



FAUNA *of* AUSTRALIA

22. MYRMECOBIIDAE

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Numbat–*Myrmecobius fasciatus* [CPR]

DEFINITION AND GENERAL DESCRIPTION

The Myrmecobiidae is a monotypic family comprising the Numbat, *Myrmecobius fasciatus* Waterhouse. The family is included in the superfamily Dasyuroidea.

The Numbat is morphologically closest to members of the family Dasyuridae, from which it is easily distinguished by its pelage: red-brown with a number of white bars across the rump and lower back, where the background colour is generally darker than the rest of the body. Unlike that of any dasyurid, the tail is almost as long as the head and body and is covered along its length in long hairs which sometimes stand erect, giving the effect of a bottlebrush. Although the teeth are variable in number, the Numbat has more teeth than any dasyurid. There are at least eight post-canine teeth on each side of the lower jaw. The alisphenoid tympanic wing forms virtually the whole floor of the middle ear, the palate is elongate and complete, and palatine vacuities are absent.

The features of the pelage, dentition and palate listed above, as well as a number of other characteristics which follow, are exclusive to the Myrmecobiidae. There is an incomplete bony bar behind the orbit formed by processes from the frontal as well as the jugal bone, the frontal bone develops an orbital process out over the orbit and the lachrymal bone is very large and extends a long way out onto the face (Fig. 22.1; Archer 1984b). The tongue is very long, thin and can protrude several centimetres beyond the end of the snout.

HISTORY OF DISCOVERY

The first specimen of a Numbat to be scientifically examined was collected within 3 years of the establishment of Perth (as Swan River Colony). The first recorded sightings of Numbats by Europeans occurred in September 1831, during an exploring trip south along the Avon valley from the site of the present township of York, by Ensign Richard Dale, George Fletcher Moore and two others. Moore's diary for 21 September reads:

“Saw a beautiful animal; but, as it escaped into the hollow of a tree, could not ascertain whether it was a species of squirrel, weazel [*sic*], or wild cat.”

On the next day, he wrote:

“... chased another little animal, such as had escaped from us yesterday, into a hollow tree, where we captured it; from the length of its tongue, and other circumstances, we conjecture that it is an ant-eater – its colour yellowish, barred with black and white streaks across the hinder part of the back; its length about twelve inches” (Moore 1884).

Examination of Moore's diary and the expedition map of Dale (1833) reveals that this animal was collected to the north-east of Brookton. Dale took the specimen back to England and lent it to G.R. Waterhouse, who described and exhibited it at a meeting of the Zoological Society of London (Waterhouse 1836a). The subsequent fate of this specimen, the holotype, is not known. The second specimen to come under scientific scrutiny, however, is held in the British Museum (Natural History). Waterhouse (1836b) first thought it had been collected in Tasmania (as Van Diemen's Land), but later (Waterhouse 1841a) found that it was from ‘Swan River’ (a term often used in reference to the colony rather than to the vicinity of the river itself). The first published illustration of the Numbat, a full-page hand-coloured lithograph, accompanied Waterhouse's detailed description (Waterhouse 1841b).

In the early 1840s, two collectors working in Western Australia, Ludwig Preiss and John Gilbert, obtained a number of specimens which are now in European museums. Gilbert made detailed natural history notes from his own observations regarding the mammals and birds he had collected. The information he passed on to his employer, John Gould, regarding the Numbat (Gould 1863) formed the most comprehensive available account of the ecology of the species until well into this century. Two of Gilbert's specimens (from Toodyay and 'Swan River') are in the British Museum (Natural History), while another (from Toodyay) survives in the collections of the Merseyside County Museums, Liverpool (Fisher 1984). There is no material with Preiss's name as collector, but the nine or ten specimens of Numbats in European museums which were purchased in the 1840s from dealers (Frank, Argent) are probably the results of his efforts.

The first reliable record of the Numbat outside south-western Australia was due to Gerard Krefft, who in 1856-1857 spent 9 months collecting in the area near the confluence of the Murray and Darling Rivers, on the other side of the continent (Krefft 1866; Wakefield 1966). Before this, Major T.L. Mitchell had proposed the name *Myrmecobius rufus* for a new species of mammal called 'the red shrew-mouse' by men in his party, which was encountered during one of his exploring expeditions in south-eastern Australia between 1831 and 1836 (Mitchell 1838). In the absence of any further description or material, it is impossible to tell if this animal was in fact a *Myrmecobius*, although Macleay (1841) concluded that it was a small undescribed *Perameles*.

Later collections, however, extended the known range of the taxon into South Australia. These include specimens from the north-west bend of the Murray River (1863: South Australian Museum), the Everard Range (1891: Elder Expedition; early 1900s, 1931: South Australian Museum), the New South Wales-South Australia border (1900: Museum of Victoria) and Ooldea (1920s: British Museum (Natural History)).

On the basis of South Australian specimens, which have a much redder pelage than those from south-western Australia, Jones (1923a) described a new species, *Myrmecobius rufus* (using the name which Mitchell had failed to formalise with a description). Two of Jones' syntypes are in the collection of the odontological museum of the Royal College of Surgeons, London (Aitken 1976). Finlayson (1933b), Tate (1951b) and subsequent workers have treated this form as a subspecies, *M. fasciatus rufus*.

Prior to the definitive study of the Numbat by Calaby (1960), knowledge of its biology was restricted to scattered observations such as those of Gilbert (in Gould 1863), Glauert (1935) and Fleay (1942). Calaby reviewed previous information about the species, mapped its current distribution and gave a detailed account of its ecology and behaviour from his observations in Dryandra Forest, 150 km south-east of Perth. The greatest contribution of his work, however, was a comprehensive study of the Numbat's feeding habits, which by analysis of scat contents and inspection of feeding sites, proved that termites extracted from subsoil galleries are its main source of food.

MORPHOLOGY AND PHYSIOLOGY

External Characteristics

The Numbat is a small marsupial which attains an adult body weight of 500–700 g, head and body length of about 270 mm, and tail length of about 200 mm. The head is relatively small, but the snout is long and pointed. The hair is short and stiff and the pelage is very distinctively marked. A dark stripe runs along the side of the face and through the eye and is accentuated by the white band immediately below it. Between four and eleven white bands pass across the

rump, where the background is dark brown to black (red-orange in *Myrmecobius fasciatus rufus*), becoming less distinct on the upper back, where the colour grades into red-brown, flecked with white. The long hair on the tail is brown interspersed with white, but orange-brown on the underside. Hair on the ventral surface is almost white, but buff in *M. f. rufus*. The eyes are set high on the head and the iris is dark brown. The ears also stand high on the head and are twice as long as broad.

Skeletal System

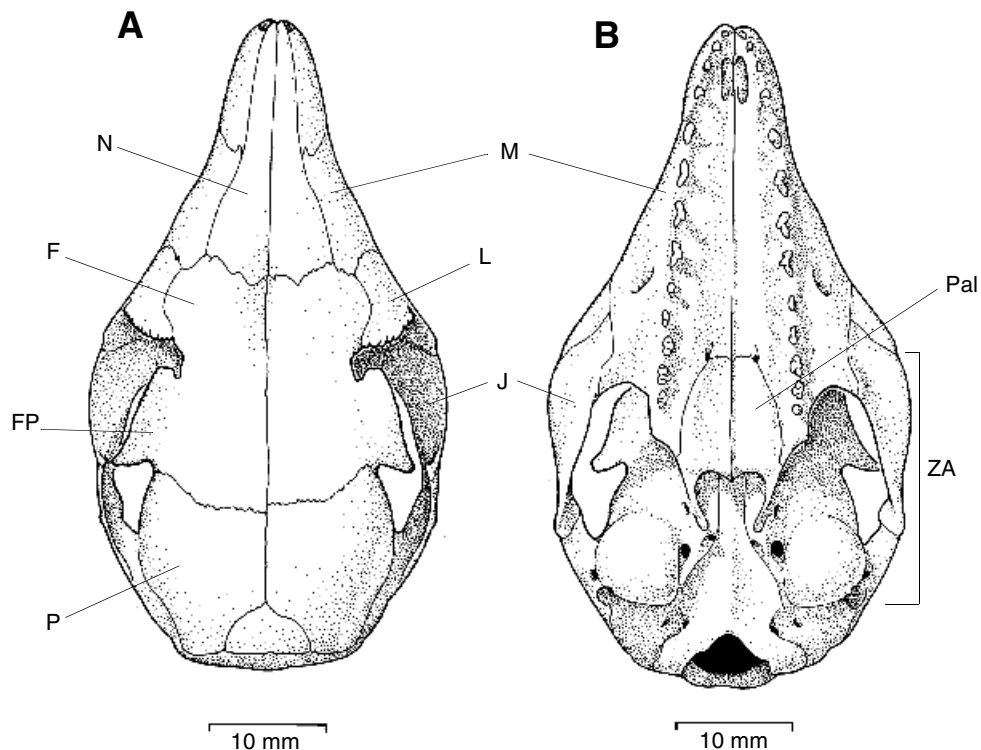


Figure 22.1 Skull of a Numbat in: **A**, dorsal; **B**, ventral view. (After Jones 1923a) ASTW = alisphenoid tympanic wing; F = frontal; FP = frontal process; J = jugal; L = lacrimal; M = maxilla; N = nasal; P = parietal; Pal = palatine; ZA = zygomatic arch. (© ABRS) [G. Milledge]

Several of the characteristic features of the skull of the Numbat have already been listed. The most striking feature is the elongation of the mandibles, so that most of the teeth are widely spaced (Fig. 22.2). The zygomatic arch is wide but delicate and is made up largely of the jugal bone, the squamosal making only a minor contribution (Fig. 22.1). Other features of the skull include the postero-lateral jugal crest, the large interparietal, the complete postero-lateral palatal foramen and the ventral position of the infraorbital foramen on the maxilla (Archer & Kirsch 1977).

The manus has five digits, of which the fourth is the longest. The pes has only four digits. The only external sign of the first digit is a small pad at its site (Fig. 22.3).

Locomotion

The gaits displayed by Numbats are described as follows: ‘The normal methods of locomotion are walking and trotting. If disturbed, the numbat runs rapidly, bounding along like most mammals of comparable size’ (Calaby 1960). The speed of a running individual was estimated at over 30 km/h (Calaby 1960).

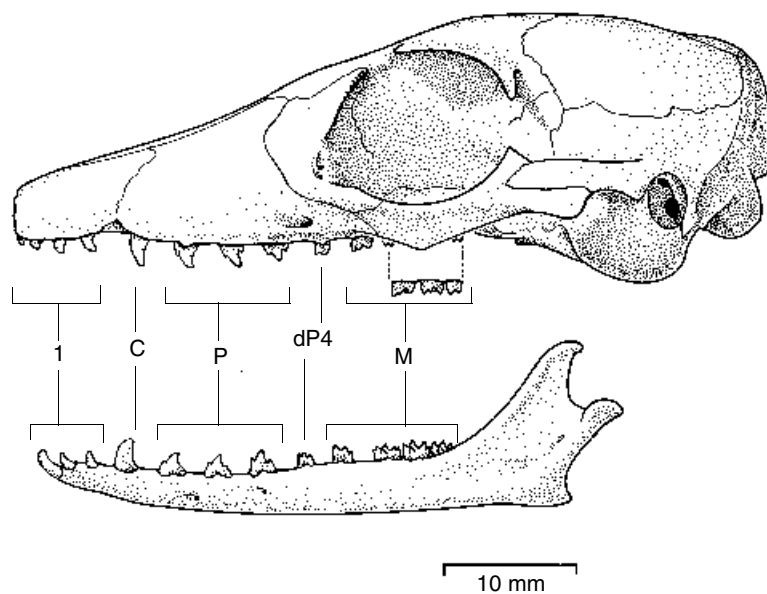


Figure 22.2 Lateral view of the skull and dentition of the Numbat. I1-3, incisors; C1, canine; P1-3, premolars; dP4, possible deciduous premolar; M, molars. (© ABRS) [G. Milledge]

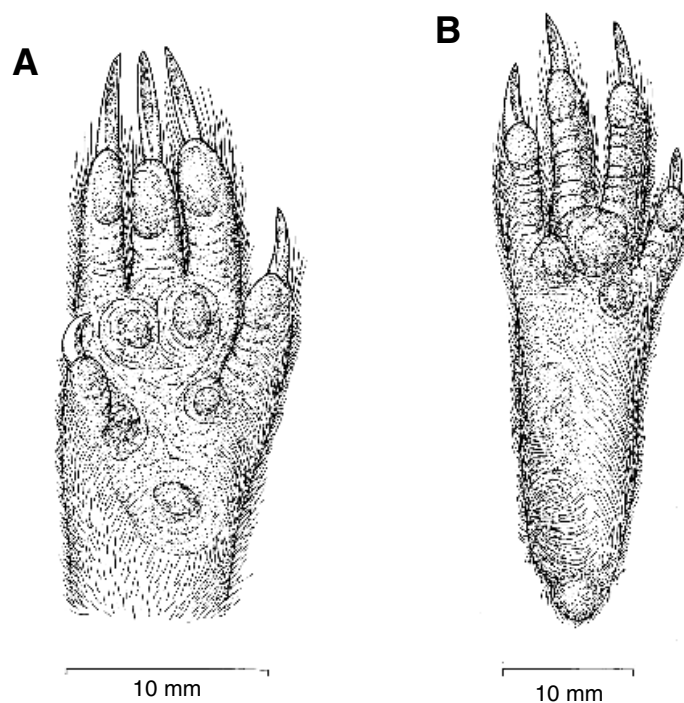


Figure 22.3 Left manus **A**, and pes **B**, of the Numbat viewed from the ventral side. Roman numerals indicate the digits, numbered from medial to lateral. (After Jones 1923a; © ABRS) [G. Milledge]

The hind quarters of the Numbat are characteristically dorso-ventrally flattened (Jones 1923a). This morphology enables the animal to turn around by doubling over inside hollows which are often just wide enough for its body, thereby allowing it to both enter and emerge from logs head-first (Friend 1982).

Feeding and Digestive System

Calaby (1960) describes feeding in Numbats as follows:

“Having located sub-surface termite galleries by scent, the numbat squats on its hind feet and digs very rapidly with both feet. The tongue is flicked in and out gathering up exposed termites... The animal may move on a few inches and repeat the process, or it may leave the spot and trot away to begin searching for another feeding place... The numbat also turns over chips and sticks with a front foot, or with its sharp nose, or by grasping the piece of wood with its teeth. The exposed termites are then licked up”.

Observations on a captive specimen by Fleay (1942) indicate that 15 000 to 20 000 termites are required by an adult animal each day.

Numbats possesses several morphological features associated with feeding which are appropriate to its specialised diet of termites and to its method of obtaining them. The snout is elongated. The tongue is extremely long and thin and can be protruded deep into winding termite galleries then rapidly withdrawn, its coating of saliva causing the apprehended insects to adhere to it. The extension of the tongue is caused by the contraction of the centrally concentrated transverse, radial and dorso-ventral muscle bundles. Retraction is achieved through contraction of the peripherally arranged longitudinal muscles (Griffiths 1968). The salivary glands are enlarged and complex (Ford 1934) and the palate bears a series of 13 to 14 transverse epithelial ridges which remove food from the tongue (Griffiths 1968). Leche (1889) found up to eight keratinised teeth in each of these ridges on the palate of a 23 mm Numbat pouch young, comparable with those of the ant-eating monotreme *Echidna*, *Tachyglossus aculeatus*, but neither he nor Griffiths (1968) found these teeth in adult Numbats which they examined.

The stomach shows no obvious specialisation to termite-eating. It has the typical glandular lining found in the stomach of any carnivorous marsupial, in contrast to the wide variety of triturating and poorly glandular stomachs found in other mammalian ant-eaters (Griffiths 1968). The forelimbs of this species, although not especially powerful, are armed with sharp claws (Fig. 22.3) which enable it to dig rapidly into the soil to expose shallow termite galleries. The Numbat thus shares a number of the morphological adaptations found in unrelated ant- and termite-eating mammals, but overall, it is the least anatomically specialised of this trophic group (Griffiths 1968).

The dentition of the Numbat shows remarkable peculiarities and anomalies (Calaby 1960). The most striking features of the teeth concern the number and shape of the molars and the variability in both. There are always more than seven post-canine teeth in the lower jaw, a condition unique amongst land mammals. There has been some argument as to whether the extra teeth are normally deciduous premolars (milk teeth) which are retained (Dependorff 1898; Tate 1951b) or supernumerary molars for which space has been created as a result of the elongation of the mandibles (Bensley 1903). The number of teeth per individual in a sample of fifteen adult specimens examined ranged from 47 to 52, as follows: 47 teeth, one individual; 48, three; 49, two; 50, three; 51, one; 52, five. Clearly, the number of teeth on opposite sides of the same jaw may also differ. The molars are simple and almost triconodont-like (Archer 1984b) and exhibit considerable morphological variability. The variability in number and form of teeth, as well as the lack of significant tooth wear have been cited as

evidence that the teeth are used very little and so are not subject to intense selection pressure (Calaby 1960). Certainly, the fact that some cheek-teeth barely protrude above the gum (Waterhouse 1841b) supports this suggestion.

Respiration

The Numbat has a lower basal metabolic rate than might be predicted from its body weight. It shares this characteristic with ant- and termite-eating eutherians and monotremes over 1 kg in body weight. The relatively low energy derived from ants and termites as a food source, which is accentuated when large quantities of detritus are ingested, is thought to be the cause of these depressed metabolic rates (McNab 1984). The burrowing habit found in numbats is common amongst the other myrmecophages and is also associated with low basal metabolic rate (McNab 1979).

Excretion

Only the male urinary system has been investigated. The bladder opens into the prostate tract of the urethra from the dorsal side. At the base of the bladder the sphincter vesicae separates the lumen of the bladder from a shallow chamber, the collum vesicae. The paired ureters pass into the collum vesicae, which opens into the urethra by a narrow canal through the wall of the prostatic tract (Fordham 1928).

Sense Organs and Nervous System

Observations of the feeding behaviour of Numbats reveal that termite galleries are located by smell (Calaby 1960). This is despite the fact that some of those excavated by the animals are 50 mm below the surface of the soil. Detection of threat from predators, however, appears to be largely visual. Gilbert (in Whittell 1954) wrote: 'By the natives the Noombat is considered the quickest sighted animal in the country'.

The brain of the Numbat exhibits a number of differences from those both of other marsupials and of eutherians. Each half of the mesencephalon is undivided and has a transverse ridge. In *Didelphis* and *Phascogale*, on the other hand, each half is separated into an anterior and a posterior part. Each hemisphere of the cerebellum has seven distinct and regular folds while the folds of the vermis are completely developed only in older animals. This is in contrast to the situation in the Eutheria, where the folds of the vermis develop before those of the hemispheres (Leche 1891).

Endocrine and Exocrine Systems

Besides the observation that the adrenal glands lie quite free from the kidneys on either side of the dorsal aorta (Fordham 1928), no work on any aspect of the endocrine system of the Numbat has been published. The only exocrine organs which have been investigated are the sternal gland and the submaxillary salivary glands (Beddard 1887; Ford 1934). Anal glands have been shown to be present in females, but absent in males (Hill 1900a; Fordham 1928).

The surface expression of the sternal gland is a practically hairless, pigmented area which is generally rounded in outline and in adults has a diameter of approximately 10 mm. Irregularly scattered over its surface are a number of openings of various sizes, the largest being about 1 mm in diameter (Ford 1934). In males, it is sometimes swollen and raised above the level of the surrounding skin and the surrounding hair may be stained orange-brown (Calaby 1960). Contained within the organ are sebaceous glands, sweat glands and sudoriparous follicles. The sebaceous glands are of the usual structure. The sweat glands

possess three tubules each and are usually isolated in groups of three. Straight ducts often lead from the sweat glands directly to the outer surface, but some pass through sudoriparous glands to the surface. The sudoriparous follicles open directly into the large surface pores. Individual glands, which occur within the follicles, are swollen and sometimes almost bifid at the base. The shaft of each gland consists of muscular fibres (Beddard 1887). The sternal gland most probably is used in territorial marking, given its similarity to the sternal scent glands in a number of marsupial genera, including many of the phalangerids and the Koala, *Phascolarctos cinereus*.

The submaxillary salivary glands in the Numbat are greatly enlarged, like those of many unrelated ant- and termite-eaters (Ford 1934; Griffiths 1968). The left and right submaxillary glands are each divided into an anterior and a posterior section. The latter, which is the larger, underlies the sternal gland, is plate-like and about 12 mm in diameter. The anterior section is serous in character, while the posterior section is of the mucous type, and both communicate with the mouth through the same duct (Ford 1934).

Reproduction

The external sex organs in male Numbats display no extraordinary features. The scrotal sac is covered in light-coloured hair and is suspended by a peduncle from the normal pre-penile position of attachment. The penis, which is completely hidden within the cloaca when non-erect, is cleft distally for about 5 mm. The free tips are rounded and the smooth skin covering them is separated by a fold from the keratinised spiny region of the shaft.

The most remarkable internal feature of the male urogenital system is the greatly enlarged prostatic tract of the urethra. The vasa deferentia enter the bladder wall near the ureters, but open into the urethra within the prostatic tract after passing along the inner prostate wall within a longitudinal ridge, the verumontanum. There are three pairs of Cowper's glands, one of which is many times larger than the other two and has a much thicker muscle coat (Fordham 1928). There is no trace of a pouch in the female; the four nipples found on the abdomen are so arranged that the posterior pair is closer together than the anterior pair. The mammary area is clothed in short, crimped, golden hair which is distinctly different from the longer white hair covering most of the ventral surface.

The ovaries are situated ventral to the anterior extremities of the uteri. The Fallopian tubes are thin, convoluted and not marked off sharply from the uteri. The body and neck of the uteri are sharply differentiated from each other. The body of each uterus is almost transversely directed to the long axis of the animal. The uterine necks come together and thicken posteriorly to form a single bulbous structure. This also encloses two median vaginae, which are short, small culs-de-sac terminating close to the upper end of the urogenital sinus and into which the uterine necks open. From the median vaginae, two lateral vaginae pass off anteriorly. At about the middle of the uterine necks, the two lateral vaginal canals pass outwards at right angles to become relatively long, free tubes. These coil around twice before again meeting the urethra and passing together with it down to the top of the long urogenital sinus, into which all three open by separate apertures. There is a distinct cloaca into which the rectum opens dorsally and the urogenital sinus ventrally (Hill 1900a).

Breeding in the Numbat is highly seasonal. In captivity, mating occurs in January and the gestation period is 14 days (Friend & Whitford 1986). Observations in the wild (Calaby 1960; Friend & Burrows 1983) suggest that most young are born in summer, although it is possible that some are born as late as April. There is evidence of a cycle of fertility in the male.

The usual litter size is four, so that all nipples are occupied. As there is no pouch, the young are held to the female only by their oral attachment to the nipples and by the active entwining of their forelimbs in the crimped hair of the mammary area. Development of the young while attached is particularly slow. The period of attachment is up to 6 months (Calaby 1960) after which time the young are placed, in late winter, in a log or burrow (Christensen 1975; Friend & Burrows 1983). The juveniles are foraging independently by October and probably breed in their first year (Calaby 1960).

Embryology and Development

There has been no study of the embryology of the Numbat before parturition. After parturition, attached young grow from less than 20 mm to about 75 mm crown-rump length before being deposited in a burrow (Calaby 1960; Friend & Burrows 1983). At both early and late stages of attachment, the young possess an extremely shortened snout, such that the eye is more than halfway from the ear to the protruding end of the lower mandible and the face resembles that of a pug dog (Jones 1923b). A light downy coat is present at 30 mm, but stripes are not visible on the rump until about 55 mm (Calaby 1960). The eyes generally do not open while the young are still attached (Friend & Burrows 1983).

NATURAL HISTORY

Life History

A captive female attained at least 5 years of age (Taronga Zoo records). Females probably breed in their first year (Calaby 1960), but as mating occurs in January after dispersal of the young, there is a low likelihood of pairing between close relatives. The rate of mortality of the young through predation appears to be particularly high during the early weeks of independent foraging (Friend & Burrows 1983).

Ecology

The diet of the Numbat consists primarily of termites. In addition, ants, which make up less than 15% of the total, are apparently ingested by accident with the termites. A detailed study of the feeding habits of Numbats in Dryandra Forest revealed that most species of termite occurring there were eaten and that the two most common species in the area, *Coptotermes acinaciformis* and *Amitermes obeuntis*, were eaten most frequently (Calaby 1960). The nests of the termites in this area occur in mounds, in tree-trunks or underground and from there their subterranean galleries spread out, giving the worker termites access to sources of food (mainly dead wood). The Numbat intercepts termites in these feeding galleries, rather than in the nests, exposing them by digging in the upper 50 mm of soil, by turning over small pieces of dead wood and by scratching bark and decayed wood from old logs, stumps and fallen tree limbs (Calaby 1960; Christensen, Maisey & Perry 1984).

The former distribution of the Numbat encompassed much of the southern half of the Australian continent, including sections of the south-western forests of Western Australia as well as much of the arid zone (see Distribution, Fig. 22.5). Where the species persists in the tall forests, it occurs in areas dominated by *Eucalyptus marginata* and *E. calophylla*, with an open understorey (Christensen *et al.* 1984). It does not occur in *E. marginata* forests in which the understorey is thick (Connell & Friend 1985). Further east, in remnants of woodland in the main cereal-growing area of the south-west, the habitat of the Numbat is in the valleys and on valley slopes dominated by *E. wandoo*, where there is an open

understorey (Calaby 1960; Friend & Burrows 1983). Previously, the species lived in *E. salmonophloia* woodlands in the eastern wheatbelt (Calaby 1960). Hollow logs, which provide refuge, are abundant in these three vegetation types. In the arid zone, however, where the species inhabited *Acacia aneura* woodland, *Triodia* grassland and sand-ridge country (Finlayson 1933b; Burbidge & Fuller 1979; Friend, Fuller & Davies 1982), hollow logs are scarce and burrows probably were used more extensively (Friend 1982). An abundance of subterranean termites, which is common to all previous Numbat habitat types, appears to be the most important single habitat requirement.

The only records of internal parasites of Numbats are two nematodes, *Beveridgeiella calabyi* and *B. inglisi*, found in the alimentary tract (Humphery-Smith 1980). Several ectoparasites have been found on this species, including the mite *Mesolaelaps australiensis* (Domrow 1958), the ticks *Ixodes vestitus*, *I. myrmecobii* and *Amblyomma triguttatum* (Calaby 1960; Roberts 1962) and the fleas *Echidnophaga myrmecobii* and *E. perilis* (Hopkins & Rothschild 1953).

The diurnal activity of the Numbat exposes it to the risk of predation from large reptiles and raptors. The only recorded incident of predation, however, was due to either Brown Goshawks, *Accipiter fasciatus* or Collared Sparrowhawks, *A. cirrhocephalus* (Friend & Burrows 1983). In its present range, other potential predators of the Numbat are: the raptors Wedge-tailed Eagles, *Aquila audax*, Brown Falcons *Falco berigora*, Square-tailed Kites, *Lophoictinia isura* and Little Eagles, *Hieraaetus morphnoides*; the monitor *Varanus gouldii*, the python *Morelia spilota* and the introduced carnivores the Fox, *Vulpes vulpes* and the Cat, *Felis catus* (Calaby 1960).

Distinct home ranges are occupied by individual Numbats (Friend & Burrows 1983; Christensen *et al.* 1984). These appear to be exclusive of other animals of the same sex as the resident, suggesting that intruders are expelled at some time of the year (Friend & Burrows 1983).

Behaviour

The tendency to be exclusively diurnal sets the Numbat apart from nearly all other marsupials. In winter, individuals are active from mid-morning to late afternoon, but during the hottest part of summer, there are two periods of movement each day. The first extends from soon after dawn until mid-day, when animals enter logs to rest until late afternoon. There is then a further period of activity until dusk (Friend & Burrows 1983; Christensen *et al.* 1984). This seasonal pattern of activity corresponds closely to the diel variation in abundance of termites in shallow subsoil galleries (Friend 1986). A significant part of the day, especially on winter mornings, is spent basking in sun, frequently on a log (Calaby 1960).

Nights are spent in logs or burrows in which nests have been constructed. Each individual has several nests in its home range, but will frequently spend every night in one or two (Friend & Burrows 1983; Christensen *et al.* 1984). The burrows are dug by the numbats themselves (Christensen *et al.* 1984; Friend & Burrows 1983). One such burrow consisted of a shaft about 1 m long and 65 mm in diameter, with a terminal chamber between 150 mm and 230 mm in diameter which was filled with nest material (Christensen *et al.* 1984; see Fig. 22.4). In *Eucalyptus marginata* forest, nests consist of a mass of bark shredded into fine strands (Christensen *et al.* 1984), but in *E. wandoo* woodland, dead grass is the most important constituent (Glauert 1935). Nests have been found in logs lying on the forest floor, but upright hollow tree-trunks are also important sites for nests (Friend & Burrows 1983).

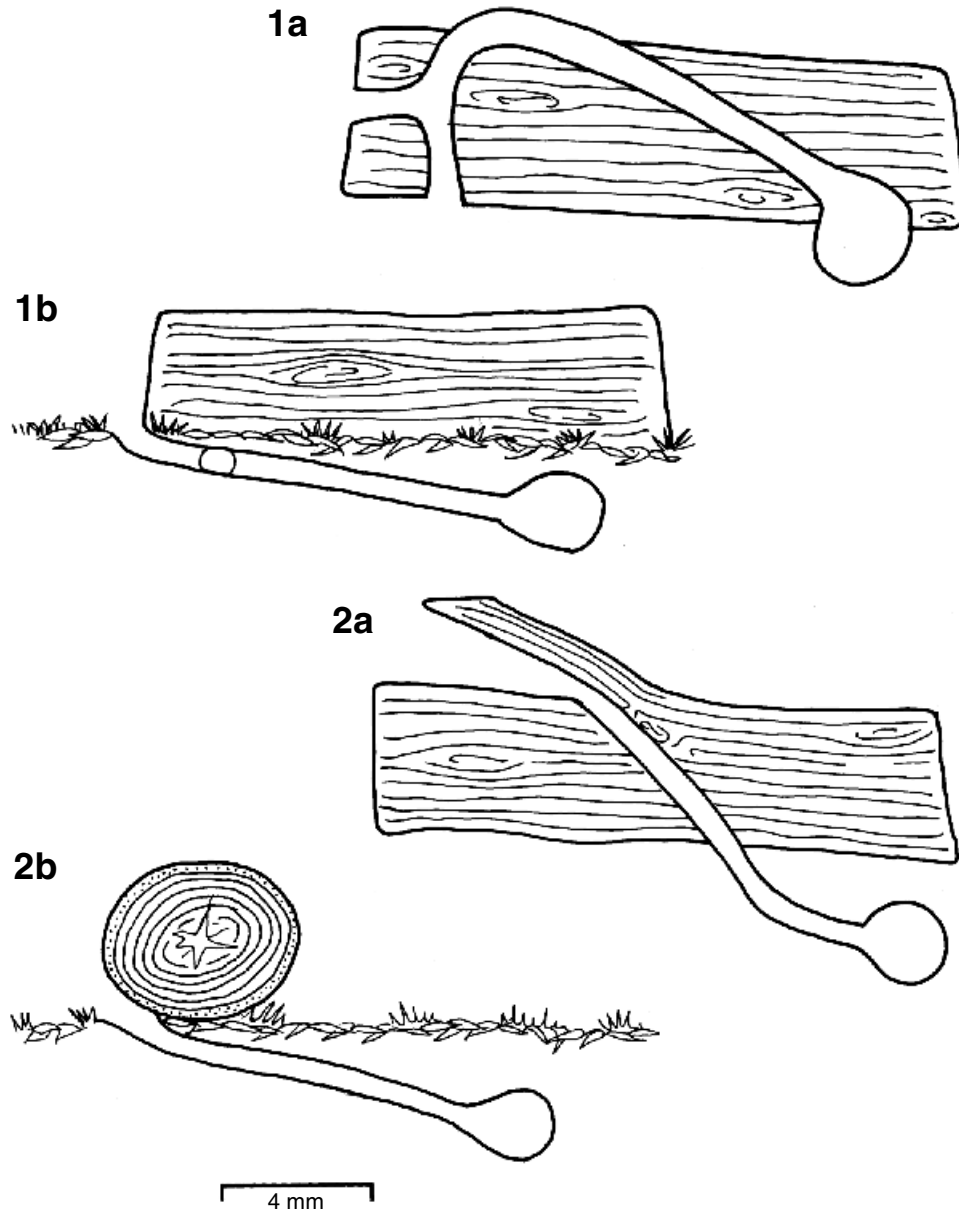


Figure 22.4 Scale drawings of two Numbat burrows (1 & 2) in the Perup Forest, Western Australia. Diagrams labelled (a) are in plan view, those labelled (b) are in lateral view. (After Maisey & Bradbury 1983; © ABRS)
[B. Scott]

Females carry their young from birth in summer until late July or August, when they deposit them in a burrow. The young are suckled at least until late October, by which time they emerge daily and forage within their mother's home range, returning to the nest before dusk. During the early days after their first emergence, the young stay very close to the burrow entrance, not feeding but moving about, playing and basking in the sun. They disappear down the burrow at the slightest hint of danger. During October, daily movements from the nest become gradually more extensive, but the young remain within their mother's home range. While the family is still together, the female may move the young to different nests several times, particularly in response to disturbance. To accomplish this, she carries the young on her back, sometimes for considerable distances, across her home range. Dispersal of the young from their natal area occurs in December (Friend & Burrows 1983). At this time, movements of up to 10.9 km have been recorded (Friend 1987).

Numbats are solitary for most of the year (Calaby 1960; Christensen *et al.* 1984). The main exception occurs when the young are mobile, but still based at their mother's burrow or nest-log. At this stage the young often associate with each other near the nest, although they rarely stay together as they move away during their daily foraging trips (Friend & Burrows 1983).

Economic Significance

There is no history of commercial hunting of Numbats besides the collection of up to two hundred specimens for museums. Older central Australian Aboriginal people, however, remember hunting this mammal, which was widely known as "walpurti", as a food item. Individuals were tracked to their burrows and dug up by hand (Friend *et al.* 1982).

Research on the Numbat has been hampered by the fact that it rarely enters baited traps. The only reliable method of capture is to chase an animal on sight until it enters a hollow from which it may be removed. Radio-tracking has recently been used extensively to elucidate aspects of its ecology (Friend & Burrows 1983; Christensen *et al.* 1984). Knowledge of the animal's sign gained in this way has allowed surveys to be conducted based on searches for diggings, scats and burrows, as well as for hairs left in logs (Connell & Friend 1985).

Due to the drastic decrease in the range of Numbats since white settlement, and after a recent decline in numbers of the few remaining populations, the western subspecies was added in 1983 to the list of Western Australian fauna which is "likely to become extinct, rare or otherwise in need of special protection" (Anon. 1983). Previously only *M. f. rufus*, which is now presumably extinct (Friend *et al.* 1982), appeared on this list. This classification provides much greater restrictions on interference with animals in the wild. The Numbat is classified as endangered in the IUCN Mammal Red Data Book (Thornback & Jenkins 1982).

Most of the surviving numbat populations are in State Forest, although a few animals apparently remain in Tutanning Nature Reserve (2000 ha). Areas of state forest at Dryandra (28 000 ha) and Perup (39 000 ha) contain important remnant populations and are managed primarily for nature conservation. A research program aimed at determining the means to conserve the species was initiated in 1981 by the Western Australian Government (Friend 1982) and has resulted in much new knowledge of the species in the wild (Friend & Burrows 1983), the first successful breeding in captivity (Friend & Whitford 1986) and the initiation of a program of re-establishment of populations in the wild.

BIOGEOGRAPHY AND PHYLOGENY

Distribution

At the time of white settlement in Australia, the range of the Numbat extended across the southern half of the Australian continent (Fig. 22.5). The species is an Australian endemic and has never been recorded from offshore islands. Today, populations survive only in forest and woodland areas of south-western Australia (Connell & Friend 1985; Friend & Kinnear 1983).

Affinities with other Groups

A significant body of evidence suggests that the Myrmecobiidae is phylogenetically closest to the Dasyuridae. Bensley (1903) concludes that the dentition (although anomalous) was derived from a primitive dasyurid. Other morphological evidence supports this conclusion (Leche 1891). The chromosome complement, $2n = 14$, is shared with the Dasyuridae as well as with other marsupial groups and, therefore, provides no clues to relationships



Figure 22.5 Recorded distribution of the Numbat. Circles: museum specimens collected alive. Squares: recent bone deposits, museum specimens. Closed triangles: literature records without specimens (Calaby 1960; Finlayson 1961; Krefft 1866). Open triangles: information from Aboriginal people (Friend *et al.* 1982; Burbidge *et al.* 1988).

(Sharman 1961a). Serological evidence, however, suggests that the Numbat is part of a dasyurid radiation (Kirsch 1968). Albumin systematics places the genus in a similar phylogenetic position (Lowenstein, Sarich & Richardson 1981).

Many distinctive features of the Numbat, like its dentition and posteriorly extended palate, are a consequence of its specialised diet. Some character states, however, such as the lack of a periotic hypotympanic sinus, suggest an early divergence from the dasyurid lineage, probably predating the Late Miocene (Archer & Kirsch 1977; Archer 1981b, 1984b).

Affinities within the Myrmecobiidae

Myrmecobius fasciatus fasciatus and *M. f. rufus* are separated only on differences in pelage colouration (Finlayson 1933b; Jones 1923a). The redness of the eastern subspecies is probably a selective adaptation which provides greater protection against avian predation where the soil is red in colour, as it is in much of central Australia.

Fossil Record

There are only three published records of fossil or sub-fossil remains of myrmecobiids. None is older than late Pleistocene and all are referable to *Myrmecobius fasciatus*. Two of these records, from Lake Menindee, New South Wales (late Pleistocene: Tedford 1967) and the lower Murray River, South

Australia (Holocene: Wakefield 1964a) are within the known modern range of the species. A record from Madura Cave on the Nullarbor Plain, Western Australia (late Pleistocene: Lundelius & Turnbull 1978), however, is well removed from any known modern occurrence (Fig. 22.5).

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