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The Julia Creek dunnart and other prey of the barn owl in Mitchell grass downs of north-western Queensland

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ABSTRACT

Analysis of the contents of pellets produced by barn owls, *Tyto alba*, has provided information on the distribution of the Julia Creek dunnart, *Sminthopsis douglasi*, and five other species of small terrestrial mammals. The pellets were collected from 28 localities in Mitchell Grass downs country around the town of Julia Creek in north-western Queensland. Mammals formed the largest component of the diet of the owls, followed by birds. Reptiles, frogs and arthropods were also preyed upon. □ *Prey of Tyto alba, Sminthopsis douglasi, dasyurid marsupials, rodents, birds, Queensland, Mitchell grass downs.*

Barn owls, *Tyto alba*, feed mainly on small terrestrial mammals but they are known to take other vertebrates and insects (Taylor 1994). Studies on the diet of barn owls in Australia (see Morton 1975 which includes a summary of earlier studies; Morton et al. 1977; Morton & Martin 1979; Valente 1981; Smith & Cole 1989; Debus et al. 1999; Heywood & Pavey 2002) have shown that a variety of mammals, birds, reptiles, frogs and arthropods may be eaten, and that rodents such as *Rattus villosissimus* and *Mus musculus*, species that undergo large fluctuations in population size, often form the bulk of the diet. Barn owls usually swallow their prey whole and the undigested remains, including bones, hair, feathers, scales and hard parts of insects that are all generally readily identifiable, are regurgitated in compact pellets. Each pellet is thought to contain most of the remains from a single foraging expedition (Taylor 1994). Freshly ejected pellets are soft and covered with mucous which, as it dries, gives them a smooth, dark, glazed appearance. In dry conditions the glaze is lost after about 10 days but the pellets remain firm and darkly coloured for eight or

more months (from Barn Owls On Site http://www.barnowltrust.org.uk/content_images/pdf [July 2008]). Barn owls roost in caves, old buildings, tree hollows and, occasionally, in trees, and pellets accumulate at the roost site.

Analysis of the contents of pellets provides not only information on the diet of the owl but also information on the composition of the fauna in the foraging area. This may lead to the detection of uncommon species, as happened in the case of a then little known species of dasyurid marsupial, the Julia Creek Dunnart, *Sminthopsis douglasi* (Woolley 1992). This species, at the time of its description by Archer (1979), was known from only four specimens in museum collections. These had been collected from three localities between the towns of Julia Creek and Richmond, Queensland. As a result of survey work commenced in mid-1990 (Woolley, 1992) the skeletal remains of Julia Creek dunnarts were found among a deposit of bones that were considered to have formed from the disintegration of owl pellets in a hollow tree. Trapping in an area close to where the bones

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TABLE 1. The localities and collecting sites together with the dates on which owl pellets were collected, the number and condition (glazed - G, unglazed - U) of the pellets, and whether or not barn owls were present at the site. Localities (abbreviation in parentheses) ordered by date of earliest collection.

Locality and collecting sites	Date of collection	No. of pellets	Locality total	Barn owls
Eureka (EUR) - 20°50'S, 141°48'E abandoned homestead	30.4.1992	72 (G)		yes
	27.5.1992	43 (G)		yes
	29.6.1992	40 (G)		yes
	3.8.1992	33 (G)		yes
	5.10.1992	17 (G)		yes
	6.7.1994	33 (15U, 18G)		yes
	24.7.1994	15 (G)		yes
	2.9.1994	18 (G)	271	yes
Crendon (CRE) - 21°26'S, 142°07'E shearing shed	-11.1993	31 (U)	31	no
Nelia (N) - 20°39'S, 142°13'E a) derelict house, b) racebook buildings	19.6.1994 a	28 (G)		yes
	10.6.1995 b	50 (G)		yes
	26.7.1995 b	19 (G)		yes
	9.10.1995 b	9 (G)		no
	27.4.1996 b	36 (G)	142	no
Nelia West (NW) - 20°42'S, 142°04'E derelict shearer's quarters	19.6.1994	19 (U)		no
	21.3.1997	66 (U)	85	no
Osbert (O) - 20°30'S, 141°46'E outbuildings on unoccupied property	20.6.1994	215 (92U, 123G)		yes
	17.6.1995	54 (26U, 28G)	269	no
Lyrian (L) - 19°27'S, 141°12'E abandoned homestead, outbuildings, nearby tree hollow	21.6.1994	30 (G)		yes
	6.10.1995	56 (35U, 21G)	86	no
Auckland Downs (AD) - 20°15'S, 141°46'E derelict outbuilding	3.7.1994	22 (U)	22	no
Huddersfield (H) - 20°57'S, 141°53'E shearing shed, outbuildings	4.7.1994	76 (U)		no
	29.4.1995	33 (G)		yes
	6.6.1998	82 (G)		yes
	30.3.1999	12 (G)		yes
	3.6.1999	81 (G)		yes
	10.9.2000	6 (U)	290	no
Eulolo (EUL) - 21°14'S, 141°33'E outbuildings on unoccupied property	5.7.1994	264 (U)	264	no
Penola Downs (PD) - 21°31'S, 141°27'E derelict shearer's quarters	5.7.1994	115 (U)	115	no
Carrum (CAR) - 20°53'S, 141°43'E unoccupied house	6.7.1994	9 (G)	9	yes
Armidale (ARM) - 20°52'S, 141°41'E shearing shed	6.7.1994	18 (G)	18	yes
Waterloo Plains (WP) - 20°57'S, 141°43'E unoccupied house, shearing shed	7.7.1994	258 (191U, 67G)		yes
	.8.1994	4 (G)		yes
	.9.1994	6 (G)	268	yes
	7.7.1994	5 (U)	5	no

Locality and collecting sites	Date of collection	No. of pellets	Locality total	Barn owls
Eastern Creek (EC) - 20°54'S, 141°47'E tree hollow at Waterloo Rd crossing	7.7.1994	20 (9U, 11G)	20	yes
Longford Plains (LP) - 20°46'S, 141°46'E abandoned homestead	8.7.1994	57 (G)	57	yes
Toorak (T) - 21°02'S, 141°48'E a) tree hollow in paddock no. 8, b) yards between paddocks 1 and 2, c) barn	8.7.1994 a	9 (G)		yes
	26.5.1998 b	43 (G)		yes
	24.5.1999 c	40 (G)		yes
	-11.1999 c	11 (G)		yes
	20.8.2000 c	85 (G)		yes
	12.11.2001 c	22 (G)	210	yes
Eddington (ED) - 20°39'S, 141°33'E shearing shed	9.7.1994	16 (U)	16	no
Ardbrin (ARD) - 21°03'S, 142°17'E shearing shed, derelict shearer's quarters	15.6.1995	260 (99U, 161G)		yes
	16.8.1995	38 (G)		yes
	19.9.1995	19 (G)		no
	18.6.1996	28 (G)		no
	13.3.1997	16 (U)		no
	28.10.1999	15 (G)	376	no
Consentes (CON) - 20°16'S, 141°36'E derelict outbuilding	17.6.1995	98 (55U, 43G)	98	no
Broadlands (B) - 21°28'S, 141°17'E disused shearing shed	22.6.1995	32 (U)	32	no
Minamere (M) - 20°52'S, 142°18'E a) abandoned homestead, b) meat house at shearer's quarters	11.7.1995 a	23 (G)		yes
	15.8.1995 b	277 (170U, 107G)		yes
	19.9.1995 b	21 (G)		yes
	15.10.1995 b	40 (G)		yes
	27.11.1995 b	26 (G)		yes
	18.1.1996 b	33 (G)		no
	20.2.1996 b	2 (G)		no
	19.3.1996 b	19 (G)		no
	24.4.1996 b	6 (G)		no
	3.6.1998 b	9 (G)	456	no
Canobie (CAN) - 19°16'S, 140°58'E (hut at Hawkes Nest bore)	7.10.1995	72 (45U, 27G)	72	no
Shilmalier (S) - 20°10'S, 141°58'E disused shearing shed	17.4.1996	24 (U)	24	no
Quambetook (Q) - 21°12'S, 142°10'E shearing shed	17.10.1996	293 (159U, 134G)	293	yes
Proa (P) - 20°54'S, 142°09'E shearer's shower block	30.5.1998	46 (G)		yes
	28.5.1999	32 (G)		yes
	29.8.1999	15 (G)		yes
	1.11.1999	5 (G)	98	yes
	3.11.1999	6 (G)		yes
Yorkshire Downs (YD) - 20°52'S, 141°58'E under trees	31.5.2000	3 (G)	9	no
Rosevale (R) - 21°06'S, 142°00'E abandoned homestead	9.9.2000	113 (G)	113	yes

were found led to the collection of live Julia Creek dunnarts in 1992.

The present study of the prey of the Barn Owl in north-western Queensland was undertaken primarily to obtain information on the distribution of the Julia Creek Dunnart which, in turn, might lead to the finding of other trappable populations for study of the biology of the species, currently listed as Endangered (EPBC Act 1999).

METHODS

Collection of pellets. Searches for pellets of the Barn Owl were made between April 1992 and November 2001 in Mitchell Grass downs country around the town of Julia Creek in north-western Queensland, an area encompassing part of the presently known range of *S. douglasi* (Kutt 2003). Pellets were found in abandoned homesteads and outbuildings, in tree hollows and under trees in 28 localities (Table 1). At some localities pellets were collected from more than one site, and sometimes one or two barn owls were present at the site where the pellets were found. Most collecting localities were revisited, or checked by local residents, after the first collection was made. At some, no further accumulations of pellets were found and barn owls, if previously present, were no longer roosting at the site. The collecting sites at Eureka, Longford Plains and Armidale were demolished early in the collecting period. Pellets of the Southern Boobook, *Ninox novaeseelandiae*, which were also found at some sites but not collected, were easily distinguished from those of the Barn Owl by their generally smaller size and friable structure.

Intact pellets were picked up, classed as either unglazed or glazed, and packed singly for transport to the laboratory.

Preparation of pellets. Pellets were soaked individually in water, to which a few drops of detergent had been added, until soft (usually 30–60 minutes). The pellets were teased apart with forceps in a white enamel tray. By a process of

differential flotation followed by sieving using a 1.2 mm mesh sieve the lighter hair, feathers and debris were separated from the heavier bones. Hair from some pellets, and distinctively patterned or coloured feathers, were saved. Once the water was relatively clear the bones and other hard parts were collected from the tray and placed in a petri dish to air dry. Before it was discarded the material in the sieve was felt for bones that may have been trapped in fur.

Identification of contents. Identification of the remains of vertebrate prey items was based primarily on characteristics of the skulls, teeth and lower jaws as seen in reference specimens. For rodents these included differences in the size of the skull, length of the molar tooth row and width of the molars. Notched incisors and a difference in the shape of the anterior edge of the zygomatic plate helped to distinguish *M. musculus* from *Leggadina forresti*. Among the dasyurids, the larger size (length of dentaries, width of third upper molar, canine teeth, pelvic girdle) was used to distinguish adult specimens of *S. douglasi* from adult *Sminthopsis macroura*. Dentaries of juvenile specimens of *Sminthopsis* that lacked teeth upon which identification could be made were assigned, if an adult was present in the same pellet, to the same species. The skeletal remains of *Planigale* were assumed to be those of *P. ingrami* based largely on the observation that this was the only species of *Planigale* either trapped or found in the study area (Woolley & Mifsud unpub. observations). Differences in the pelvic girdle (shape of obturator foramen and anterior edge of pubic bones) were found useful in distinguishing dasyurid marsupials from small rodents, and the rodents *M. musculus* and *L. forresti* from each other, and provided additional confirmation of identity. Experts (see acknowledgments) assisted with the identification of some taxa. The identity of one mammal was confirmed by examination of hair structure, and of some birds by distinctive feathers. The minimum number of individuals of a vertebrate prey item in a pellet was calculated

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TABLE 2. The number of pellets obtained at each locality, and the number containing each taxon. For each taxon the number of pellets as a percentage of the total is shown in square parentheses, followed by the number of individuals (arthropods were not counted). Key to localities in Table 1.

Locality	No. of pellets	No. of pellets containing remains of each taxon, [% of total] , (no. of individuals)				
		Mammals	Birds	Reptiles	Frogs	Arthropods
EUR	271	227 [83.7] (295)	36 [13.2] (82)	14 [5.1] (15)	1 [0.3] (1)	13 [4.7]
CRE	31	10 [32.2] (10)	28 [90.3] (73)	5 [16.1] (8)	0	19 [61.2]
N	142	114 [80.2] (185)	25 [17.6] (36)	22 [15.4] (55)	23 [16.2] (82)	60 [42.2]
NW	85	64 [75.2] (85)	9 [10.5] (17)	7 [8.2] (7)	6 [7.0] (24)	22 [25.8]
O	269	149 [55.3] (215)	96 [35.6] (187)	46 [17.1] (176)	8 [2.9] (18)	50 [18.5]
L	86	84 [97.6] (131)	1 [1.1] (1)	1 [1.1] (1)	1 [1.1] (1)	3 [3.4]
AD	22	9 [40.9] (18)	0	9 [40.9] (15)	8 [36.3] (35)	6 [27.2]
H	290	214 [73.7] (277)	77 [26.5] (132)	19 [6.5] (33)	7 [2.4] (13)	69 [23.7]
EUL	264	255 [96.5] (635)	29 [10.9] (39)	9 [3.4] (11)	3 [1.1] (6)	22 [8.3]
PD	115	111 [96.5] (271)	1 [0.8] (2)	1 [0.8] (2)	0	1 [0.8]
CAR	9	9 [100] (18)	1 [11.1] (2)	0	2 [22.2] (5)	2 [22.2]
ARM	18	16 [88.8] (33)	5 [27.7] (14)	1 [5.5] (1)	0	3 [16.6]
WP	268	170 [63.4] (295)	145 [54.1] (368)	9 [3.3] (11)	10 [3.7] (16)	101 [37.6]
K	5	3 [60.0] (8)	3 [60.0] (13)	0	1 [20.0] (1)	2 [40.0]
EC	20	16 [80.0] (20)	3 [15.0] (13)	0	0	1 [5.0]
LP	57	54 [94.7] (80)	2 [3.5] (2)	0	0	1 [1.7]
T	210	184 [87.6] (252)	60 [28.5] (108)	13 [6.1] (26)	10 [4.7] (14)	38 [18.0]
ED	16	9 [56.2] (10)	3 [18.7] (3)	11 [68.7] (48)	6 [37.5] (18)	12 [75.0]
ARD	376	329 [87.5] (664)	51 [13.5] (75)	65 [17.2] (159)	4 [1.0] (7)	89 [23.6]
CON	98	93 [94.8] (141)	1 [1.0] (1)	1 [1.0] (2)	2 [2.0] (22)	16 [16.3]
B	32	30 [93.7] (47)	1 [3.1] (1)	0	0	0
M	456	351 [76.9] (613)	137 [30.0] (310)	53 [11.6] (135)	10 [2.1] (21)	141 [30.9]
CAN	72	64 [88.8] (75)	1 [1.3] (1)	3 [4.1] (3)	9 [12.5] (30)	14 [19.4]
S	24	8 [33.3] (13)	1 [4.1] (1)	14 [58.3] (55)	18 [75.0] (58)	18 [75.0]
Q	293	161 [54.9] (232)	194 [66.2] (493)	41 [13.9] (140)	0	88 [30.0]
P	98	66 [67.3] (90)	31 [31.6] (37)	4 [4.0] (4)	1 [1.0] (1)	23 [23.4]
YD	9	9 [100] (9)	0	0	0	0
R	113	59 [52.2] (71)	42 [37.1] (42)	0	0	15 [13.2]
All localities	3749	2868 [75.5] (4793)	983 [26.2] (2053)	348 [9.3] (907)	130 [3.4] (373)	829 [22.1]

from the number of dentaries (mammals), lower mandibles (birds), lower jaws (reptiles) and ilia (frogs). The number determined in this way was often supported by counts of other elements e.g. for mammals the number of upper jaws and pelvic bones matched the number of dentaries, and for some birds the number of sacra / keels/ gizzards matched the number of lower mandibles. Mammals and birds were identified to species, reptiles to family and frogs to order.

Identification of the remains of invertebrate prey items, which included several orders of arthropods, was based on wing fragments, head capsules, mandibles and legs. The number of individuals of each invertebrate prey item in a pellet was generally not determined. The bulk of the material extracted from the pellets for identification has been lodged in the Queensland Museum.

Prey of barn owl in Queensland

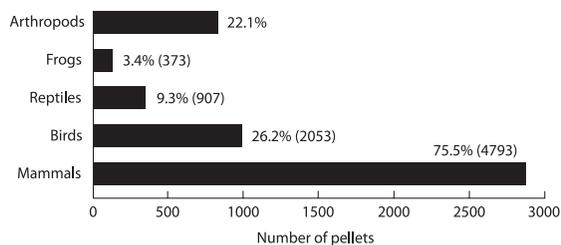


FIG. 1. Number of pellets containing the countable remains of prey items for each taxon. In the case of arthropods (mostly grasshoppers) the actual number of individuals was not determined. The number of pellets expressed as a percentage of all pellets examined (3,749) is shown at the end of each bar, together with the number of individuals in parentheses.

RESULTS

The contents of 3,749 pellets collected between April 1992 and November 2001 have been examined. They were obtained from 28 localities (Table 1), and the number of pellets per locality ranged from 5 to 456. At 16 localities, 15 of which were revisited, no more pellets were obtained after the initial collection. The pellets from 8 (CRE, AD, EUL, PD, K, ED, B and S) of these 16 localities were probably not of recent origin; they had lost their glaze and no barn owls were present at the sites at the time the pellets were collected. At some localities (e.g. WP, A, and M) where sequential collections were made the first, usually large, collection contained both unglazed and glazed pellets. However it was not known if the barn owls, present at the time the pellets were collected, had been roosting at the site continuously over a long period, or if the older (unglazed) pellets represented an earlier accumulation. The pellets varied greatly in size, ranging from balls about 2 cm in diameter to cylinders about 8 cm in length. The largest pellets were usually found to contain the remains of a single large prey item e.g. either a large rodent or bird.

The prey items identified included mammals, birds, reptiles, frogs and arthropods (mostly

orthopterans). The contribution of each taxon to the diet (Table 2, Fig. 1) was based, in the case of vertebrate prey items, on the number of pellets that contained countable remains, i.e. remains upon which a count of the number of individuals eaten could be made and, for arthropods, the number of pellets in which they were found. Mammals were present in 75.5% of all pellets, birds in 26.2%, reptiles in 9.3%, frogs in 3.4% and arthropods in 22.1%. The contribution of each taxon to the diet varied between localities (Table 2). Mammals were represented in the pellet collection from every locality, and all taxa in the collections from 16 localities. Birds were not found in the pellets from two localities, reptiles from seven, frogs from nine and arthropods from two.

Mammals. The species identified included three rodents (*R. villosissimus*, *L. forresti* and the introduced house mouse *M. musculus*), three dasyurids (*Planigale ingrami*, *S. macroura* and *S. douglasi*), two bats (a single *Saccolaimus flaviventris* from Eulolo and one other, tentatively identified as *Mormopterus beccarii*, from Huddersfield) and one cat (*Felis catus*) from Toorak. Identification of the cat (a kitten) based on teeth was confirmed by examination of the structure of hairs from the same pellet. The last three species, of which only a single individual of each was found, are not further considered. No *Sminthopsis crassicaudata*, a species known to the author to occur to the east of the study area at Leslew Downs (20°59'S, 142°55'E) and to the south-west at McKinlay (21°16'S, 141°17'E), were found among the remains of mammals in the pellets.

Rattus villosissimus (mass up to 280 g) is the largest of the mammals frequently preyed upon and up to four individuals, but never more than two with adult dentition, were found in a single pellet. Many pellets contained recognisable hair and post-cranial bones of this species but not the countable remains (dentaries). Of the smaller rodents as many as six *L. forresti* (mass up to 20 g), or five *M. musculus* (mass up to 25 g),

TABLE 3. The number of mammals in the pellets from each locality, and the number of pellets containing the remains of each of the six species of mammals in each locality. The number of individuals of each species is shown in parentheses and this number, as a percentage of the mammals in the locality, in square parentheses. For all localities the number of pellets, as a percentage of the total number collected (3,749), and the number of each species as a percentage of the total number of mammals (4,793) is given in bold figures. Key to localities in Table 1.

Locality (no. mammals)	No. of pellets containing remains of each species, [% of mammals], (no. of individuals)					
	<i>R. villosissimus</i>	<i>L. forresti</i>	<i>M. musculus</i>	<i>P. ingrami</i>	<i>S. macroura</i>	<i>S. douglasi</i>
EUR (295)	201 [81.0] (239)	14 [7.1] (21)	0	20 [8.5] (25)	1 [0.3] (1)	5 [3.1] (9)
CRE (10)	2 [20.0] (2)	0	1 [10.0] (1)	8 [70.0] (7)	0	0
N (185)	63 [36.2] (67)	7 [3.8] (7)	2 [1.1] (2)	52 [50.8] (94)	7 [4.3] (8)	7 [3.8] (7)
NW (85)	56 [85.9] (73)	0	1 [1.2] (1)	5 [8.2] (7)	1 [1.2] (1)	3 [3.5] (3)
O (215)	96 [51.6] (111)	17 [9.8] (21)	0	31 [25.1] (54)	13 [8.8] (19)	7 [4.7] (10)
L (131)	83 [91.6] (120)	0	0	9 [7.6] (10)	0	1 [0.8] (1)
AD (18)	3 [16.7] (3)	0	0	8 [77.8] (14)	1 [5.5] (1)	0
H (277)	152 [57.8] (160)	12 [4.7] (13)	0	38 [19.1] (53)	6 [2.5] (7)	39 [15.9] (44)
EUL (635)	47 [8.7] (55)	194 [52.0] (330)	26 [6.8] (43)	43 [10.2] (65)	98 [22.2] (141)	1 [0.1] (1)
PD (271)	38 [15.5] (42)	85 [72.7] (197)	3 [1.1] (3)	7 [3.3] (9)	12 [7.0] (19)	1 [0.4] (1)
CAR (18)	4 [33.3] (6)	3 [16.7] (3)	0	1 [11.1] (2)	4 [38.9] (7)	0
ARM (33)	10 [39.4] (13)	0	0	7 [45.5] (15)	0	4 [15.1] (5)
WP (295)	88 [35.3] (104)	1 [0.3] (1)	3 [1.0] (3)	81 [60.7] (179)	3 [1.0] (3)	5 [1.7] (5)
K (8)	0	0	0	2 [87.5] (7)	0	1 [12.5] (1)
EC (20)	15 [80.0] (16)	0	0	3 [15.0] (3)	0	1 [5.0] (1)
LP (80)	53 [90.0] (72)	1 [1.25] (1)	0	3 [5.0] (4)	1 [1.25] (1)	2 [2.5] (2)
T (252)	125 [54.3] (137)	35 [18.6] (47)	6 [2.4] (6)	26 [15.1] (38)	8 [4.4] (11)	13 [5.2] (13)
ED (10)	0	3 [30.0] (3)	0	5 [50.0] (5)	1 [10.0] (1)	1 [10.0] (1)
ARD (664)	237 [39.4] (262)	6 [0.9] (6)	0	140 [55.0] (365)	18 [3.5] (23)	8 [1.2] (8)
CON (141)	87 [72.3] (102)	2 [4.3] (6)	0	8 [22.0] (31)	0	1 [1.4] (2)
B (47)	22 [49.0] (23)	13 [44.7] (21)	0	1 [2.1] (1)	2 [4.2] (2)	0
M (613)	205 [40.8] (250)	31 [8.3] (51)	33 [10.9] (67)	115 [32.5] (199)	8 [1.5] (9)	29 [6.0] (37)
CAN (75)	57 [77.4] (58)	1 [1.3] (1)	0	9 [20.0] (15)	1 [1.3] (1)	0
S (13)	0	0	0	7 [76.9] (10)	3 [23.1] (3)	0
Q (232)	79 [37.1] (86)	5 [2.6] (6)	0	79 [47.4] (110)	19 [8.2] (19)	10 [4.7] (11)
P (90)	21 [26.7] (24)	4 [5.5] (5)	0	11 [16.7] (15)	7 [8.9] (8)	31 [42.2] (38)
YD (9)	8 [88.9] (8)	0	0	0	0	1 [11.1] (1)
R (71)	58 [84.6] (60)	3 [7.0] (5)	0	1 [5.6] (4)	1 [1.4] (1)	1 [1.4] (1)
All localities	1810 (2093)	437 (745)	75 (126)	720 (1341)	215 (286)	172 (202)
% pellets	48.3	11.6	2.0	19.2	5.7	4.6
% mammals	43.7	15.5	2.6	28.0	6.0	4.2

were found in a pellet. Up to 14 individuals of the smallest dasyurid preyed upon, *P. ingrami* (mass up to 5 g), but usually only one or two of the larger dasyurids, *S. macroura* (mass up to 25 g) and *S. douglasi* (mass up to 70 g), were found in a pellet. If larger numbers of either *S. macroura* or *S. douglasi* were found they were always individuals assessed as juveniles. It was

not uncommon to find the remains of more than one species of mammal in a single pellet. *R. villosissimus* was found in 48.3% of all pellets, *L. forresti* in 11.6%, *M. musculus* in 2.0%, *P. ingrami* in 19.2%, *S. macroura* in 5.7% and *S. douglasi* in 4.6% (Table 3, Figure 2). The localities at which the remains of each of these species were found in the pellets can be seen in Figure 3.

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Birds. Seventeen species were identified. Of the 2053 individuals found in the pellets 30 (1.4%) could not be identified. The species most commonly preyed upon was the Zebra Finch, *Taeniopygia guttata* (75.9% of the total number of birds), followed by the Budgerigar, *Melopsittacus undulatus* (7.8%); Black-faced Woodswallow, *Artamus cinereus* (4.2%); White-winged Triller, *Lalage sueurii* (2.5%); Red-capped Robin, *Petroica goodenovii* (2.3%); White-winged Fairy-wren, *Malurus leucopterus* (1.6%); Singing Bushlark, *Mirafra javanica* (1.6%) as well as, each at less than 1.0%, swallows, *Hirundo* sp.; Golden-headed Cisticola, *Cisticola exilis*; Little Button-quail, *Turnix velox*; Red-chested Button-quail, *T. pyrrhorostrax*; Baillon's Crake, *Porzana pusilla*; Brown Songlark, *Cincloramphus cruralis*; Rufous Songlark, *C. mathewsi*; Spiny-cheeked Honeyeater, *Acanthagenys rufogularis*; pigeons, *Phaps* sp. and Australian Pratincole, *Stiltia isabellae*. Up to seven zebra finches (mass 12-13 g) were found in a single pellet, but seldom more than two of any other species.

Reptiles. Representatives of three families, the Gekkonidae, Agamidae and Scincidae, were found in the pellets. Most of the jaw bones, upon which the count of individuals was made, were very delicate and some may have been overlooked in the preparation of the pellets. Thus the total number of individuals found (907) may be an underestimate of the extent to which reptiles are preyed upon. Some of the 907 specimens could not be identified, and some were not placed to family with certainty but the majority were considered to be geckoes (762 individuals), followed by agamids (85) and skinks (11). Frequently large numbers of geckoes (up to 18) were found in a single pellet. Geckoes were often seen in numbers at roosting sites in old buildings and so may have been very readily accessible to resident owls. Confirmation of identity for some of the agamids was provided by the presence of portions of tail, still covered with rough skin.

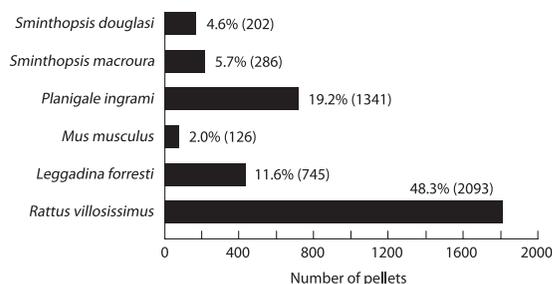


FIG. 2. Number of pellets containing each species of rodent (*R. villosissimus*, *L. forresti* and *M. musculus*) and dasyurid (*S. douglasi*, *S. macroura* and *P. ingrami*) preyed upon by the owls. The number of pellets, expressed as a percentage of all pellets examined (3,749), is shown at the end of each bar together with the number of individuals in parentheses.

One agamid was further identified as a juvenile *Pogona brevis* (G. J. Witten pers. comm.).

Frogs. The remains of 373 frogs were found in the pellets. The ilium, upon which the estimate of numbers was based, ranged in length from 11 to 33 mm. Up to 20 individuals with short (13-14 mm) ilia were found in some pellets. Some indication of the size of the frogs preyed upon by the owls can be gained from measurements taken from the dry remains of an unidentified frog found in the study area. The body length of this specimen was about 75 mm, and the length of the ilium, 26.5 mm.

Arthropods. The remains of a few large spiders (*O. Araneae*) and one centipede (not further identified) were found in the pellets but the majority of the arthropods were insects, including beetles (*O. Coleoptera*), bugs (*O. Hemiptera*), mantids (*O. Mantodea*), and crickets and grasshoppers (*O. Orthoptera*). Grasshoppers were by far the most numerous of the arthropod prey items, and their eggs were frequently seen in the pellets. Some of the beetles and bugs were very small and they may have been ingested along with other prey such as frogs.

Other items. Seeds considered to have been ingested along with a prey item were found in many pellets, especially those containing bird remains. The large oval seeds of the paddy melon, *Cucumis melo*, were often found in pellets that contained the remains of *R. villosissimus*.

DISCUSSION

Consistent with the findings of studies on the diet of barn owls referred to above the prey of the owls in the study area in north-western Queensland included a variety of mammals, birds, reptiles, frogs and arthropods, with mammals forming the major component of the diet. The remains of individual mammals were found in three quarters of all pellets examined, and mammals were taken in greater numbers than individuals of other vertebrate taxa. All six species of small terrestrial mammals (3 rodents, 3 dasyurids) preyed upon were previously known to occur in the study area.

The most frequently taken species was *R. villosissimus* (43.7% of all mammals) and it was found in pellets from all but three localities. The area around Julia Creek is thought to be a 'refuge' area for *R. villosissimus* when it is not in plague proportions (Carstairs 1974). This species has been found to form a large component of the diet of the Barn Owl in some other studies e.g. Morton et al., 1977 (41.6%); Valente, 1981 (60.9%); Debus et al., 1999 (65%).

Smaller contributions to the diet were made by the other two species of rodents. In the case of *L. forresti* (15.5% of all mammals) the majority (527 of the 745 individuals) were found in pellets collected in July 1994 from just two of the nineteen localities in which it was detected. In one of the two, Eulolo, they constituted 52% of all mammals from that locality and at the other, Penola Downs, 73%. Although this species is seldom encountered in large numbers (Watts & Aslin 1981; Dickman et al. 2000) it seems that it was plentiful in these localities at the time the pellets accumulated. Morton & Martin

(1979) also found it to form a large component of the diet of barn owls in 2 of their 11 study sites (59% at Coober Pedy and 20% at Warrina). The introduced house mouse, *M. musculus*, the least frequently preyed upon species (2.6% of all mammals) was found in pellets in only eight localities and the majority (110 of 126 individuals) were taken in just two; at Eulolo it constituted 6.8% of the mammals and at Minamere, 10.9%. When numbers of house mice were high at Fowler's Gap, N.S.W., they formed the bulk of the diet (up to 96.4%) of the owls (Morton & Martin 1979).

Planigale ingrami, the smallest of the three dasyurids, was the second most frequently preyed upon species (28% of all mammals) and it was found in pellets from all localities except one. *Sminthopsis macroura* (6% of all mammals) was preyed upon a little more frequently than *S. douglasi* (4.2%), and both species were found throughout the study area in a majority (21, 22 respectively) of the localities from which pellets were obtained. *Sminthopsis douglasi* has not previously been recorded as prey of the barn owl but *S. macroura*, which has a much larger distribution, has been found in owl pellets from other areas. Heywood & Pavey (2002) found it to be the major prey item (81.8% of identified items) in a sample of pellets from Connell's Lagoon on the Barkly Tableland at a time when numbers of *R. villosissimus*, a species known to occur in the same locality, were not found in the pellets. In the present study *S. macroura* never formed more than 38.9% of the mammalian prey items at any one locality.

Among birds, the vertebrate taxon making the second largest contribution to the diet of the owls, the species most frequently preyed upon was the Zebra Finch, *T. guttata*. It is not known if this species was generally more abundant in the study area than others, or if some aspect of its behaviour makes it more susceptible to predation. It is known to nest in colonies throughout the year (Zann, 1996) and this may

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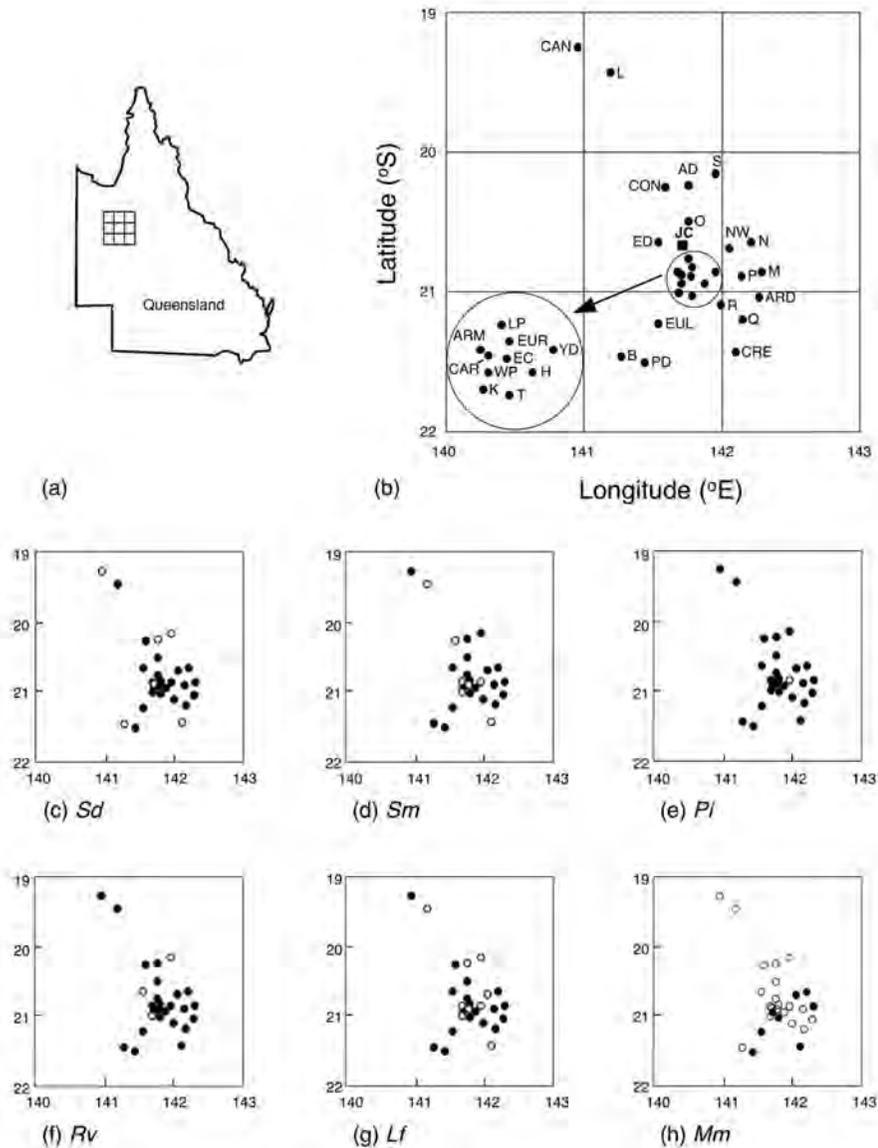


FIG. 3. Distribution of the species of dasyurids and rodents based on remains found in barn owl pellets collected in north-western Queensland. a) location of the study area; b) the collecting localities (see Table 1 for full names) around the town of Julia Creek (JC); c) *Sd* = *S. douglasi*; d) *Sm* = *S. macroura*; e) *Pi* = *P. ingrami*; f) *Rv* = *R. villosissimus*; g) *Lf* = *L. forresti* and f) *Mm* = *M. musculus*. A filled symbol indicates a record of a species; an open symbol, no record.

lead to several (up to seven) being taken at a time: barn owls have been observed to disturb communally roosting birds by beating their wings against the bushes in which the birds are roosting (Bunn et al. 1982).

No assessment of either seasonal or long term changes in the availability of prey species at the various localities within the study area can be made because the pellets were collected opportunistically over a period of 8-9 years, and in many cases the period over which the pellets had accumulated was not known. Differences between localities in the relative importance of the various prey taxa (see Tables 2 and 3) probably reflect what was readily available to the owls at the time they were present in the area. Frogs may form a larger component of the diet during wet periods, and insects such as grasshoppers when local infestations occur. The absence of a particular taxon from some localities may be due in part to the small number of pellets found at the locality.

From the information obtained on the distribution of the three species of rodents (*R. villosissimus*, *L. forresti* and *M. musculus*) and the three dasyurids (*S. douglasi*, *S. macroura* and *P. ingrami*) it seems likely that this suite of small mammals, with the possible exception of *M. musculus*, may be found throughout the study area. The absence of a species from the pellets from any one locality does not necessarily mean that the species does not occur there. *S. douglasi*, the species of particular interest, was not found in pellets collected from Crendon in 1993, but a live individual had been obtained from that locality in 1992. To date, live animals or carcasses of *S. douglasi* have been collected from 6 of the 28 localities, including Lyrian, Crendon, Nelia, Toorak, Proa and Yorkshire Downs (Woolley 1992; Woolley & Mifsud unpub. observations). Specimens have also been collected from other localities within the study area, including Euraba, Julia Creek, Edith Downs and Euroka (Woolley 1992), and one was found

alive near Penola Downs (at 21°28'S, 141°10'E) in the wet season of 1997-98 (S. Malone pers. comm.). These localities all lie within the known range of the Julia Creek Dunnart (Kutt 2003).

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