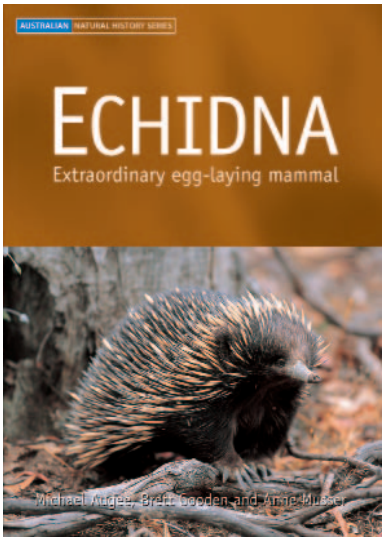

Echidna
Extraordinary egg-laying mammal

Michael Augee, Brett Gooden and Anne Musser

Australian Natural History Series

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1
The monotremes

There are only three types of living monotreme – the short-beaked echidna, the long-beaked echidna and the platypus. They are mammals, and like all mammals they have fur and produce milk to nourish their developing young. But in a lot of ways they are not quite like their fellow mammals – the marsupials and the placentals. The most obvious difference is that platypuses and echidnas lay eggs (oviparity), and so their young are hatched, not born alive.

Since humans are placentals and humans write the textbooks, monotremes often get put in their place as 'almost' mammals or Prototheria in the Latin of scientific nomenclature. This placental-biased view of monotremes as some sort of early test model that wasn't quite right has tarnished them for two centuries. However, as we shall point out in this book, monotremes have been around for a lot longer than placentals and have remained masters of their environmental niches. That means that even if they are not very good at being humans or laboratory rats, they are in fact very, very good at being echidnas and platypuses.

Monotremes are often listed as being Australian, but both types of echidna are found in New Guinea, although the living long-beaked echidna is not found in Australia at all. The platypus is a 'fair dinkum' Aussie these days, but its ancestry includes a South American relative that lived in Argentina just after the dinosaurs disappeared from the scene.

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The short-beaked echidna

The short-beaked echidna is a medium-sized mammal, rarely weighing more than seven kilograms, covered on its back and sides with stout spines amongst a fur coat of varying colour from light brown to black (Figure 1.1). Very lightly coloured individuals are occasionally reported as 'albinos', although, as can be seen in the photographs on page 26, while the eyes are pink there is pigment in the hair and spines.

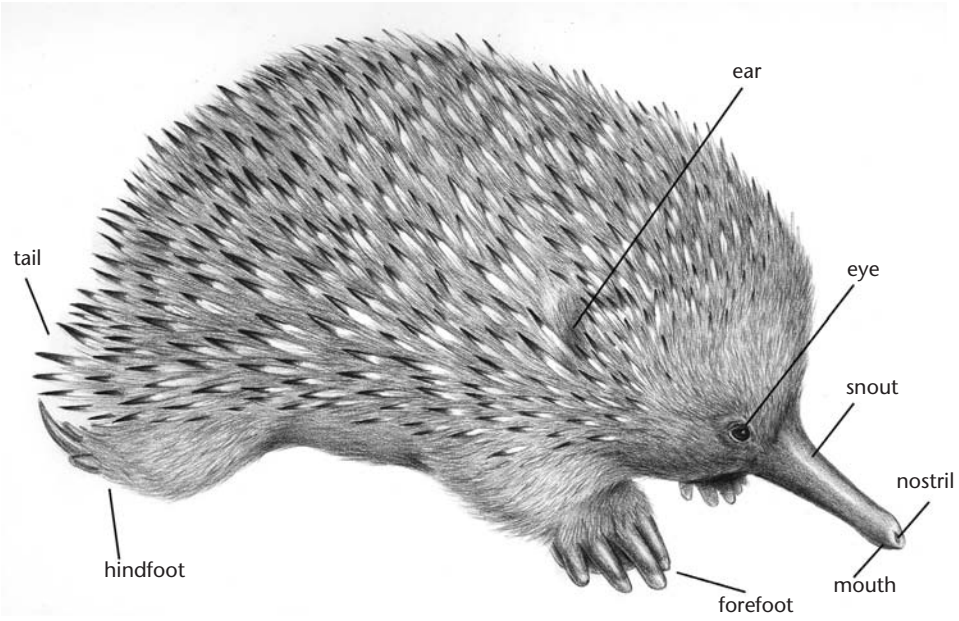

Figure 1.1 ***Tachyglossus aculeatus,*** **a typical adult echidna from Tasmania.**

The echidna's head appears small relative to its stocky body, particularly because it has no obvious neck. Its head tapers to a naked, cylindrical snout, which serves as a prod and lever in the search for the ants and termites that comprise the main part of its diet. The name 'spiny anteater' is therefore an apt description, but 'echidna' is much more widely used as the common name in Australia although that name came about rather by accident.

The eyes of the echidna are small, black and somewhat protruding – they are sometimes referred to, unkindly, as 'beady'. The ear opening is not readily visible – it is usually obscured by spines, but it is quite a large vertical slit. The external ear (the pinna) is unlike that of other mammals and is formed by a large cartilaginous funnel that is largely buried in a superficial muscle.

The limbs of echidnas are held horizontally away from the body, as they are in platypuses. The forelimb is short and stout, ending in a broad hand

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(manus). The manus has five distinct digits, each ending with a flattened claw, forming an effective spade for digging. The hindlimb is much less robust than the forelimb and the hindfoot (pes) is smaller and narrower than the manus. The bones of the lower hindlimb (the tibia and fibula) are rotated in echidnas so that the hindfeet are pointed to the rear. The claws on the hindfoot are long and thin compared with the spatulate claws on the forefoot. The second digit on the hindfoot is long and recurved and is often called the 'grooming claw'. Echidnas have a remarkable ability to groom in hard-to-reach places, even behind the neck, by rotating the hindlimb, twisting the foot and using the grooming claw to scratch between the spines. The tail is stubby; the spines form two handsome semicircular whorls over the tail area.

The hindfoot of a short-beaked echidna, showing its enlarged second or 'grooming' claw, as well as the crural spur in the region of its ankle.

Without picking them up (not an easy task!) for close inspection, it is impossible to distinguish male from female echidnas by their appearance. Although overall males are about 25 per cent larger than females, there is so much overlap that the sexes cannot be distinguished on size. There are no outward signs of sexual organs. Both sexes have only one opening leading from the cloaca to the outside, through which urine, faeces, and reproductive products must pass. The egg must pass through this opening when laid by the female and the penis protrudes through it in the male when mating. The penis of the male can usually be located by feel under the skin near the cloaca.

Adult male echidnas have a spur in the region of the ankle which is known as the crural spur. This is not a digit but an entirely separate structure. In the

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platypus the spur is connected by a duct to a venom gland lying behind the knee. In the echidna the spur is 0.5 to 1 cm in length and well developed. The duct and gland are vestigial. The spur may not be obvious until the fold of skin covering it is probed. The echidna does not appear to have the muscular ability to erect or retract the spur. In the young, spurs begin to develop in both sexes, but in the female the spurs regress and are not obvious. In the male the spur is covered by a sheath which is lost at some point before the animal reaches four years of age. Presence or absence of this sheath can be taken as an indicator of sexual maturity.

In our experience of many years working with echidnas, we have found in all cases where we were able to verify the sex of the animal by other means, such as determining the presence or absence of a penis, animals with unsheathed spurs were males. However, some authors have claimed that one or both spurs can be retained by adult females. Therefore the presence of a spur in an adult echidna can be taken as a useful (but not necessarily foolproof) indicator of male sex.

The pouch can likewise be an inconsistent indicator of sex. A depression on the ventral surface of the abdomen, bounded by two ridges of muscle, can be seen in both sexes. In pregnant females enlarged mammary glands form thick lips on either side of the midline and the resultant pocket envelops and protects the egg and, subsequently, the newborn young. At the front of the pouch area there are two small, hairy areas (known as areolar patches) where the milk glands open. Monotremes do not have teats or nipples and the young suck milk directly from the hairs over the openings of the milk glands. The pouch regresses after the young is independent. It is worth noting that the platypus does not have a pouch even though the milk delivery system is the same as it is in echidnas.

Discovery and early scientific studies by Europeans

The first written description of an echidna is found in Captain Bligh's log of the ship *Bounty*. The *Bounty* was on its way to Tahiti in 1792 and had stopped at Adventure Bay on Bruny Island off the coast of Tasmania for two weeks. The entry for 9 February 1792 reads:

> 'An animal shot at Adventure Bay. It had a Beak like a Duck – a thick brown coat of Hair, through which the points of numerous Quills of an Inch long projected these very sharp – It was 14 inches long & walked about on 2 legs. Has very small Eyes & five claws on each foot – Its mouth has a small opening at the end of the Bill & had a very small tongue. – W.B.'

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The echidna was shot by George Tobin, a ship's officer, who reported: 'The animal was roasted and found of a delicate flavour'.

The scientific, as opposed to culinary, interest in echidnas began when they were brought to the attention of Western scientists shortly after European settlement of Australia. The first scientific name for the echidna was given by George Shaw in the *Naturalists Miscellany*, Volume 3 in 1792 as *Myrmecophaga aculeata*. By assigning this name, he placed the spiny anteater of Australia in the same genus as the placental anteater of South America. He illustrated his article with a painting made in Sydney by John White, a collector of plants and animals as well as a painter. White apparently gave an echidna to Governor Philip, who sent it to Joseph Banks by the ship HMS *Gorgon*. The specimen travelled in an eight-gallon cask with a number of marsupial specimens. They arrived in England in July 1792, and Shaw published his description by the end of that year.

In 1802 the British anatomist Everard Home recognised the relationship of the spiny anteater to the platypus, which he had earlier described as *Ornithorhynchus paradoxus*, and renamed the spiny anteater *Ornithorhynchus hystrix*. Generic-level differences between the platypus and the spiny anteater were duly noted, and the spiny anteater became *Echidna hystrix* shortly thereafter. *Echidna* refers to the Greek goddess Ekhidna who was half snake (reptile) and half woman (mammal), indicating that the possession of a mixture of reptile-like and truly mammalian characters by monotremes was recognised very early.

An important rule in designating scientific names is that a name given to one genus should never be used for another and that, when there is a conflict, the older use has priority. The name *Echidna* had been given to a genus of fish in 1788, and so in 1811 spiny anteaters were assigned the genus name *Tachyglossus* meaning 'rapid tongue'. However, 'echidna' lives on as the common name. The species name *aculeata* (meaning 'spiny') corrected to *aculeatus* (to grammatically fit with *Tachyglossus*) remains valid.

In the early days of European settlement of Australia, naturalists had a tendency to create many species based on colour, size and other characters that in due course were found to be highly variable. Later, as the concept of the biological species became accepted, a species was seen as encompassing all individuals with the capacity to interbreed. Consequently a number of earlier 'species' in the genus *Tachyglossus* were lumped into the single species *aculeatus*. Some of the older names have remained as subspecific designations, as listed in Table 1.1. We have not included *T.a. ineptus*, which was once applied to echidnas from Western Australia, since there are no characters of importance that separate it from *T.a. acanthion*. It is of course possible, even

likely, that modern techniques of molecular biology, especially using DNA and MRNA analysis, will require a re-evaluation of these subspecies and perhaps even a splitting of the species *aculeatus*. In terms of morphology, the only consistent character that appears to divide the species is the state of the claw on the third digit of the hindfoot. In *T.a. aculeatus* and *T.a. setosus* it is as long as the grooming claw on the second digit.

Table 1.1. Subspecies of *Tachyglossus aculeatus*, the short-beaked echidna.

Name	Distribution	Distinguishing characters
T.a. acanthion	Northern Territory, northern Queensland, inland Australia and Western Australia	Hairs, usually black, are bristle-like, sparse on the back and often absent on the ventral surface. Spines long and stout.
T.a. aculeatus	eastern New South Wales and Victoria; southern Queensland	Spines overshadow fur, which is relatively short.
T.a. lawesii	New Guinea lowlands	Spines long and stout; fur thick and usually brown.
T.a. multiaculeatus	South Australia, especially Kangaroo Island	Many long, thin spines which project well beyond the fur.
T.a. setosus	Tasmania	Soft thick fur with spines relatively short and few. Spines rarely protrude above fur. Fur often light brown.

Distribution and habitat

Other than the house mouse, no other mammalian species can be found in so many divergent habitats. Short-beaked echidnas are found in the Snowy Mountains (where they hibernate over winter), in the tropics, in the tropical grasslands of the Northern Territory, throughout the arid zone and all along the coast. In fact a distribution map of echidnas includes all of the Australian mainland, Tasmania and other offshore islands (e.g. Kangaroo Island). Short-beaked echidnas also occur in New Guinea and on some islands off the main island (e.g. Salawati Island). On New Guinea *Tachyglossus* is found in lowland habitats, especially in eucalyptus woodland around Port Moresby, and at altitudes up to 1600 metres in the central highlands. However, *Tachyglossus* is rare in New Guinea today and, like the highland long-beaked echidna, *Zaglossus bruijni*, is a truly endangered species there.

In general, the subspecies of *Tachyglossus* listed in Table 1.1 can be related to habitat. The Tasmanian subspecies, *T.a. setosus*, occupies the southernmost part of the range – not surprisingly, it is distinguished by the thickness of its coat (which often obscures the spines). What is surprising is that on average Tasmanian echidnas weigh less than any other subspecies – about two-thirds the weight of mainland echidnas. This runs counter to Bergman's Rule, which predicts larger body size within a cline as the poles are approached. *T.a. acanthion*,

which inhabits the hot, dry centre of Australia as well as some tropical zones, is almost hairless but weighs considerably more than *T.a. setosus*. The New Guinea and northeastern Queensland subspecies, *T.a. lawesii*, primarily inhabits tropical lowlands, confounding expectations by being much hairier than *T.a. acanthion* and heavier than *T.a. setosus*.

Longevity

Echidnas may enjoy exceptionally long life spans. One short-beaked echidna lived for nearly 50 years in captivity at the Philadelphia Zoo in the USA. Peggy Rismiller reports a free-living individual as having been observed over a period of 45 years. This relatively long life span is no doubt a benefit of life 'in the slow lane'.

The long-beaked echidna

The long-beaked echidna belongs to the genus *Zaglossus* (Figure 1.2). It is considerably larger than the short-beaked echidna and has a longer and more down-curved snout.

- The maximum weight recorded for *Zaglossus* is about 17 kg, compared to a maximum of about 7 kg for *Tachyglossus*.
- The snout of *Zaglossus* is about 10.5 cm long, compared to about 5.5 cm for *Tachyglossus*. There is considerable variation between indi-

Figure 1.2 *Zaglossus bruijni*, the long-beaked echidna of New Guinea.

vidual long-beaked echidnas in the degree to which the snout is bent downwards. *Zaglossus* also shows greater development of the tongue and salivary glands than does *Tachyglossus*.

Other differences include variation in the number of claws, and differences in their spines.

- While most *Zaglossus* have claws on all digits, many lack claws on the first and fifth digits of the hindfeet. *Tachyglossus* invariably has five clawed digits on the manus.
- The spines of *Zaglossus* are shorter and more solid than those of *Tachyglossus*. They also have a smaller lumen.

External features

Zaglossus usually has thick fur, varying from shades of light brown to black. Some individuals may have white markings on the face, paws and rump. Albino forms have been recorded.

There is a great deal of variation in the length and distribution of spines. Spines usually show only above the fur on the flanks, but Salawati Island forms are reported to have spines on the ventral surface (belly). Spines are usually light-coloured, although one type has been described as a separate subspecies (*Z. b. nigroaculeata*) because it has black spines. Other forms have black spines tipped with white, and some individuals have a mix of black and white spines.

As in *Tachyglossus*, *Zaglossus* males have a spur on the hindlimb and females usually do not. The spur has been described as 'well developed' in some males, however the scant information available suggests that the duct and venom gland are vestigial or absent.

It has been reported that *Zaglossus* develops a pouch for its young in the same way as *Tachyglossus* does, but this remains to be confirmed.

Long-beaked echidnas have been reported to make a soft snuffling, snorting sound.

Taxonomy

The long-beaked echidna was first brought to the attention of European scientists by the Dutch merchant and natural historian A.A. Bruijn. He had received a partial skull (lacking the lower jaw) of this animal from a native hunter from Mt Arfak in northern New Guinea. The skull was sent to Italy and subsequently described by Peters and Doria in 1876. They named this remarkable new echidna *Tachyglossus bruijni*, but several competing generic names were published in quick succession: *Zaglossus* by Gill in 1877, *Proechidna* by Gervais in 1877, *Acanthoglossus* also by Gervais, *Bruynia* by Dubois in 1881,

and *Bruijnia* by Thomas in 1882. The fact that so many names were proposed for this singular animal highlights the interest generated by this unique monotreme as well as differences of opinion as to what constitutes a generic difference between two taxa. Anyway, the name proechidna was for many years the most well-known term for the New Guinea long-beaked echidna, although the generic name *Zaglossus* won out on the basis of priority. *Zaglossus* means great (za) tongue (glossus). The species name is on occasion given as *bruijnii*, but the reason for the double *ii* is unknown to us, and since it seems an unnecessary complication to a name that is already difficult, we will stick to the more widely used spelling '*bruijni*' in this book.

The taxonomy of species and subspecies of *Zaglossus* has likewise been controversial. This is primarily because there is so much morphological variation within *Zaglossus*. Does this mean that there are several different species, or is this variation only a difference between races or subspecies?

The question of whether or not there are at least two separate species of *Zaglossus* goes back to shortly after its discovery when, in 1884, Dubois described a second species based on its small size, relatively straight beak and thick fur. A comparative study made by Allen in 1912 found no reason to separate *Zaglossus* into more than one species, and that view has dominated to the present. However, in 1998 Flannery and Groves proposed splitting *Z. bruijni* by resurrecting the species *bartoni*, which had been used by Thomas in 1907. The main character used to split *Zaglossus* is the number of claws on the forepaw, with *Z. bartoni* always having the full complement of five claws, while *Z. bruijni* always has less than five, with the first and fifth usually missing. The two species as resurrected by Flannery and Groves do not overlap in their geographical range at present. *Z. bruijni* occurs west of Lake Paniai, including the Vogelkop Peninsula and a small portion to the east in what is now Irian Jaya. It is also found on the island of Salawati, just to the north of the Volgelkop Peninsula. *Z. bartoni* is found only east of Lake Paniai, occupying the central highlands of most of the island of New Guinea. Flannery and Groves also erected a new species, *Z. attenboroughi*, on the basis of one skin and a crushed cranium. This is a weak basis on which to construct a new species, especially within a genus that shows so much variation, and we will not consider it further.

Distribution, habitat and diet

The habitat of *Zaglossus* is primarily highland forest (above 2000 m), although in some areas the distribution extends above the highland forest into alpine habitat and below it into hill forest. On Salawati, *Zaglossus* inhabits low-lying, flat, forested areas characterised by rich, deep soil.

Several species and genera of long-beaked echidna have been described from fossil deposits throughout mainland Australia and Tasmania. If these animals had the same habitat requirements as the living long-beaked species (wet forest with soft soil), it is likely the shrinking of their range and ultimate disappearance from Australia was due to the increasing aridity of the Pleistocene. *Zaglossus bruijni* has a fossil record in New Guinea (from the Nombe rock shelter site) dating back to the Pleistocene.

While echidnas in general are often termed 'spiny anteaters', long-beaked echidnas are mainly earthworm eaters. Their diet can also include varying amounts of small centipedes, scarab beetle larvae, lepidopteran larva and subterranean cicadas, depending on availability. The animal uses its long snout to probe the soft soil to locate prey, and its tongue has a unique adaptation for taking earthworms. The anterior third of the tongue has a deep groove on the upper surface which contains three longitudinal rows of backwardly directed, sharp, keratinous (like fingernail) spines. Earthworms are manoeuvred until they can be taken into this groove from either end. The tongue extends only 2–3 cm, which is much less than the 18 cm extension possible for the short-beaked echidna. On protrusion, the tongue of *Zaglossus* bends downwards, opening the groove in the process. When the tongue is retracted, the groove is tightly closed. This structure is not present in the short-beaked echidna which is a true anteater.

No echidnas have teeth, and both long- and short-beaked echidnas thoroughly masticate (mash) food items between horny plates at the back of their tongue and on the roof of their mouth (palate).

Food supply does not seem to be a limiting factor for long-beaked echidnas. Earthworms are abundant and relatively large in the humid montane forests inhabited by them. However, all *Zaglossus bruijni* are rare and are listed as 'endangered' by The World Conservation Union (IUCN). The decline in numbers is due to land clearing and the use of dogs and firearms in hunting. There has also been a breakdown of taboos against hunting that were in place before the spread of Western beliefs in New Guinea. Roasted in the coals of a fire, echidnas are considered a great delicacy by all peoples of New Guinea. Not surprisingly, *Zaglossus* is now absent from areas where human population densities are high.

The above information covers almost all that is known about the biology of long-beaked echidnas. The rest of this book will deal with the short-beaked echidna and for the sake of brevity the term 'echidna' can be assumed to refer to *Tachyglossus aculeatus* unless stated otherwise.

The platypus

Although this book is about echidnas, it is convenient to include a few details about the platypus for comparison.

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Platypuses feed and mate in freshwater streams and lakes of eastern Australia, including Tasmania, King Island and Kangaroo Island (where they have been introduced). The platypus is predominantly an opportunistic predator on benthic invertebrates, mainly insect larvae, although small fish may also be taken. Like the echidna, the adult platypus lacks teeth. However, teeth are present in fossil platypuses and begin to develop in very young platypuses, only to be lost before they are fully formed.

The platypus takes food in through its open mouth and into cheek pouches where it sorts out the indigestible bits and spits them out. It then grinds the food items into a paste by means of hardened keratinous (horny) pads that have replaced the teeth.

Aquatic adaptations include webbed feet, a streamlined body shape and a waterproof and highly insulative coat. When underwater, platypuses close their eyes, which is therefore assumed to be an adaptation for swimming although other mammalian swimmers, such as otters, do not close their eyes in the water. When underwater, platypuses also close the flaps of skin over their nostrils, effectively shutting down the sense of smell through the nasal passages. This raises the question of how platypuses navigate underwater, find their prey and keep from bumping into things. It has been suggested that electro-receptors located in the snout of the platypus (and also present in echidnas) might serve these functions, but they are passive detectors of electric currents and it is unclear how they could respond to anything but large prey items such as yabbies.

Male platypuses, like male echidnas, have a sharp spur on the inside of the ankle. This interesting structure is not found in any other living mammals, although some fossil Mesozoic mammals may have had such structures. In the male platypus venom is produced by a gland lying behind the knee and delivered through a duct to the spur. Though functional, the spur is of questionable use. It is not used in capturing prey, which are relatively small invertebrates and fish which can be taken into the mouth whole. The fact that the spur does not develop in females suggests some sort of specialised sexual function, but its use in sexual encounters has never been observed and it would certainly be a matter of 'overkill' since the venom is strong enough to kill a female platypus. Male platypuses often have wounds apparently caused by spurs, but male to male combat using spurs has not been observed.

The platypus is a burrower as well as a swimmer – it digs complex burrows in the banks of streams. Nesting burrows, much larger than camping burrows, end in a chamber lined with leaves and grass for newly hatched young. For an animal with webbed feet to also be an efficient digger requires special adaptations. Digging is achieved by folding back the webbing on the

forepaws to free the claws for the task of excavation. In swimming there is some rotation of the tibia and fibula to turn the hindfeet towards the rear, but in normal stance the hindfeet of the platypus are not pointed backwards as they are in echidnas.

Relationships

The relation between the living monotremes and between monotremes and the other major mammalian groups is reflected in the traditional divisions of the living mammals:

<table>
<tr><td colspan="4">Mammalia</td></tr>
<tr><td colspan="3">Prototheria</td><td colspan="2">Theria</td></tr>
<tr><td colspan="3">Monotremata
(monotremes)</td><td>Metatheria
(marsupials)</td><td>Eutheria
(placentals)</td></tr>
<tr><td>Ornithorhynchidae</td><td colspan="2">Tachyglossidae</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Ornithorhynchus
platypus</td><td>Tachyglossus
short-beaked
echidna</td><td>Zaglossus
long-beaked
echidna</td></tr>
</table>

There have been several recent attempts to revise the traditional taxonomy, including a proposal to put platypuses and echidnas in separate orders, but in our opinion these are not well supported by available data and merely serve to create confusion by redefining established names.