What the new Life Sciences curriculum for Grade 12 says

STRAND: Life processes in plants and animals

Grade 12: Responding to the environment and reproduction

In Grade 10 and Grade 11 some of the life processes that enable plants and animals to survive have been covered and related to organisms’ different and changing environments. Plants and animals have a variety of ways of detecting stimuli and responding to their environments. The way of life, for example, whether relatively stationary (plants) or mobile (most animals) influences this process greatly. Reproduction is the one life process that is not necessary for the survival of the individual but is concerned with continuation of the species.

What’s the buzz?

Veld & Flora updates teachers and scholars on what is happening in the world of science, especially the Life Sciences and Geography. Even if an article is not directly about teaching the National Curriculum Statement, it will widen your and your class’s general knowledge, and give you a step up the academic ladder.

A pollination syndrome

You may have noticed that the flowers of different species sometimes look the same. This is because they are hoping to attract the same pollinator. This is called a pollination syndrome. Read about a pollination syndrome in the article ‘Klein Karoo buzz: Why unrelated flowers look the same’ by Jan Vlok in the March 2009 issue of Veld & Flora on page 24. It describes how four unrelated species look similar because the attract the same pollinator which is a long-tongued fly.

Plant a pollinator-friendly garden in your school

Lists of suitable indigenous plants can be found in the book Cape Flats Flora Treasures: A teacher’s guide to Active Learning in Cape Town Schools and in Charles and Julie Botha’s books Bring Nature Back to your Garden and Bring Butterflies Back to your Garden. If you want to find out more about these books, contact the editor at veldfloraed@gmail.com.

Quizzz

Can you guess what pollinates the plant below? Tritoniopsis nervosa has long-tubed, fragrant cream-coloured flowers that are pollinated by long-proboscid moths. A proboscis is an insect’s tongue, hollow in the middle for sucking.

Draw a mind map

Flowers

A flower is the reproductive organ of a plant. It contains the female and male sex organs (the carpel or pistil, and stamens) which are protected inside the corolla (the petals). The calyx (sepals) protect the flower bud. Flower shape varies: proteas and daisies consist of a flowerhead (inflorescence) of many simple flowers whereas others, like the gladiolus, is a single flower on a stem.

Seed and fruit

After fertilization the ovule (now a zygote) develops into a seed and the ovary becomes the fruit. A seed is made up of an endosperm, which is the food store, and a seed coat (testa) which is the outer covering that protects the seed. Seeds are adapted for dispersal in many different ways. Animals (including humans) rely on seed (like maize and wheat) and fruit for survival.

Fertilization

Once the pollen grains reach the stigma of the female flower, the grains grow down the style in order to reach the ovules. When a pollen grain meets an ovule, they fuse and fertilization takes place. In other words, the gametes (the ovule and pollen cells that contain the haploid number of chromosomes) fuse to form a zygote that contains the diploid number of chromosomes.

Pollination

The transfer of ripe pollen from the anthers to the receptive stigma is called pollination. Although some plants are able to pollinate themselves (self-pollination), cross-pollination between two different plants of the same species is better as it enhances genetic diversity. As plants cannot move, they rely on pollination agents like wind, water and animals to help.

Sexual reproduction in plants.

Significance of the seed.

The importance of seeds as a food source.

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Bee a show off

Send a poster or study that your class has done on pollination to the Editor of Veld & Flora (see address on page 98) and bee in line to win a subscription to the Botanical Society of South Africa, which includes free copies of Veld & Flora for your school library.
**Red, orange or yellow flowers, nectar: Birds**

The flowerhead or inflorescence of a protea consists of many flowers that are opened sequentially to ensure that new pollen is continuously released over a period of time. Flowerheads of bird-pollinated proteas are often brightly coloured. Because bird and human vision is similar, these flowerheads are aesthetically pleasing to us. The bright red, orange, yellow, green and pink colouring serves as a visual attraction. Colours are relatively inconspicuous to most insects which cannot see red and orange. Since birds do not rely on smell, bird-pollinated flowers have little odour. A perch may be provided by stems, unopened flares and awns. In the illustration opposite the main stem of the Rat’s Tail (Babiana ringens) forms an off perch for sunbirds, and the tube-shaped flowers are produced on side branches below the perch. Copious quantities of easily digested glucose-rich (fruit sugar) nectar are secreted as a reward for the birds.

The most important bird pollinators in South Africa are sunbirds and, in the fynbos, the Sugarbird, which is shown in the illustration above visiting a King Protea.

**Some flowers attract many different pollinators: the generalists (like the Seabeo flowers in the article on p. 114 that have many different insect pollinators visiting them).**

**Other flowers are dependent on one pollinating agent: the specialists (like the flowers of many figs that are pollinated by one fig wasp only).**

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**Inconspicuous flowers, lots of pollen: Wind**

Wind pollination is common in many flowers, for example, grasses, restios and yellowwood trees. The restios (sometimes called Cape Restios) are unusual plants (or dicots) which means that male and female flowers are borne on separate plants. This is common for wind-pollinated flowers and prevents the plant from pollinating itself. The male flowers produce copious amounts of pollen that is blown in the wind from the male to the female flowers of a separate plant. The female flowers have feathery styles that protrude from the spikelets and are adapted to trap the wind-borne pollen of the male plant. The photograph opposite shows two female inflorescences (flowerheads) which are made up of several spikelets with their feathery styles protruding outwards. Yellowwood trees (Podocarpus) are wind pollinated. It may be a primitive method, but it is effective and economical.

**Why do some flowers close at night?**

Not having to manufacture it, some trick insects by pretending they do but actually getting away with it. Such tricksters come in many guises, for example the Cluster Disa (Disa nonginea) looks identical to the iris, Mountain Pips (Tritonopsis tritica) but the disa has no nectar while the iris does, but the Mountain Beauty butterly that pollinates both can’t tell the difference. A few flowers smell and even look like rotting meat, as does the Spinnekopblom (Ferraria crispa) to attract fly and wasp pollinators. Some flowers like the Twinspur (Diascia integerrima) produce oil that attracts oil-collecting bees. Namaqualand is the centre of diversity for solitary bees, wasps, monkey beetles (illustrated left) and flies, all of which are vital pollinators of the famous spring flowers pollinated by bees usually can be distinguished by their production of sweet, spicy or sour shapes, designs and behaviour in order to attract pollinators and survive in a changing world.

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**Colourful, nectar present, scented: Insects**

Globally, honeybees are the most important pollinator of commercial pollinator-dependant crops – with at least 90% of these crops reliant on honeybee pollination. Read the article on p. 122 to find out more about this important subject. Insects such as butterflies, bees and beetles provide vital pollination services (i.e. the transfer of pollen from the female of one flower to the male of another) in natural vegetation. Most flowers lure insects with the promise of an energy-rich nectar or pollen reward for performing the act of pollination, and although most of them produce the goods, some trick insects by pretending they do but actually getting away with it without having to manufacture it. Such tricksters come in many guises, for example the Cluster Disa (Disa nonginea) looks identical to the iris, Mountain Pips (Tritonopsis tritica) but the disa has no nectar while the iris does, but the Mountain Beauty butterfly that pollinates both can’t tell the difference. A few flowers smell and even look like rotting meat, as does the Spinnekopblom (Ferraria crispa) to attract fly and wasp pollinators. Some flowers like the Twinspur (Diascia integerrima) produce oil that attracts oil-collecting bees. Namaqualand is the centre of diversity for solitary bees, wasps, monkey beetles (illustrated left) and flies, all of which are vital pollinators of the famous spring flowers pollinated by bees usually can be distinguished by their production of sweet, spicy or sour shapes, designs and behaviour in order to attract pollinators and survive in a changing world.

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**White flowers, nectar, scent: Mammals**

Pollination by mammals occurs in some flowering plants. There are two main mammal pollination syndromes: flying mammals and non-flying mammals. Bats are the pollinators of Baobab flowers and other night-scented, hanging flowers like this Sicklebush (Dichrostachys cinereus) shown here. Nectar-feeding bats are important pollinators of tropical rainforest plants, and unlike insectivorous bats, they need to be able to see the flowers where the flower nectar is located. Thus flowers targeted by these nocturnal bats are night-blooming and are easily seen in relative darkness with large, white petals. Nectar-feeding bats are equipped with a long, thin tongue, like that of a hummingbird, to reach nectar deep inside the flower. Of the non-flying mammals, rodents are the most well-known pollinators and are regularly observed pollinating ground proteas. Rodents are attracted by a strong musty odour, and a reward of syrupy sugar which is secreted by ground proteas in large quantities. In order to prevent birds and insects from stealing this nectar, rodent-pollinated (therophilous) proteas have inconspicuous brown or black involucral bracts. Flowerheads are usually hidden inside the bush at ground level, where they are accessible to rodents. The inside of the involucral bracts may be pale white and the tips of the flowers may be shiny red – both serve to guide the rodent to the nectar in the dark. The nectar is contained within the tepal tube, and the distance between the pollen presenter and the nectar is the same as the length of the rodents snout (about 10 mm) allowing pollen to be deposited on the head. Other mammal pollinators include primates, some marsupials, lemurs and, if you read the article on page 112 of this issue, another mammal that is not an insectivore, nor a rodent, but an omnivore closely allied to the dassies and elephants - the Cape Rock Elephant-shrew - has been found to pollinate the Pagoda Lily (Whiteheadsia biformis) in the Cederberg.
Crop agriculture, pollination and honeybees

The Global Pollination Project and the Honeybee Forage Project

by Carol Poole, Project Co-ordinator – Ecosystem Services, SANBI

Globally, honeybees are the most important pollinator of commercial pollinator-dependant crops. While wild insect pollinators such as butterflies, bees and beetles are also vital (particularly for the pollination services they provide to natural vegetation), no other insect besides the honeybee can be managed by humans in the numbers required for the pollination of large-scale commercial crops. About 50 crops in South Africa are insect pollinated – with these crops worth over R10 billion annually and supporting at least 100 000 jobs. The flowering time of these crops is short, however – lasting from a few days to only a few weeks – requiring the services of numerous honeybee hives at the same time. 87% of the managed honeybee hives in the Western Cape are used for commercial pollination – with pollination services being over 60% of beekeepers’ incomes.

In Europe and North America, mounting evidence points to a ‘pollination crisis’ with declines in populations of wild pollinators, and significant losses of managed honeybee colonies. In South Africa, we have an indigenous honeybee species, Apis mellifera, with two subspecies – both of which are used for managed colonies. Essentially, therefore, there is no difference between the wild and the managed honeybee population in South Africa, as beekeepers replace their colonies from the wild. South African honeybee populations are also fairly healthy in comparison with Northern Hemisphere counterparts – but they are facing increased stress. Stress on honeybees arises from pests or diseases, the use of pesticides, pollution, nutritional stress from loss of forage resources, and even operational stress from the continual movement of hives and high workload on the bees for the pollination service in agriculture.

Understanding the extent to which world agriculture is threatened by pollinator decline is crucial, both for food security and biodiversity conservation, and has lead to the development of the Global Pollination Project. This Global Environmental Facility (GEF) project is implemented through the United Nations Environment Programme (UNEP) and executed by the Food and Agriculture Organization of the United Nations (FAO) in co-ordination with the governments of seven project partner countries. In South Africa, it is being implemented by the South African National Biodiversity Institute’s (SANBI) Applied Biodiversity Research Division based in Cape Town. The project runs until the end of 2013, and entails carrying out scientific research on pollinators and pollination in three agricultural crops: apples near Elgin and Ceres; onion seed production near Oudtshoorn; and sunflower (for oil) production near Bela-Bela. Each crop is highly dependent on insect pollination, and most of the farmers rely on managed honeybees to ensure adequate pollination. Some farms are situated next to natural veld and obtain an ecosystem service of pollination from wild pollinators, thus providing an interesting mixture of wild and managed pollination services.

Early research findings show that both sunflower yield and the abundance of pollinators decreased with distance from natural habitat. The conservation of natural veld patches within sunflower farmland could help to increase pollinator diversity, which in turn can improve honeybee movement between plants – enhancing cross-pollination.

The linkage to the world of managed honeybees is vitally important to the Global Pollination Project in South Africa, and part of the research will investigate the reliance of certain crops on managed honeybees. In South Africa, the managed honeybee industry is reliant on two services that nature provides for free (ecosystem services): the first is forage provision (to sustain the colony and produce honey) and the second is colony replacement (replenishment of a beekeeper’s colony stock from the capture of wild bees). Therefore, while the commercial crop grower becomes more reliant on the beekeeper for the pollination service their honeybees provide, the beekeeper in turn becomes more reliant on numerous, and at times controversial, forage sources that can sustain their colonies throughout the year, even when no crops are flowering.

This issue has led to the institution of the Honeybee Forage Project, a project funded by the Working for Water Programme and implemented by SANBI and the Agricultural Research Council. Some forage species are vitally important to beekeepers, however these species are considered alien invasives in South Africa, as are seven Eucalyptus or gum tree species listed in the Conservation of Agricultural Resources Act (CARA). With gum trees responsible for almost 60% of honey production in South Africa, the CARA regulations are a serious concern for beekeepers. The Honeybee Forage Project research aims to investigate possible alternatives to conflict species such as Eucalyptus, and also to present recommendations on the management of honeybee forage.

With the human world’s need for food security, our reliance on the honeybee and other wild pollinators is growing. Therefore, our reliance on viable forage resources, sustainable habitats, and healthy environments for our pollinators is also growing. The two projects hope to work out strategies for the future that will include management of pollinator forage and habitat, awareness of what forage species should be planted and where, and better landscape-level management of pesticides.

GET CONNECTED
For more information on the two projects, contact Carol Poole, Project Co-ordinator – Ecosystem Services, SANBI at c.poole@sanbi.org.za.