

Biology Stage 6 Syllabus Patterns in Nature

A Nectar Feeding Mammal – The Honey Possum *Tarsipes rostratus*

The honey possum is a small, mouse-sized marsupial mammal that lives in south-western Australia. It weighs no more than 10 g. Like other marsupial and eutherian mammals the honey possum is an endotherm. Its basal metabolic rate (BMR) is high compared with most marsupials and this means that the animal consumes a lot of oxygen per gram of body weight per hour and in turn this means that a lot of food is required to fuel this high metabolic rate. Incidentally most marsupials have a BMR of between 64 and 75% of the value of eutherians of similar sizes.



The diet of the honey possum is a mix of nectar and pollen which provides the energy rich food needed to maintain its high metabolic rate.

Nectar is essentially a sugary solution containing sucrose, glucose, fructose, produced by plants to reward pollinators. Banksia nectar has high concentrations of these carbohydrates, sometimes in similar proportions, with an average sugar concentration of 25% w/w sucrose equivalents but low concentrations of protein, vitamins and minerals. Pollen, on the other hand, is essentially the male gametes of a plant. The food reserves of pollen cells contain protein, carbohydrate and fat.

Banksia pollen is special. It is high in protein (36-42%) and the pollen from only a few “flowers” (inflorescences) would be needed to satisfy the protein requirements of the honey possum. Most pollen grains contain only about 20% protein, with 37% carbohydrate, 4% lipid and 3% minerals. Pollen is an ideal supplement to the sugar rich nectar, and pollen and nectar always go together.

Honey possums visit plants that produce the nectar they require (Banksias, bottlebrushes, Hakeas and Dryandras). In testing for feeding preference, honey possums prefer sucrose to fructose, and both sucrose and fructose to glucose, but there is no evidence that they can tell differences in concentrations of these three sugars in combinations.

The honey possum is a nectar and honey specialist, and unlike its close relatives it almost never eats insects. Several features of the honey possum are correlated with this diet.

- The head is sharply tapered, delicately constructed and has only a few, minute teeth. The mandible (lower jaw) is reduced to a thin flexible rod and is not suitable for the insertion of strong musculature or deep-rooted teeth. The incisors and canines are pointed but the cheek teeth are flattened pegs with rounded tips and do not resemble the normal structure of mammalian teeth.
- The tongue is long and stiffened by a keratinised keel (keratin is what hair and nails are made of) and over the surface of the tongue are finger-like projections (long filiform papillae at the tip of the tongue and shorter compound papillae over most of the dorsal surface). The long tongue is used to collect nectar and pollen from flowers, particularly of Banksia spp. As the tongue is withdrawn into the mouth the pollen is scraped from the finger-like projections by a series of transverse ridges on the roof of the mouth and the pollen falls back into the mouth and is swallowed.



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- The gut (digestive tract) is different from other omnivorous arboreal (tree-dwelling) marsupials (sugar glider, pygmy possum) in two ways. First it lacks a caecum so there is little to identify where the small intestine finishes and where the large intestine starts! Secondly it has a large, two-chambered stomach. The main chamber is elongated, with a mean length of 11mm and a mean mid-length diameter of 2.7mm. The second chamber is a diverticulum about half the size of the main chamber and connected to its medial surface by a small channel (isthmus). This diverticulum may serve to store nectar in times of surplus.
- The inside surface of the stomach is arranged in simple flat ridges running the length of the main chamber. These ridges fill most of the lumen (space) of the diverticulum. At the entry of the oesophagus to the stomach (the cardia) the lining of the oesophagus changes from a layered epithelium (stratified squamous) to tall column shaped cells. The lining of the stomach secretes mucus but no protein digesting enzyme (pepsinogen). The stomach may serve as a storage organ for nectar, and it is known that captive honey possums can drink up to 10-20% of their body mass (weight) in a few minutes.
- Pollen is digested progressively in the small intestine. Experiments to show the passage of pollen through the intestines (remember it is hard to tell the small from the large) indicate that pollen is digested by the time it reaches the rectum. In the experiments, in the first quarter of the intestines most of the pollen grains had content in them; in the second quarter of the intestines between 1-50% of the grains had lost their content; in the third quarter 60-95% were empty and in the last quarter 50-100% were empty.
- The movement of pollen through the digestive system is not unlike that of other marsupials that also eat pollen - in all cases investigated the pollen grains progressively lost their contents as they travelled through the intestine and this took about 12-24 hours.

The dietary specialisation of honey possums appears not to be due to any specialisation of the digestive system but to the specialisations of the tongue and palate which enable the animal to harvest sufficient pollen and nectar to provide protein and energy required for all life's purposes. The honey possum has both a high rate of mortality and a high reproductive potential. These two features are probably linked to its specialised nectar and pollen diet. A high fecundity throughout the year (up to three litters each year) may enable it to respond opportunistically to seasonal and random changes in nectar and pollen supply resulting from fire and rain.

Being such a small mammal the honey possum needs to avoid extremes of temperature, especially cold. It practices daily torpor, which is a shallow form of hibernation, in winter (temperature of 5°C) and can "sleep" for up to 10 hours at a time. This conserves fuel.

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Digital Resources:

Colour photograph:
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Photograph of the week: 15 May 2002
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Case Study 3; Honey Possums and Wildflowers
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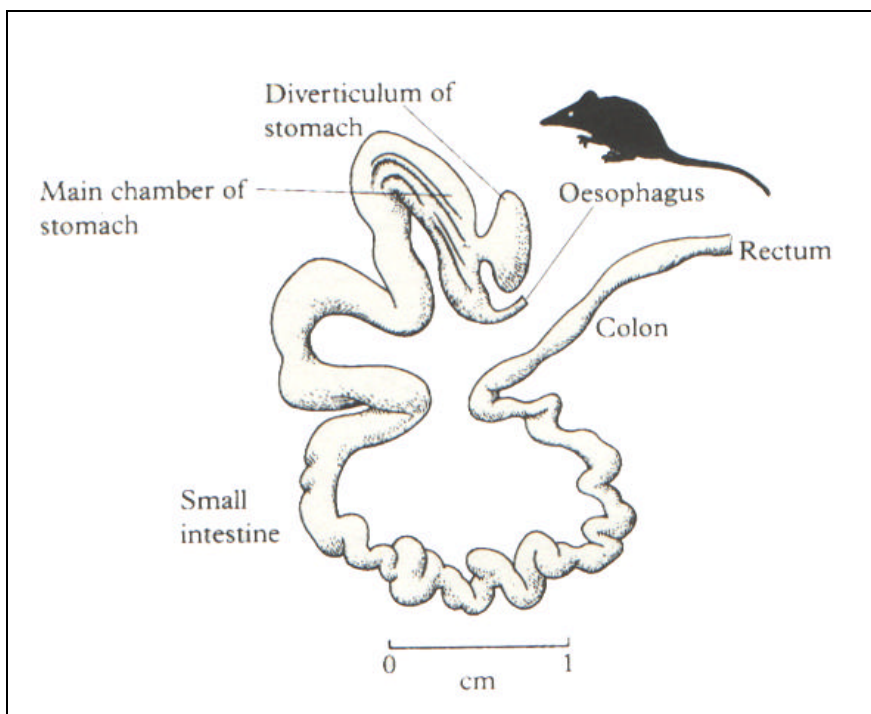
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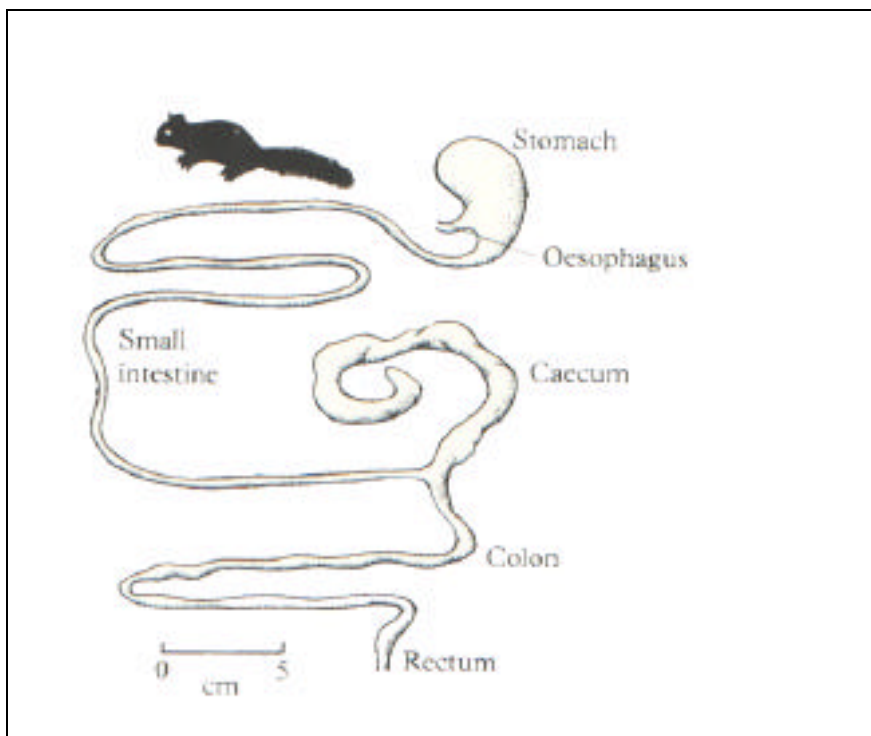


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Digestive System of the Honey Possum (*Tarsipes rostratus*)



Digestive System of the Sugar Glider (*Petaurus breviceps*)

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