vation Perspective. Eds J.C. Noble, P.J. Joss & G.K. Jones. CSIRO, Melbourne.
Booth, D.T. 1986. Crop and Gizzard Contents of Two Mallee Fowl. Emu 86, 51-53.
Braun-Blanquet, J. 1928. Pflanzensoziologie. Springer, Berlin.
Frith, J.H. 1962. Conservation of the Mallee-fowl, *Leipoa ocellata*, Gould (Megapodidae). CSIRO Wildlife Research 10, 33-51.
Jessop, J.P. & Toelken, H.R. (Eds) 1986. Flora of South Australia Parts I-IV. South Australian Government Printing Division, Adelaide.
Ross, J.H. (Ed.) 1993. Census of the vascular plants of Victoria, 4th edn. National Herbarium of Victoria, Melbourne.

Dispersal of Germinable Seeds by Emus in Semi-arid Queensland

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It is well established that Emus *Dromaius novaehollandiae* are agents of seed dispersal (Noble 1975; Willson 1989), and are capable of moving seed large distances (Dawson *et al.* 1984). That the seeds dispersed by Emus are viable has been demonstrated for only a few species with fleshy fruits (Clifford & Monteith 1989; Noble 1975), however, folklore in inland Australia asserts that seeds of Quandong *Santalum acuminatum* (which also has a fleshy fruit) must pass through the gut of an Emu before they will germinate, and it is claimed by pastoralists that Emus disperse viable weed seed. Willson (1989) considered the possibility of Emu dispersal of seeds and fruit and some possible adaptations of seed and fruit for Emu dispersal. Very large numbers of seeds can be egested by Emus; Noble (1991) reported 1000 seeds of *Nitraria billardieri* in a single pat.

Dispersal of seeds is likely to be important not only in terms of weed invasions but also in the maintenance of populations of those trees and shrubs which do not form long-term seed-banks in the soil, or in those circumstances in which soil seed banks have been exhausted, especially areas subject to severe or long-term disturbance. Emu dispersal is therefore possibly important in conservation and regeneration of plant communities. Given the interest in Emus as dispersal agents and their possible role in the spread of weeds in arid lands, a study of the seed actually present in Emu dung, and its germinability, is significant.

Methods

In order to examine the role of Emus in dispersing seed in and about Idalia National Park (85 km south-west of Blackall, Queensland), 30 Emu dung pats that had not started decay were collected and taken back to the laboratory. The pats were divided into quarters, two of which were spread out to be germinated on a layer of vermiculite and kept well watered for a month. Seedlings of herbaceous plants were grown until they flowered and fruited to permit identification, those of woody plants were identified on the basis of vegetative morphology and remaining fruit structures. One quarter of each dung pat was broken up and sorted for seed and fruit contents under a dissecting microscope.

Results

All the sorted dung contained identifiable seeds or fruit, but only 14 of the 30 pats produced seedlings. The species reported and the number of samples containing those species, together with the total number of individual seeds or fruits in all samples, are shown in Table 1.

Of all the species in the dung only the fruit of *Eremophila longifolia*, *Enchylaena tomentosa* and *Solanum* sp. produce fleshy fruit of the kind usually associated with bird dispersal (O'Dowd & Gill 1986). The other fruits are small and dry, and in the case of *Sclerolaena*

Table 1 Species reported as germinable seeds or as fruits from Emu dung from Idalia National Park in semi-arid Queensland. Columns indicate the number of samples containing a species and the total number of individuals of the species in all samples. (Species not previously reported in the diet of Emus are denoted by *.)

	Seedlings		Fruits	
Species	Samples	Total	Samples	Total
Abutilon sp.*	0	0	4	21
*Alternanthera denticulata**	4	4	0	0
*Bidens pilosa**	1	1	0	0
Bothriochloa sp.*	0	0	1	1
*Centipeda cunninghamii**	2	9	0	0
Cyperus sp.*	1	1	0	0
*Dysphania myriocephala**	5	8	0	0
*Enchylaena tomentosa**	2	2	5	5
Eremophila longifolia	1	1	5	429
Medicago sp.	0	0	1	3
*Portulaca intraterranea**	1	1	0	0
*Rorippa australis**	5	5	3	6
*Sclerolaena bicornis**	0	0	3	6
*S. divaricata**	4	4	9	390
*S. echinopsila**	0	0	1	1
*Solanum?quadriloculare**	0	0	1	1
Grass	1	1	1	1
Dicot	1	1	0	0
Totals	14	38	14	858

and *Rorippa* the fruit are woody with long spines. In one quarter of one pat, 111 spiny fruit of *Sclerolaena divaricata* were identified on the basis of their long spines.

Up to 297 seeds of *Eremophila longifolia* (known as 'Emu Bush') were found in a quarter of a pat (indicating a total of over 1000 in a pat) but over 60% had the tough woody endocarp damaged, and although 429 seeds of *E. longifolia* were sorted from portions of the dung, only two grew in the portions set out for germination. Fourteen of the 16 taxa identified (Table 1) had not previously been reported as components of Emu diet (Barker & Vestjens 1989; Davies 1978).

Discussion

The large number of seeds found in Emu dung is consistent with other reports (e.g. Noble 1991). However, the presence of large numbers of spiny woody fruit of *Sclerolaena* and *Rorippa* in Emu dung is of particular interest given the assertion of Davies (1963) that Emus are selective in their grazing and avoid unpalatable matter. It must be presumed that the presence of succulent green herbage in *Sclerolaena* and *Rorippa* compensated for the spines on the fruit. It is possible that these fruits function as gastroliths (Davies 1978; Noble 1991) aiding the digestion of succulent foliage which surrounds them. The presence of so many spiny woody fruit (which are concealed amongst the foliage of these herbaceous species) in Emu dung raises the possibility that such fruit represent an adaptation to Emu dispersal.

Of the species listed, *Eremophila longifolia* is a woody weed problem and *Bidens pilosa* a weed not previously reported from Idalia. All species except *Bidens pilosa* occur in the region and all except two (*Eremophila longifolia* and *Enchylaena tomentosa*) are herbaceous; however, both these woody species produce fleshy fruit and E. *tomentosa* has succulent foliage.

It should not be assumed that all of the viable seeds in the Emu dung germinated in this short and simple study, nor that all of these seeds would have germinated in the field. However, the study does give an insight into the role of Emus as dispersal agents. The diversity of fruit and seed consumed by Emus is impressive, as is the number of seeds found in a single pat. Although the number of apparently germinable seeds present in Emu dung is small compared with the total number voided, Emus are likely to be a significant factor in distributing seed of herbaceous species, in semi-arid environments.

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References

Barker, R.D. & Vestjens, W.J.M. 1989. The Food of Australian Birds 1. Non-passerines. CSIRO Division of Wildlife Research, Canberra.

Clifford, H.T. & Monteith, G.B. 1989. A three phase dispersal mechanism in Australian quinine bush (*Petalostigma pubescens* Domin). Biotropica 21, 284-286.

Davies, S.J.J.F. 1963. Emus. Australian Natural History 14, 225-229.

Davies, S.J.J.F. 1978. The food of Emus. Australian Journal of Ecology 3, 411-422.
Dawson, T.J., Read, D., Russell, E.M. & Herd, R.M. 1984. Seasonal variation in daily activity patterns, water relations and diet of Emus. Emu 84, 93-102.
Noble, J.C. 1975. The effect of Emus (*Dromaius novaehollandiae* Latham) on the distribution of the nitre bush (*Nitraria billardieri* DC). Journal of Ecology 63, 979-983.
Noble, J.C. 1991. On ratites and their interactions with plants. Revista Chilena de Historia Natural 64, 85-118.
O'Dowd, D.J. & Gill, A.M. 1986. Seed dispersal syndromes in Australian *Acacia*. Pp 87-121 in Seed Dispersal. Ed. D. Murray. Academic Press, Melbourne.
Willson, M.F. 1989. Gut retention times of experimental pseudoseeds ingested by Emus. Biotropica 21, 210-213.

Home Range of Plumed Frogmouths *Podargus ocellatus plumiferus* During the Non-breeding Season as Shown by Radio-tracking

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Since discovery of the Plumed Frogmouth *Podargus ocellatus plumiferus* in the Conondale Ranges in 1976 (Roberts & Ingram 1978), the distribution of this subspecies (as distinct from the Marbled Frogmouth *P. o. marmoratus* in north Queensland) has been critically examined (Corben & Roberts 1993), and population status and habitat preferences investigated (Kehl & Corben 1991). However, there are few published observations of foraging behaviour because the birds are difficult to observe in the wild (Schodde & Mason 1980)

We undertook a pilot study to assess the feasibility of radio-tracking Plumed Frogmouths and present information obtained from two radio-tagged Plumed Frogmouths.

Methods

Radio-tracking was undertaken at Booloumba Creek (26°41'S, 152°37'E) at 500 m asl in the Conondale Ranges, approximately 100 km NNW of Brisbane (Roberts & Ingram 1978). Within this region Plumed Frogmouths occur primarily in notophyll vine forests bordering creeks and gullies (Corben & Roberts 1993; authors' pers. obs.), as has been found in the Nightcap Ranges (D. Milledge & T. Meggs pers. comm.).

Two Plumed Frogmouths from separate pairs and territories were caught in different mist nets at heights of approximately 20 m (female 10 March 1993 and male 7 May 1993). Both individuals were banded with ABBBS metal bands (sizes '08' and '09'). Radio-transmitters (AVM single-stage, weighing approximately 4 g) were hot-glued to the under-surface of the two central tail feathers, at their base, according to the method of Fitzner & Fitzner (1977).

The birds were tracked separately for 35 days each, between March and June, by using three and four element hand-held Yagi antennas in conjunction with headphones attached to Telonics and Titley (Regal) receivers. Fixes on birds carrying transmitters were obtained by bisecting the arc between nulls occurring either side of the strongest signal and recording the direction and strength of that peak (very strong, strong, medium, weak and very weak).

Triangulation from three or more sites was carried out at two-hourly intervals through the night so as to obtain mapped positions of birds. These three or more sites were selected from 43 surveyed and mapped receiving stations spread throughout the study area, mainly at the edges of each bird's territory. For each fix, stations were selected as close to birds as possible with-