Echidnas, the Different Mammal

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Dr. Peggy Rismiller is an environmental physiologist and educator who studies the interactions of living organisms and environmental cues. Peggy has lived, studied and worked on three continents with birds, reptiles and mammals. In 1988 she made Kangaroo Island her home. Since then she has been following individuals in a wild population through their life history from egg to adult. Her specialty areas include echidna and goanna life histories and wildlife rescue. Peggy has particular interest in environmental physiology, circadian rhythms, body temperature regulation and reproductive physiology. She spends her days documenting, writing, consulting, sharing and providing biological facts to the greater community. Peggy is affiliated with the University of Adelaide, a Visiting Lecturer at the Hannover School of Veterinary Science, Germany and supervises Graduate Students and volunteers from around the world. She is a consultant for echidna captive breeding programs at a number of international zoos. Each year Peggy conducts workshops for wildlife rescue and rehab groups around Australia as well as international popular and scientific presentations.

Abstract
The biology and physiology of short-beaked echidnas is different from any other mammal in the world. They have a low, active body temperature and can use torpor (a lowering of body temperature, heart rate, respiration and metabolism) at any time of the day in any season. Echidnas lack a permanent pouch, yet they carry their young for up to 50 days then place them in a nursery where they are suckled (without the female having a teat) only every 5 days until the young is weaned at 7 months of age. After weaning there is no parental guidance, so young are totally on their own to search for food and establish home ranges. They are solitary living, feed on invertebrates, stubbornly independent and can be escape artists in captive situations.

All of these special echidna peculiarities can pose challenges for the rescue and care of injured animals or hand rearing and release of orphaned young. This presentation shares insights on the natural behaviour and activities of echidnas, gained through 22 years of living, working and documenting echidna biology in the wild. It addresses what makes echidnas special, how they respond to various events and how knowledge of natural free ranging animals can benefit wildlife rehabilitation.

Introduction

In 1988 I went to work in the field on Kangaroo Island with a wild population of echidnas. My job was to find echidnas with an egg in the pouch, in order to measure the respiration of the developing embryo. Not a simple task at any time and back then 1) courtship behaviour had only been scantly described, 2) no one had seen and described copulation in wild echidnas 3) published times between mating and egg laying varied from 9 to 42 days and 4) behaviour of the female with an egg and later with a pouch young had not been documented.

We searched and found echidnas in courtship trains and put radio transmitters on all the females and some of the males. For the first time in recorded history, we witnessed and documented mating behaviour in wild echidnas. Because echidnas do not have a permanent pouch, it was assumed the female went into a burrow to lay her egg and remained there until it hatched, much as platypuses do. When I discovered an egg hatching in the pouch of a female who had been active every day, even swimming through rivers, I was hooked on the enigmatic echidna and wondered what other biological mysteries shrouded this ancient Australian creature.

Based at the Pelican Lagoon Research & Wildlife Centre at the east end of Kangaroo Island we have microchipped all, and radio tracked many individual echidnas on the Pelican Lagoon peninsula over the past 22 years. We have answered questions posed as early as 1834 by Sir Richard Owen, such as 1) how echidnas copulate, 2) period of gestation 3) size and condition of young at birth 4) age of sexual maturity and two question posed a few years later, how often echidnas breed and reproduce and how the egg gets into the pouch. In addition to answering these early questions we have examined home range sizes, foraging habits and food preferences, documented details of female behaviour from egg laying through to weaning the young, monitored growth rates, followed young to sexual maturity and conducted experiments on orientation and navigation. We have also had the opportunity to hand rear a number of orphaned puggles implementing natural methods adopted from what we learned from wild animals.

What makes echidnas so exceptional?

Body temperature and torpor

Short-beaked echidnas have the lowest, most variable body temperature of all mammals. The intrigue with echidna body temperature started in 1879 when Brisbane based scientist, Nicolai de Miklouho-Maclay, obtained two *Echidna hystrix* for brain study. Before euthanising the first specimen he inserted a thermometer in the cloaca and found a surprisingly low 28°C. Believing that the large opening of the cloaca had interfered with the correctness of the observation, he made an incision just large enough to insert the ball of the thermometer into the abdominal cavity. After 10 minutes it registered 30°C. Not satisfied with this observation because it was much below the known average body temperature of mammals, he repeated the observation on the other specimens and found temperatures of 26°C. (Miklouho-Maclay 1883).

These observations triggered an ongoing interest in echidna body temperature and this area remains the most studied aspect of echidna physiology. With advancements in technology, research on echidna body temperature moved out of the laboratory and into the natural environment. It is now accepted that the normal active body temperature of an echidna is 30 to 33°C. If exposed to higher temperatures over a period of time and the body temperature elevates above 34°C, an echidna can heat stress and die (Schmidt-Nielsen et al. 1966).

What is torpor?
Torpor describes a state when the body temperature, metabolism, respiration and heart rate are lowered. It is sometimes referred to as an energy saving mechanism of the body. Echidnas use torpor, but it appears that platypuses do not. It is not necessarily a response to cold and on Kangaroo Island; echidnas may use torpor at any time of the day and year (Rismiller 1992, 1999). Extended use of torpor is sometimes referred to as hibernation. In Tasmania, one group of echidnas studied not only showed extended periods of lowered body temperature, but body temperature indicated when a female was going to lay her egg (Nicol and Andersen 2004, 2006; Nicol et al. 2004). During hibernation echidnas have lowered body temperature to 4°C and reduced heart rate to 4 beats per minute (Augee et al 2006).

Echidnas are also known to let their body temperature lower passively during daily inactivity and have been observed basking, with their spines spread, early in the morning (personal observation).

How can an understanding of echidna body temperature be applied to wildlife care?

1) Torpor, ie lowered body temperature, heart rate and respiration can be a natural response to trauma and stress. Ability to lower body temperature can facilitate healing.
2) Injured echidnas should not be placed on hot water bottles, heat pads or under heat lamps.
3) It is not unusual for an injured echidna to remain in a ball for several days and refuse all food or water for over a week.

<u>Missing, additional and different body parts</u>
Beak: The long and short-beaked echidnas are the only mammals that have a true beak, a bony part of the skull structure. In the short- beaked echidna the beak is shaped like a double wedge, giving it the mechanical advantages of a crowbar.

Panniculus carnosus: this muscle, located under the skin and around the body, allows echidnas to assume contortionist shapes from very round to nearly flat. It also allows echidnas to move individual spines and helps form the temporary pouch in reproductively active females.

Shoulder girdle: Weird and wonderful. Described as being more like that of extinct cynodonts or living reptiles; echidnas have two extra bones in their tightly fused pectoral girdle, a T-shaped interclavical and two epicoracoids. This sturdy base provides support for the strong front limbs.

Front and back legs and hind feet: Short, stout and held horizontally away from the body. The well developed and large muscle mass of the front limbs attach to the solid shoulder girdle. The result is a huge mechanical advantage which gives the echidna tremendous digging strength and also makes them very difficult to pick up. The tibia and fibula of the hind legs are rotated so the hind feet point backwards. Echidnas are the only mammal that can dig straight down.

Penis: Located in a ventral sac inside the cloaca, the penis is only outside of the body during copulation, it is not used for urination. It has a remarkable bifid structure, with each half sporting two bulbous protrusions with openings.

Testes: Located in the peritoneal cavity, usually just below the kidneys. As seasonal breeders, the testes are pea size outside of the breeding season and enlarge up to golf ball size. They are never externally visible.

Mammary glands: When not lactating, mammary glands regress and are not externally visible.

Teat or nipple: None

What do all these differences mean for the Wildlife Carer?

1) Gender of an echidna cannot be determined by looking at the animal
2) Because of their strength, anatomy and dislike of being handled, it can be extremely difficult first to pick up and echidna and second, to examine it for injuries
3) Because of their strength and digging abilities, echidnas are great escape artists. Special considerations must be taken regarding transport containers and enclosures.
4) A broken beak often results in suffocation because both the nares and mouth opening are located at the tip of the beak

Reproduction and care of young

In general, it is said that echidnas breed during the winter months (June – August). Studies in various parts of Australia (Table 1) examined this in detail and found that the exact timing and duration of the breeding season varied from region to region. At the lowest latitude (Tasmania, 42°S) echidnas mated over a period of 65 days, starting on 23 June. At the most northerly study site, south-east Queensland (28°S), mating occurred over 31 days, but did not commence until 1 August. Mating durations at the 35°S, Kangaroo Island, and 36°S, Kosciusko sites were 45 and 36 days, respectively. However, breeding at these 2 locations overlapped by only one day, ending on Kangaroo Island and beginning at the Kosciusko site on 30 July.

Table 1. Field study sites in Australia where echidna matings have been verified by observation of actual mating or presence of a young.

Location	Lat/Long	Elevation	n	Source
South-east Queensland	27°28'S 153°02'E	300-600m	7	Beard and Grigg 2000
Kangaroo Island, SA	35°47'S 137°47'E	0-60m	17	Rismiller 1992 Rismiller and McKelvey 2000
Kosciusko, NSW	36°10'S 148°15'E	1000-1750m	5	Beard et al. 1992
Tasmania	42°25'S 147°14'E	200-300m	10	Nicol et al. 2004

The single egg is laid directly into the pouch after a gestation period of 22 days (Rismiller and McKelvey 2000) and hatches after 10.5 days (Griffiths 1978). The size of the puggle at hatching is between 270 - 328 mg (Rismiller and McKelvey 2000). A way to relate to this minuscule size is to hold an Australian 5 cent coin in your hand and remember it talks 8 newly hatched echidnas to weight as much as the coin. The puggle has no teat to attach to, but clings with its well developed front legs to the hairs on the mother's belly. The milk patches are located on either side of the pouch approximately where one would expect a teat or a nipple to be. The young suckles at the milk patches, it does not lick. Echidnas are different in many ways to other mammals. Echidna milk is rich in fat and protein and the young grow rapidly (Fig. 1 from Rismiller and McKelvey 2003). While in the pouch, puggles grow at approximately the same rate, irregardless of the body mass of the mother.

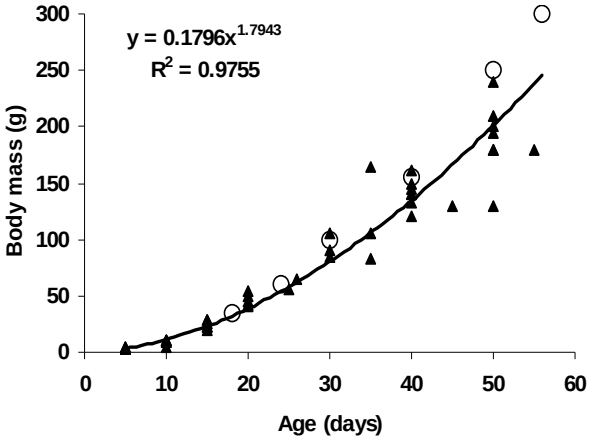

Figure 1: Body mass changes in echidna young during growth in the pouch from age 5 to 55 days. Closed triangles with regression line represent data from free-ranging animals (Rismiller and McKelvey 2003). Open circles are data from one young reared by a female taken into captivity (Griffiths, 1978).

Depending on the body mass of the female the puggle will be carried for between 45 and 55 days before being placed in a special dug nursery burrow. A nursery burrow can be dug just about anywhere (Table 2). Once inside the nursery, the life of the young changes dramatically. It goes from clinging to the belly of its mother and having access to the milk patch at all times to being left alone in a cool (15 - 18°C) chamber (Rismiller 2008).

Types of nursery burrows	n	%
Cave	4	11.4
dirt piles*	3	8.6
litter (base of tree)*	5	14.3
open ground*	5	14.3
reeds*	2	5.7
rock (under)*	3	8.6
sand hill*	4	11.4
tree root	5	14.3
termite mounds*	4	11.4
Total	35	

Table 2: Different types and numbers of nursery burrows used by female echidnas. *denotes burrows that were entirely self-dug. (from Rismiller and McKelvey 2009)

After discovering active nursery burrows it took hundreds more hours of observations to conclusively determine that females returned to suckle their young for only 2 hours once every 5 days (Rismiller 1999; Rismiller and McKelvey 2009). On a number of occasions over the past 22 years we had the opportunity to access the nursery chamber and weigh the young before and after the mother had visited. We discovered that 1) a young will ingest between 10 to 40% of its own body mass in any one feeding session and 2) once in the burrow, young grew at different rates depending on the body mass of the mother (Rismiller and McKelvey 2003; Rismiller

2008). Regardless of body mass, young are weaned at about 7 months of age (Fig. 2) with small mother's weaning small young and larger mother's weaning larger young. At weaning the female opens the burrow, suckles the young and rarely returns. This means there is no mother/offspring relationship or teaching the young what to eat and where to go. Some would call this a hard release.

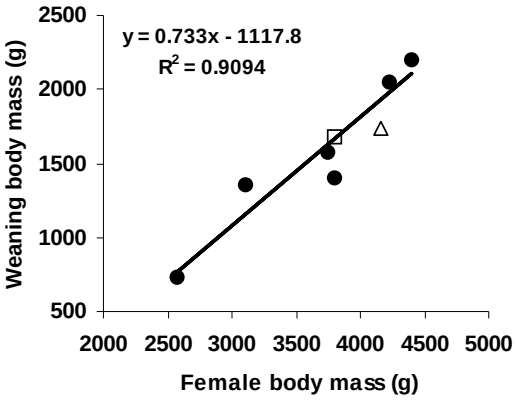

Fig. 2. Relationship of young's body mass to mothers at the time of weaning. Closed circles, T. a. multiaculeatus (Rismiller and McKelvey 2003), open square, T. a. acanthion, Western Australia (Abensperg-Traun, 1989) and open triangle, T. a. setosus, Tasmania (Andersen and Nicol, unpublished 2003).

How observations on wild echidnas can assist with successful echidna rescue and rearing

1) A 'rescued' echidna should always be retuned close to the area it was found because a) echidnas do have home ranges and a good sense of orientation (Rismiller and McKelvey 1995), b) between August and March a displaced lactating female will travel great distances to get back to her burrow young.
2) Hand rearing a pouch or burrow young echidna is very different to hand rearing any type of marsupial.
3) A natural as possible approach to rearing and releasing an echidna will benefit the long term health and welfare of the animal returned to the wild.

Post weaning – what happens in the wild?

Young echidnas, like adults are solitary. They leave their natal area between 12 and 18 months of age (Rismiller 1999;Rismiller and McKelvey 2003). Some have been radio tracked and found to travel as much as 40 km before establishing a home range (Rismiller 1999). They live alone until sexually mature. A 12 year field study monitoring body masses of 10 hatchling (< 48 hrs old) or pouch young (between 5 and 60 days) echidnas until they either laid an egg or joined a train showed that the. average age of sexual maturity was 7 to 8 years (Rismiller and McKelvey 2003). We are currently radio tracking individuals I have known for 22 years. The longest known female with a confirmed age of 45 is still reproductively active.

Summary

Understanding an animal's biology, physiology and natural behaviour in the wild is essential for its welfare while in care and for successful rehabilitation. Having an echidna in care or hand rearing a puggle is not as common in wildlife rescue situations, compared with other native species encounters. It is therefore important to stop and consider the needs of this very different mammal. How should they be picked up and handled? What type of transport and holding facilities are safe? What temperatures should be avoided? How will they react in a captive situation?

What type of behaviour is ‘normal’? Having, referring to and using the comprehensive information that has been collected and documented about how echidnas live, function and behaviour in the wild is a valuable resource for successful echidna rescue and rehabilitation.

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Workshops and accredited training with Dr. Peggy Rismiller for BIOLOGY, RESCUE AND REHAB OF SHORT-BEAKED ECHIDNAS are available in all States and Territories. For more information contact Echidna Care Inc, PO Box 640, Penneshaw SA 5222 ph +61 8 8553 7174. Sorry, no reliable mobile service in the field.