

Acacia is one of the most important genera of woody plants on Earth. Distributed in all of the continents except Antarctica, acacias are dominant shrubs and trees in many bushland and savanna habitats (Ross 1981; Coe *et al.* 1999; Maslin 2001; Maslin *et al.*, this volume, Rico-Arce, this volume). Acacias are commonly key species in such environments, providing food and other resources for an enormous diversity of mammals, birds and invertebrates (e.g. Krüger and McGavin 1998; Bond and Loffell 2001; Dean *et al.* 2002). Indirect interactions, mediated by shared herbivores and pollinators, link acacias to other plants within the communities of which they are a part (Stone *et al.* 1998). The foliage, fruits, wood and bark of many acacias have been used by humankind for centuries as fodder for livestock, sources of famine food and medicines, and fuel, and many species are important in modern agroforestry worldwide (Midgley and Turnbull, this volume). Given this importance, it is incredible how little we know about the vast majority of acacias. The papers collected in this special journal issue were presented at the Fourth International Legume Conference in Canberra (2–6 July 2001). Each highlights a current issue in acacia research, combining new results or synthesis with discussion of the challenges to be met in future work.

One of the most basic questions remains the taxonomic status of the genus (Maslin *et al.*, this volume), and its relationship to other closely related mimosoid genera. As currently defined, *Acacia* comprises three subgenera: *Acacia*, *Aculeiferum* and *Phyllodineae*. These three subgenera differ substantially in their geographic distributions and in a range of biological characters. For example, *Acacia* and *Aculeiferum* have bipinnate leaves, and have major centres of species richness in Central America and Africa. These subgenera have short-lived and apparently protandrous flowers, and both groups include species ('ant acacias') that harbour mutualistic ant guards in hollow swollen thorns (Stone *et al.*, this volume). In contrast, most species in the subgenus *Phyllodineae* have phyllodes (flattened photosynthesising leaf rachises) rather than bipinnate leaves, and most species are found in Australia. Their flowers are generally long-lived and clearly protogynous, and despite the great species richness of both the *Phyllodineae* and the Australian ant fauna, there are no phyllodinous ant acacias. Does this diversity in *Acacia* represent the result of adaptive radiation within a single monophyletic lineage? A growing body of research based on DNA sequence data strongly suggests that the answer to this question is no. *Acacia* is an artificial polyphyletic assemblage (Maslin *et al.*, this volume, Miller and Bayer, this volume, Murphy *et al.*, this volume), and relationships between and within the recognised *Acacia* subgenera, and between *Acacia* and related mimosoid genera, need to be reassessed. Improved understanding of

acacia phylogeny may help explain much of the variation currently encompassed within the genus (e.g. Lamarque and Fortunato, this volume), and is essential for reconstructing the evolutionary history of important biological traits, such as the floral traits and ant associations discussed above.

Relationships within currently recognised *Acacia* species raise as many questions as those among species and subgenera. Many *Acacia* species include morphologically distinct growth forms—an issue that is well-illustrated in this volume by work on three groups of Australian taxa (Andrew *et al.*; Byrne and Broadhurst; McDonald *et al.*). Are such forms genetically distinct ecotypes, or does such diversity have a non-heritable, environmental origin? This is an important issue for land managers, where the alternative growth forms differ in properties such as wood quality and resistance to soil salinity or fire (Byrne and Broadhurst, this volume). It is also just as important for those working in conservation. Increasingly, fragmented habitats threaten the survival of many acacias, particularly in the Wheat Belt region of Western Australia (Cunningham 2000a, 2000b), and difficult decisions must be made about where limited resources for conservation and environment restoration should be invested. Population genetic methods provide the best available approach for assessing patterns of genetic diversity within species, and so provide a means to prioritise populations for protection (Crandall *et al.* 2000).

Studies of genetic diversity within *Acacia* species are also being used increasingly to reveal fundamental aspects of acacia biology. Two applications discussed in this volume include the distinction between sexual and asexual reproduction (Andrew *et al.*, this volume), and the extent to which seeds on a given tree are produced by outcrossing and self-fertilisation (Mandal and Ennos 1995; Kenrick, this volume). In general, acacia populations show a high level of outcrossing, illustrating the point that management of acacia populations (both wild and managed) requires an understanding of the ecology of their pollinators. This is an issue of immediate concern, because, although we know a lot about the pollination biology of a small number of acacias, almost nothing is known about the vast majority (Kenrick, this volume, Stone *et al.*, this volume). Enlightening our ignorance will not only involve identifying flower visitors and assessing their role as pollinators of specific acacias, but also needs to examine the importance of other factors (such as resources provided by other plants and the availability of suitable breeding or nesting sites) in pollinator survival (Stone *et al.*, this volume). The human effort required to investigate these issues in detail means that the high species richness of acacias, in Australia in particular, represents a major challenge for pollination ecologists. However, the potential rewards are also great: preservation of functioning

plant–pollinator relationships (Lennartsson 2002), and a wealth of data for the analysis of patterns in pollinator assemblages across species.

In addition to their roles in natural ecosystems, many acacias have been introduced to novel habitats as sources of timber and fodder, in land reclamation (Bell *et al.*, this volume) and as amenity trees in parks and gardens. Acacias hold great promise as sustainable sources of food for humans and their domestic animals in arid and semi-arid habitats (Midgely and Turnbull, this volume). However, acacias also illustrate all too well the potential dangers of biological introductions (Paynter *et al.*, this volume). Introduced acacias have become major invasive weeds in Australia (where African *Acacia nilotica* is a major problem in Queensland) and southern Africa (where, in a rare example of reciprocal trouble-making, the invaders are Australian species) (Radford *et al.* 2001; Hoffman *et al.* 2002). The threats may be obvious ones: reducing land value for stock grazing, or depleting available soil water levels (Le Maitre *et al.* 2002). However, many other impacts on native taxa may be less obvious. For example, do introduced acacias compete with native species for the services of pollinators, so reducing the seed set of the native species, or do they enhance pollinator populations to mutual advantage (Stone *et al.*, this volume). Do they maintain high populations of pests that inflict damage on native species through apparent competition? (Holt and Lawton 1994).

The issues raised in this preface cover a wide range of scientific disciplines, and apply equally to other plant groups. The ecological and economic importance of acacias means that biologists must rise to the challenge of combining science and management to maintain what is valued, and control what is not. The greatest challenge remaining is to make ‘value’ an issue that is not defined solely by human need.

Graham N. Stone

University of Edinburgh
Institute of Cell, Animal and Population Biology,
West Mains Road,
Edinburgh EH9 3JT

References

- Bond WJ, Loffell D (2001) Introduction of giraffe changes acacia distribution in a South African savanna. *African Journal of Ecology* **39**, 286–294.
- Coe MJ, McWilliam NC, Stone GN, Packer MJ (1999) (Eds) ‘Mkomazi: the ecology, biodiversity and conservation of a Tanzanian savanna.’ (Royal Geographical Society: London)
- Crandall KA, Bininda-Emonds ORP, Mace GM, Wayne RK (2000) Considering evolutionary processes in conservation biology *Trends in Ecology and Evolution* **15**, 290–295.
- Cunningham SA (2000a) Depressed pollination in habitat fragments causes low fruit set. *Proceedings of the Royal Society of London B Biological Sciences* **148**, 1149–1152.
- Cunningham SA (2000b) Effects of habitat fragmentation on the reproductive ecology of four plant species in mallee woodland. *Conservation Biology* **14**, 758–768.
- Dean WRJ, Anderson MD, Milton SJ, Anderson TA (2002) Avian assemblages in native *Acacia* and alien *Prosopis* drainage line woodland in the Kalahari, South Africa. *Journal of Arid Environments* **51**, 1–19.
- Hoffmann JH, Impson FAC, Moran VC, Donnelly D (2002) Biological control of invasive golden wattle trees (*Acacia pycnantha*) by a gall wasp, *Trichilogaster* sp. (Hymenoptera: Pteromalidae), in South Africa. *Biological Control* **25**, 64–73.
- Holt RD, Lawton JH (1994) The ecological consequences of shared natural enemies. *Annual Review of Ecology and Systematics* **25**, 495–520.
- Krüger O, McGavin GC (1998) The insect fauna of *Acacia* species in Mkomazi Game Reserve, north east Tanzania. *Ecological Entomology* **22**, 440–444.
- Le Maitre DC, van Wilgen BW, Gelderblom CM, Bailey C, Chapman RA, Nel JA (2002) Invasive alien trees and water resources in South Africa: case studies of the costs and benefits of management. *Forest Ecology and Management*, **160**, 143–159.
- Lennartsson T (2002) Extinction thresholds and disrupted plant–pollinator interactions in fragmented plant populations. *Evolution* **83**, 3060–3072.
- Mandal AK, Ennos RA (1995) Mating system analysis in a natural population of *Acacia nilotica* subspecies *kraussiana*. *Forestry Ecology and Management* **79**, 235–240.
- Maslin B (2001) ‘Mimosaceae, *Acacia*. Flora of Australia, Vols 11A, B.’ (ABRS/CSIRO Publishing, Melbourne, Australia)
- Radford IJ, Nicholas DM, Brown JR, Kriticos DJ (2001) Paddock-scale patterns of seed production and dispersal in the invasive shrub *Acacia nilotica* (Mimosaceae) in northern Australian rangelands *Austral Ecology* **26**, 338–348.
- Ross JH (1981) An analysis of the African *Acacia* species: their distribution, possible origins and relationships. *Bothalia* **13**, 389–413.
- Stone GN, Willmer PG, Rowe JA (1998) Partitioning of pollinators during flowering in an African *Acacia* community. *Ecology* **79**, 2808–2827.