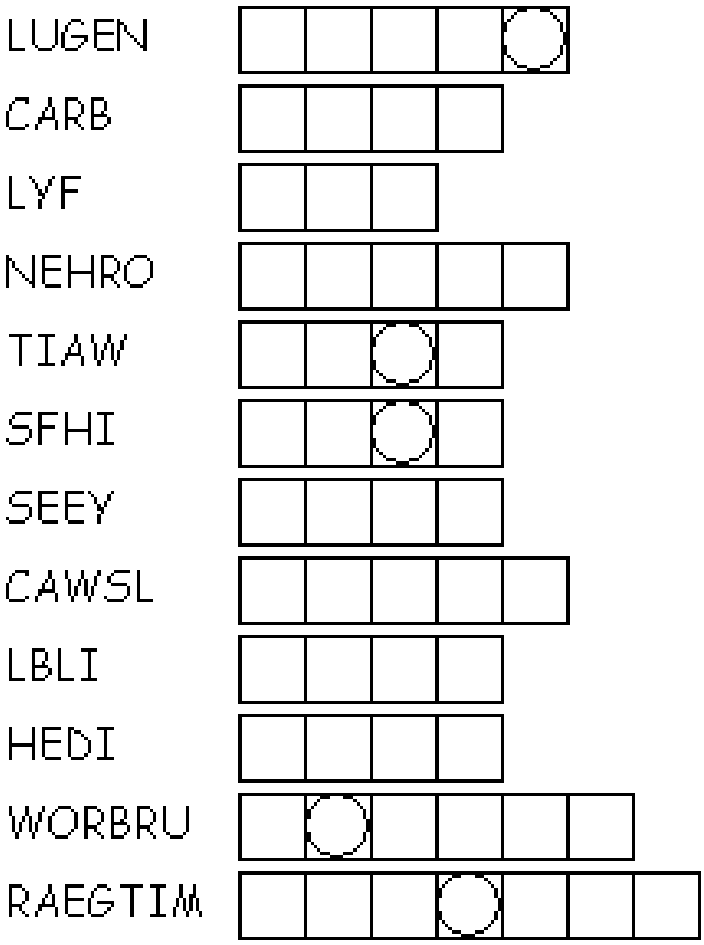
6. Why does the Silverfish live in large shoals?

7. Why does the Blue Land Crab have to migrate back ot the sea?

8. Why does the Yellow-crowned Night Heron have a strong, heavy bill?

9. Write your own sentence about something else you know about adaptions of living organisms in the mangrove ecosystem.

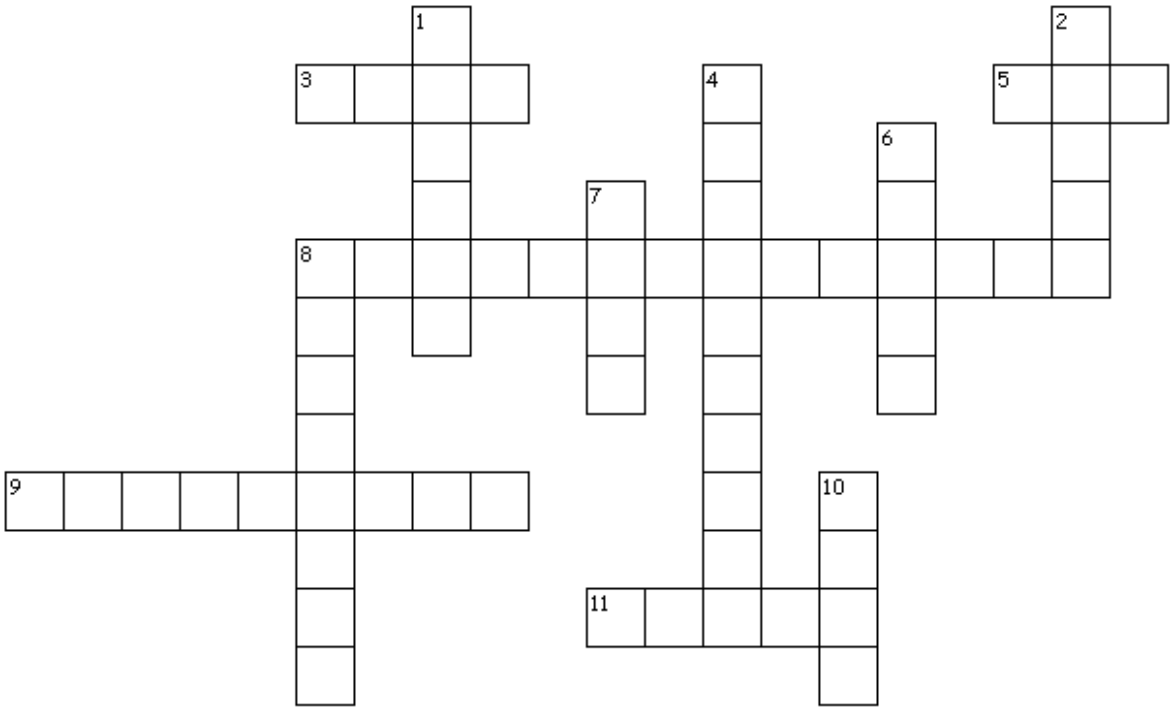
Mangrove Adaptations Scrambled Letters Puzzle



Unscramble each of the clue words.

Take the letters that appear in ◯ boxes and unscramble them for the final message.

Adaptations in the Mangroves



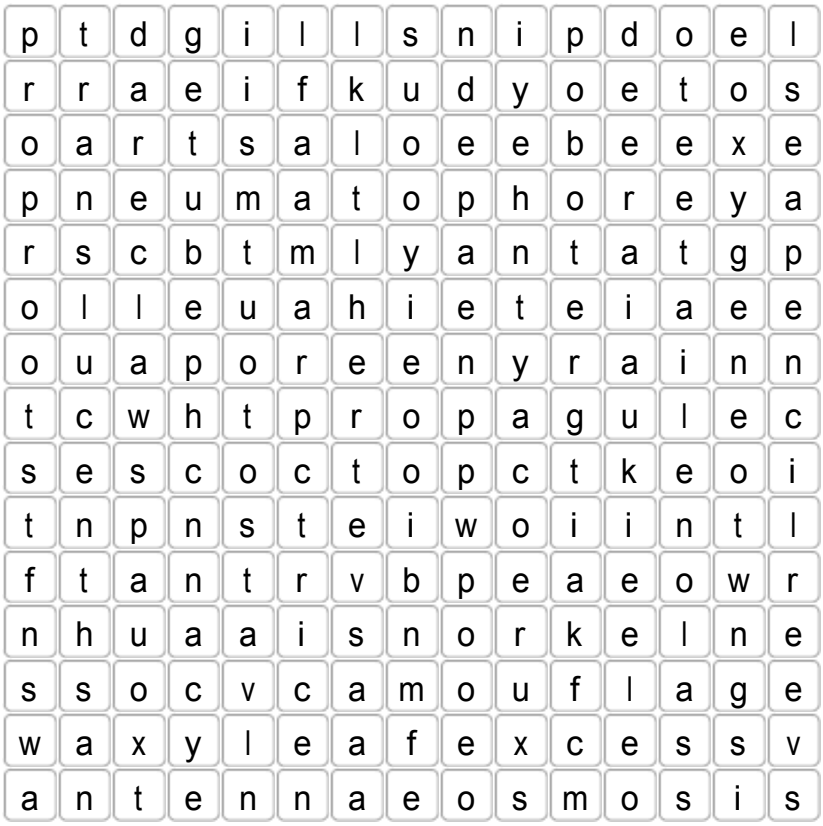
Across

3. A _____ coating on mangrove leaves reduces water loss.
5. A Yellow-crowned Night Heron can ____ to get away from danger.
8. The Black Mangrove gets oxygen to its roots through _____.
9. The hairs on Silver Buttonwood leaves are a natural _____.
11. The crab is protected by its hard _____.

Down

1.. All living organisms need this gas to survive. _____
2. The crab can defend itself with its large _____.
4. When an animal can blend into its background it is called _____.
6. Mangrove seeds can _____ in the seawater for a long time.
7. Red Mangrove prop roots exclude _____.
8. Keeps the Red Mangrove leaves up above the water.
10. The Yellow-crowned Night Heron has a strong ____.

Adaptations in the Mangroves Wordsearch



p	t	d	g	i	l	l	s	n	i	p	d	o	e	l
r	r	a	e	i	f	k	u	d	y	o	e	t	o	s
o	a	r	t	s	a	l	o	e	e	b	e	e	x	e
p	n	e	u	m	a	t	o	p	h	o	r	e	y	a
r	s	c	b	t	m	l	y	a	n	t	a	t	g	p
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f	t	a	n	t	r	v	b	p	e	a	e	o	w	r
n	h	u	a	a	i	s	n	o	r	k	e	l	n	e
s	s	o	c	v	c	a	m	o	u	f	l	a	g	e
w	a	x	y	l	e	a	f	e	x	c	e	s	s	v
a	n	t	e	n	n	a	e	o	s	m	o	s	i	s

Words to find:

antennae, burrow, camouflage, claws, desalination, excess, float, gills, osmosis, oxygen, pneumatophore, prop root, propagule, sea pencil, shoal, snorkel, sunscreen, translucent, viviparity, waxy leaf.

A free online tool for creating wordsearches can be found at:

http://www.teachers-direct.co.uk/resources/wordsearches/index.aspx

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