

BLINDNESS AND SURVIVAL IN FREE-RANGING ECHIDNAS, *TACHYGLOSSUS ACULEATUS*

BLINDNESS or poor vision in mammals is often associated with a way of life where vision plays little or no role in the species' fitness (Nevo 1979), defined as lifetime reproductive success (Arnold 1988). Australian examples include the blind marsupial mole *Notoryctes typhlops*, which spends most of its life underground (Johnson 1983), and the amphibious platypus, *Ornithorhynchus anatinus*, which has poor vision, closes its eyes, ears and nostrils when foraging underwater, and may use electroreception predominantly to locate prey (Griffiths 1978; Grant 1989). Alternatively, blindness may be the result of a birth defect or of an accident in which previously functional eyes have been disabled. In such individuals, one would usually predict premature death through predation, exposure or starvation, particularly when blindness is complete. However, in some social species or species where vision is less important than other senses in finding food, visually disabled individuals can survive for extended periods (MacDonald 1987). Marais and Irish (1990) reported on a Namibian population of cave-dwelling shrews, *Crocidura cyanea*, which have adapted to life in total darkness, but they failed to discuss vision. This note examines cases of partial and complete blindness in the spiny, termite- and ant-eating echidna *Tachyglossus aculeatus*.

As one of its defence strategies, *T. aculeatus* rolls into a ball by arching the heavily spined stubby tail over its spineless belly, legs, face and snout (spines are rigid, sharp and up to c. 8 cm long). While in such a defensive posture, I observed one of my study animals (Abensperg-Traun and De Boer 1992) to puncture, and blind, its left eye with a long spine of the tail. An additional study animal was blind in one eye at first capture (cause unknown). Of 16 *T. aculeatus* captured and studied, two animals (12.5%) were thus partially blind, suggesting that this is a relatively common condition. Subsequent monthly measurements showed that seasonal energy budgets of both animals were well within the body weight fluctuations seen in other study animals (Abensperg-Traun and De Boer 1992). Augee and Gooden (1992, quoting Grigg pers. comm.) reported extensive observations on a completely blind, free-ranging *T. aculeatus* apparently in good health. Eye puncture may also occur during aggressive encounters between individuals, as described by Augee, Bergin and Morris (1978) and Rismiller (1993). Good health in partially and completely blind

T. aculeatus implies that vision plays a subordinate role in food acquisition. Three lines of argument support this conclusion. Firstly, termites and ants, the species' main food, are obtained primarily from beneath the surface of the soil and wood where they are 'invisible' until excavated by foraging animals. *Tachyglossus aculeatus* has not yet been observed to eat termites (harvesters) and ants which forage on the surface. In fact, its feeding apparatus, particularly the long, narrow and sticky tongue, largely restricts *T. aculeatus* to capturing prey where they are most concentrated, such as in mounds, subterranean nests, foraging chambers and galleries; this strategy maximises the ratio of prey to non-prey material (soil and plant debris) ingested (Redford 1987). An exception is the scarab beetle larvae which echidnas excavate from the soil on the New England Tablelands (Smith, Wellham and Green 1989). Its relatively large size and high energy content may explain this deviation from the echidna's normal foraging strategy. Evidence now suggests that in locating its prey, *T. aculeatus* may also use electroreception in the snout (Augee and Gooden 1992), and possibly hearing (Griffiths 1989), as do some other mammals which are specialist predators on termites and ants (Kruuk and Sands 1972).

Secondly, once prey are located, *T. aculeatus* eats them in bulk because, apart from alates, the different castes of termites and ants are similar in nutrient content (Redford and Dorea 1984). Although the small gape of *T. aculeatus* limits the species to relatively small invertebrate prey, there is no evidence that *T. aculeatus* prefers larger, energetically more profitable termite or ant species. Exceptions are termite and ant alates, and scarab beetle larvae, which are of limited seasonal availability (Griffiths and Simpson 1966; Smith, Wellham and Green 1989). The presence of alates and scarab larvae, in any case, can only be detected by sense of smell, possibly hearing and electroreception. Thus vision may not be required in prey selection.

Thirdly, most termites (soldiers) and ants use chemical secretions to varying degrees in communication and defence of the colony (Prestwich 1979). These are detectable before consumption, thus obviating the need for vision in selecting palatable food items. A good example is *Drepanotermes*, a mound-building termite common in arid and semi-arid Australia (Watson 1982) which restricts predation by *T. aculeatus* through the secretion by soldiers of copious quantities of pungent chemicals

(Moore 1968; Abensperg-Traun, Dickman and De Boer 1991). Other examples include species of *Schedorhinotermes*, *Coptotermes* and *Mastotermes darwiniensis* among the termites, and Australia's most common ants, species of *Iridomyrex*, *Campanotus* and *Melophorus* (Moore 1968; Abensperg-Traun 1988, 1993; Griffiths, Greenslade, Miller and Kerle 1990; Taylor 1991). *Tachyglossus aculeatus* feeds mostly on unseen prey, probing deeply into termite and ant nest chambers with its long, sticky tongue where sense of smell, rather than vision, is likely to determine food selection.

Walls (1942), discussing vision in *Tachyglossus*, pointed to keratinisation of the corneal epithelium in this genus as well as in the termite- and ant-specialised armadillos, *Cobassous* species, and Aardvark, *Orycteropus afer*, implying a diet-related condition. This may make for impaired vision and ultimately complete blindness. M. Griffiths (pers. comm.) enlarged on this theory, and suggested a link with bites and chemical secretions from ants and termites, and continuous abrasion from dirt and sand lodged in secretions around the eyes.

Experiments by Gates (1978) to examine some aspects of vision in captive *T. aculeatus* showed that the species is capable of some visual discrimination. They suggested that vision in *T. aculeatus*, although poor relative to most placental mammals, may not be as defective as one may conclude from their poorly developed visual anatomy, which incorporates both reptilian and mammalian characteristics (Griffiths 1989). Whereas vision appears to play no significant role in food acquisition, it does not necessarily exclude its use in the performance of other activities.

The extreme morphological adaptations of *T. aculeatus* to a diet of social insects (for example, broad, spatulate forelimbs and claws for digging) sacrifices speed as a mechanism of defence. In return, *T. aculeatus* benefits by gaining access to a food source for which there is relatively little competition from other mammals (Redford 1987). The development of spines compensates for slow movement by minimising predation (Abensperg-Traun 1991). Spinescence in Old and New World porcupines such as *Hystrix indica* and *Coendou prehensilis* may be similarly explained as both are slow in movement (Vincent and Owers 1986). Underlining the effectiveness of spines is the fact that *T. aculeatus* has maintained its continentwide distribution since European colonisation of Australia, despite the presence of exotic predators, such as the fox and cat (Burbidge and McKenzie 1989; Griffiths 1989; Abensperg-Traun 1991).

While spines are effective against predation, their observed role in at least partial blindness in

T. aculeatus is paradoxical. However this paradox may be partly explained by the fact that requirements for adaptation (for example, the need for improved defence mechanisms, as well as increased tolerance to prey chemicals by *T. aculeatus*) arise simultaneously, not sequentially. Natural selection thus acts on the whole organism rather than on specific traits in isolation of all others. As a consequence, there is a trade-off between achieving the best solution to individual 'problems', and attaining the best possible mix of solutions (Jenetos and Cole 1981). Spinescence in *Tachyglossus* is clearly 'good enough' to ensure the species survival.

The 'arms race' between *T. aculeatus* and its prey provides further support for the arguments that perfect adaptation is likely to be unattainable (Dawkins and Krebs 1979), and probably undesirable, at least in predator-prey relationships. As pointed out earlier, most termites and ants effectively reduce predation by *T. aculeatus* by use of chemical secretions, in addition to swarming, biting, stinging and large size (Griffiths and Simpson 1966; Moore 1968; Abensperg-Traun 1988, 1993; Griffiths et al 1990; Abensperg-Traun et al 1991). *Tachyglossus aculeatus* clearly lags behind its prey's defences, allowing prey colonies to recover from its raids, and so ensuring a permanent supply of food.

Based on extended observations on one completely blind individual, and an understanding of the ecology of both *Tachyglossus* and its prey, I conclude that it is the adaptations of *T. aculeatus* to eating social insects, termites and ants, that allow survival despite complete blindness. These are: a 'heightened' sense of smell, and possibly electroreception and hearing, to locate 'invisible' termites and ants; the characteristics of the prey (nutrients, chemical defences), with vision playing no significant role in prey selection; spinescence to minimise predation, to compensate for slow movement as a result of morphological adaptations to its diet. These conclusions complement those of an earlier study (Abensperg-Traun 1991).

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