

The Black-breasted Buzzard *Hamirostra melanosternon*: a Review

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Summary

The literature concerning the Black-breasted Buzzard's morphology, diet, hunting behaviour and breeding biology is reviewed and supplemented with observations on wild and captive birds. The Buzzard is considered a generalised predator and scavenger of woodland and treeless country, preying on a variety of arboreal and terrestrial vertebrates detected primarily on long, fast gliding transects. It has some specialisations and behavioural peculiarities, such as use of stones to break the eggs of large ground-nesting birds, and a possibly polyandrous breeding system in desert areas. It requires mature eucalypts for nesting, breeds at low density, and has a traditional nest site and large home range. Its existence in the arid zone is dependent on rainfall, and may be precarious. It has declined in south-eastern and eastern parts of its range, through disturbance and degradation of breeding habitat. Its biology and conservation status require investigation, and further behavioural study would be rewarding.

Introduction

Of the three endemic, monotypic Australian raptor genera two, *Erythrotriorchis* and *Lophoictinia*, have been the subjects of previous review articles (Debus & Czechura 1988, 1989). For completeness, the remaining genus *Hamirostra* is reviewed here. The Black-breasted Buzzard *Hamirostra melanosternon* is of particular interest because for many years there have been unsettled questions about its feeding behaviour (possible tool use) and plumages (age-related phases versus morphs); some aspects of its breeding behaviour, including possible polyandry, are unusual for a raptor (see for example Cupper & Cupper 1981, Hollands 1984). As previously noted (Badman & Debus 1987), there have also been some possibly erroneous statements in the literature on this species. The Buzzard is now reasonably well known, particularly at the nest (Cupper & Cupper 1981, Hollands 1984, Baker-Gabb 1990), but much valuable information is scattered through the literature. Here we review and interpret the literature on its biology, and supplement this with data from the RAOU Atlas of Australian Birds and Nest Record Scheme, and our own field experience. Generally, we have chosen not to repeat information in Baker-Gabb (1990) but instead to concentrate on other aspects of the Buzzard's biology.

Field identification

There is little to add to Badman & Debus (1987), except to note that Pepper-Edwards & Notley (1991a) have clearly established that the so-called 'light phase' is an immature plumage stage. Regrettably, Pepper-Edwards & Notley were incorrect in stating that 'the Slaters [1986] also introduced a third or red plumage, yet to be confirmed — that of the juvenile'. In fact North (1912) first described the juvenile plumage, from a series of nestlings in The Australian Museum. Slater (1970) described and illustrated the rufous 'immature' (by which he meant juvenile, i.e. first-year) as well as the 'pale phase', and Cupper & Cupper (1981) and Hollands (1984) published colour photographs of rufous nestlings and fledglings.

Pepper-Edwards & Notley's work confirms that the Buzzard is not colour-dimorphic, and that the 'dark phase' is the adult plumage. This means that three age classes of Buzzard (juvenile, immature and adult) can be recognised in the field, although fading

and individual variation may mean that juveniles approaching the end of their first year may be difficult to distinguish from some immatures. For instance the plumage of a captive juvenile had, by the end of its first year, become considerably bleached and abraded (SJSD). In May, at about 7 months of age, this bird's plumage was not worn, but it was a pale, faded rufous with the crown, back and shoulders bleached. Its shoulders were similar to those of an adult, but the paleness was more extensive. Its eyes were hazel. In September it was moulting on the breast, wing coverts (which were abraded) and inner primaries. In November it was still scruffy and moulting, browner on the wings (especially flight feathers) than a fresh juvenile, and still had hazel eyes. New feathers on its underparts and mantle were browner than those of a fledgling. In May 18 months later (i.e. in fresh plumage in its third year, at c. 31 months of age), its dorsal plumage was essentially adult-like (mantle mottled black and chestnut), with black forehead and face. Its ventral surface was rufous-brown, with a broad black (arrow-head or diamond-shaped) blaze down the centre of each breast feather, though these streaks did not coalesce into a black patch on the breast. Its eyes were dark hazel with a brown tint, and its outer primaries were worn, suggesting incomplete primary replacement in a given moult cycle. Immature plumage appears to last for two years (second and third year) until birds acquire some ventral black early in their fourth year; one was in all but full adult plumage, with a few brown feathers remaining amongst the black, in its fifth year (see Pepper-Edwards & Notley 1991a). This bird was in full adult plumage in its sixth year (SJSD pers. obs.). It was examined in 1984 by SJSD and considered then to be a first-year bird.

The fresh tail illustrated in Badman & Debus (1987) is rarely seen in the field. Many birds have a rather worn and slightly rounded tail. Juveniles may have slightly longer and more rounded tails than adults, an impression supported by two captive birds: an adult had proportionally longer primaries and shorter rectrices than a juvenile housed with it (SJSD).

Baker-Gabb's (1990) information on calls confirms that the Buzzard mainly utters monosyllabic yelps, but also soft piping and low rasping calls at the nest, and occasionally a long alarm note which is presumably the 'thin whistling scream' described by Cupper & Cupper (1981).

Morphology

Two male Black-breasted Buzzards weighed 1150 and 1242 g (Badman & Debus 1987), mean 1196 g. A captive female weighed 1210 g when it was received as a lean immature, and 1450 g as a well-fed adult (Pepper-Edwards & Notley 1991a), therefore a mean of 1330 g may approximate that of wild females. These figures show that the Buzzard is weakly sexually dimorphic in weight (male 90% of female weight), much heavier than the slim Square-tailed Kite *Lophoictinia isura*, but only 100-200 g heavier than large female Little Eagles *Hieraaetus morphnoides* (cf. Debus & Czechura 1989, Baker-Gabb 1984a). It is also weakly sexually dimorphic in wing length (male 98% of female: data from Condon & Amadon 1954). These weights, and the formula in Cade (1982), give a calculated wing-loading index of 0.42 and 0.47 g/sq. cm for male and female Buzzard respectively. This is much higher than that of the Square-tailed Kite but nevertheless the Buzzard appears buoyant in flight, perhaps related to its long wings held in a pronounced dihedral (Hollands 1984).

Hamirostra is said to have strong legs and feet and heavy tarsi and toes (Condon & Amadon 1954, Brown & Amadon 1968). Published photographs confirm that the Buzzard's legs and feet are almost aquiline in proportions (Cupper 1977-1978, Plate 20, p. 157; Cupper & Cupper 1981; Hollands 1984; Baker-Gabb 1990, Plate 61, p.

232). It is readily apparent from captive birds and museum specimens that its feet and claws are as large as those of the Little Eagle. However, it has weak, 'flabby', kite-like toes with less strongly curved claws than the powerful, sinewy feet of eagles (P. Olsen pers. comm.). *Hamirostra* is also characterised by a large, coarse bill (Brown & Amadon 1968) and bulbous cere (Hollands 1984), and it is evident from museum specimens, captive birds and published photographs that the Buzzard has relatively and absolutely heavier bill and feet than the Square-tailed Kite. Its bill length (male 46.2 mm; two females 45.3, 47.3 mm; unsexed 45.6 mm: Aust. Museum) is much greater than that of the Square-tailed Kite, and greater than that of the Little Eagle (female means 34.0 and 35.6 mm respectively: Debus & Czechura 1989, Baker-Gabb 1984a). However, its bill is long and slender, having less bite force than the deep, powerful bill of an eagle (P. Olsen pers. comm.). Its bill resembles forceps, which may give extra leverage for opening large eggs, and allow probing in crevices (e.g. deep cracks in black-soil plains).

The above measurements and weights confirm that the Buzzard is a large and robust hawk, for instance with feet strong enough to catch and transport large rabbits (e.g. Beruldsen 1972). However, it seems relatively weak-footed for its size, and a less potent predator than similarly sized eagles (P. Olsen pers. comm.).

A remarkable feature of the Black-breasted Buzzard is its flight silhouette. Its short tail and long, back-swept wings, though less extreme, recall those of the Bateleur Eagle *Terathopius ecaudatus* of Africa, as noted by Hollands (1984). The Buzzard similarly seems to spend much time coursing its habitat rapidly at moderate altitude (see below).

General habits and behaviour

Like the Square-tailed Kite, the Black-breasted Buzzard gives the impression of being a highly aerial bird, spending long periods in soaring and sailing flight with scarcely a flap of the wings. It is capable of rapid and effortless height gain, and is a powerful flier in active flight and in stamina on the wing (e.g. Dickison 1932, Hollands 1984, Gearing 1986). It can spiral to a great height from low to the ground, with almost no flapping (GVC). In contrast with the Kite, the Buzzard seems more inclined to spend time standing, squatting or foraging on the ground, where it can walk well (SJSD); it sunbathes on the ground as well as on a perch (Debus 1991a). In other behavioural aspects there are similarities and differences between the two species (cf. Badman & Debus 1987, Debus & Czechura 1989). The Buzzard is more sociable, and sometimes gathers in small numbers (<10) at a food source (e.g. Kingston 1988) or at communal roosts (Baker-Gabb 1990). Both often appear lethargic, particularly in captivity (SJSD). However, wild Buzzards at the nest are warier and more nervous than Square-tailed Kites, often flushing and circling about an intruder with yelping cries (SJSD pers. obs.; Baker-Gabb 1990; see also breeding biology, p. 251).

Habitat, distribution and population

From the literature (e.g. references in Table 1 and Table 2) it is apparent that the Black-breasted Buzzard occurs in a variety of open habitats from eucalypt woodland to shrub steppes, grassy plains and sandy deserts. In Queensland most sightings appear to be from *Triodia* and *Astrebla* grassland savanna, e.g. Mitchell Grass (*Astrebla*) a long distance from trees (central Queensland: GVC). In the better-watered parts of its range clumps or belts of woodland through treeless country are a feature of its habitat, where it breeds in trees and often forages out over plains. Similarly, it forages over deserts where it rests on the ground in the absence of trees, but in the most arid areas breeding is restricted to watercourses that support sufficiently large trees. It

appears to be one of the few truly arid-zone Australian raptors. An observation of an adult pair soaring together in summer at Ayers Rock, Northern Territory (SJSD), raises the possibility that in treeless country it may nest on rock-faces below which water run-off creates locally productive sites in good seasons, e.g. MacDonnell Ranges, Ayers Rock-Mt Olga, rocky 'breakaways' in the western deserts.

The Black-breasted Buzzard is now primarily an inland and tropical species (e.g. Blakers et al. 1984). However, it was formerly a moderately common breeding species in the Riverina and central-west of New South Wales (Campbell 1900, Bennett and Lane in North 1912) and was formerly more numerous in parts of central-eastern Queensland (Mathews 1916, Barnard 1925). The first (Gould) specimens came from inland northern New South Wales (Mathews 1916), and it once occurred in the Clarence Valley in north-eastern New South Wales (Ramsay 1867). It is apparent that it has declined considerably in the south-east and east of its range. This is most probably attributable to habitat destruction and disturbance to nesting areas, and perhaps poisoning of carcasses from which the Buzzard scavenges (e.g. Berney 1905, Bennett in North 1912, Mathews 1916, Barnard 1925).

Hollands (1984) speculated that the Buzzard may be a non-breeding visitor to the Top End of the Northern Territory. It also breeds in the Top End, where some birds are present all year (Schodde 1973, Thompson 1977, Barnett 1980, Blakers et al. 1984, Baker-Gabb 1990, SJSD). There is some spring southwards movement in New South Wales (Blakers et al. 1984) and it is a dry-season visitor to islands in Torres Strait (Draffan et al. 1983), therefore some southern or inland birds may winter in the north, augmenting the resident population. There may be some annual movement between coastal open forest and inland grasslands in tropical Queensland; in south-eastern Queensland it appears near the coast during severe drought conditions farther west (GVC).

Diet

The Black-breasted Buzzard is a generalist, taking a wide range of mammals, birds, reptiles, some insects and carrion, including nestlings of other raptor species (Table 1). In addition to species in Table 1, it has been seen in pursuit of a Varied Lorikeet *Psitteuteles versicolor* (Hayward 1988). Like the Square-tailed Kite it is a nest-robber (cf. Debus & Czechura 1989), but the Buzzard takes eggs of large ground-nesting birds and also adult and young birds of larger species than those taken by the Kite. In the Northern Territory, the Buzzard is the only regular avian predator of nests of the Magpie Goose *Anseranas semipalmata*, whose eggs it breaks *in situ* with blows of its bill (N. Dexter pers. comm.). Adult birds taken by the Buzzard range up to ducks of 790 and 887 g (means from Frith 1977), and even an Australian Bustard *Ardeotis australis* of perhaps >2 kg. Similarly, mammal and reptile prey of the Buzzard is larger than that taken by the Square-tailed Kite. In contrast with the Kite, reptiles (mainly dragons and varanids) appear to be taken from the ground and from crevices, especially on black-soil plains in Queensland (GVC). This accords with the Buzzard's greater body weight and heavier bill and feet. The maximum prey size seen carried was a Plumed Whistling-Duck *Dendrocygna eytoni* (Berney 1905), 580-1400 g, mean 790 g, but many of the rabbits taken may equal or exceed this. Nevertheless, Table 1 clearly shows that the Buzzard takes many young animals, and suggests that it is not a particularly potent predator.

Carrion eaten includes road-killed macropods, cattle and feral buffalo (Table 1), and the Buzzard itself occasionally is killed by passing traffic while feeding on road-kills (Thompson 1977, SJSD). Groups of up to nine Buzzards have been seen at a carcass (Kingston 1988).

Table 1: Species recorded as prey of the Black-breasted Buzzard. Sources: 1 = McGilp (1934); 2 = North (1912); 3 = Beruldsen (1972); 4 = Cupper & Cupper (1981); 5 = Hollands (1984); 6 = Angus (1992); 7 = Bennett (1881); 8 = Berney (1905); 9 = Moriarty (1972), 10 = Serventy & Whittell (1976), 11 = N. Dexter; 12 = Barrett (1989); 13 = Cupper (1977-78); 14 = Campbell & Barnard (1917); 15 = Maher (1988); 16 = Garnett (1985); 17 = I. Mason/NRS; 18 = S. Debus; 19 = Hardy (1985); 20 = Hobbs (1984); 21 = Baker-Gabb (1990); 22 = E. Olive/Aust. Museum; 23 = J. Strudwick & J. Bell/NRS; 24 = Mathews (1910); 25 = Wheeler (1968); 26 = Mathews (1916); 27 = J.H. Calaby; 28 = Thompson (1977); 29 = McLaren (1992); 30 = Condon & Amadon (1954); 31 = Reid & Gordon (1988); 32 = Hooper & Wells (1988); 33 = Baker-Gabb & Fitzherbert (1992). NRS = RAOU Nest Record Scheme.

<i>Species</i>	<i>Life stage</i>	<i>Source(s)</i>
Kangaroo <i>Macropus</i> sp.	juvenile	1
Rabbit <i>Oryctolagus cuniculus</i>	kitten/not aged	1, 2, 3, 4, 5, 6
Emu <i>Dromaius novaehollandiae</i>	eggs	2, 7, 8, 9, 10
Magpie Goose <i>Anseranas semipalmata</i>	eggs	11
Plumed Whistling-Duck <i>Dendrocygna eytoni</i>	adult	8
Radjah Shelduck <i>Tadorna radjah</i>	adult	12
Black Kite <i>Milvus migrans</i>	nestling	4, 5
Australian Kestrel <i>Falco cenchroides</i>	nestlings	4, 5, 13
Falcon <i>Falco</i> sp.	nestlings	5
Brolga <i>Grus rubicunda</i>	eggs	14
Australian Bustard <i>Ardeotis australis</i>	eggs	2, 7
	adult	15
Little Tern <i>Sterna albifrons</i>	eggs/nestlings	16
Crested Pigeon <i>Ocyphaps lophotes</i>	adult?	17
Galah <i>Cacatua roseicapilla</i>	adult, nestling	4
Cockatiel <i>Nymphicus hollandicus</i>	adult?	17
Red-collared Lorikeet <i>Trichoglossus rubritorquis</i>	adult	18
Parrot sp.	adult?	17
Yellow-throated Miner <i>Manorina flavigula</i>	?	4
Australian Magpie-lark <i>Grallina cyanoleuca</i>	?	5
Australian Magpie <i>Gymnorhina tibicen</i>	adult	19
Australian Raven <i>Corvus coronoides</i>	?	4
Little Crow <i>Corvus bennetti</i>	adult, nestling	4
Corvid <i>Corvus</i> sp.	fledgling	5
Unidentified passerines	?	4
Bearded Dragon <i>Pogona vitticeps</i>		5
Sand Goanna <i>Varanus gouldii/panoptes</i>		4, 5, 20
Shingle-back Lizard <i>Trachydosaurus rugosus</i>		2
Lizard sp.		4, 21
Snake sp.		22, 23
Grasshoppers		24
Carrion:		
Rat-kangaroo		26
Black Wallaroo <i>Macropus bernardus</i>		27
Wallaby		2, 28, 29
Kangaroo		2, 30, 31
Rabbit		19
Cattle <i>Bos taurus</i>		32
Water Buffalo <i>Bubalus bubalis</i>		28
Goat <i>Capra hircus</i>		8
Common Bluetongue <i>Tiliqua scincoides</i>		33

Table 2: Breeding parameters of the Black-breasted Buzzard. W = woodland. E = *Eucalyptus*. Sources: 1 = L. Golding/Atlas; 2 = Storr (1984a); 3 = Storr (1985); 4 = Aumann (1991); 5 = J. Strudwick & J. Bell/Atlas; 6 = Buchanan (1992 and in litt.); 7 = Barnard (1914); 8 = Storr (1977); 9 = S. Debus; 10 = I. Mason/NRS; 11 = J. McKean/NRS; 12 = Jakes & Jakes (1988); 13 = D. Gibson/NRS; 14 = Macgillivray (1914); 15 = Macgillivray (1929); 16 = Storr (1984b); 17 = A. Ley; 18 = Wilson (1974); 19 = M. Seyfort/NRS; 20 = North (1912); 21 = McGilp (1923, 1934); 22 = Cox & Pedler (1977); 23 = A. Johnson; 24 = L. Smith/NRS; 25 = D. Baker-Gabb/NRS; 26 = Cupper & Cupper (1981); 27 = Hollands (1984); 28 = Maher (1988); 29 = Qld Museum; 30 = Campbell (1900); 31 = Macgillivray (1912); 32 = Beruldsen (1969, 1972); 33 = Cupper (1976); 34 = Brooker (1982); 35 = Cooper (1989); 36 = Angus (1992). NRS = RAOU Nest Record Scheme.

Habitat	Nest tree species	Height (m)	Month	Stage	Clutch/brood size (n)	Source
Western Australia:						
?	<i>E. camaldulensis</i>	?	Aug.	?	?	1
?	?	?	Sept.	eggs	C/2	2
?	?	?	Sept.	eggs	C/2	3
Riverine W	?	?	Oct.	eggs/chicks	?	4
Riverine W	<i>E. camaldulensis</i>	18	Sept.	eggs	C/2	5
Riverine W	<i>E. camaldulensis</i>	?	Sept.	incubation	?	6
Northern Territory:						
?	?	?	Sept.	'breeding'	?	7
?	?	?	Sept.-Oct.	eggs	?	8
Eucalypt W	<i>Eucalyptus</i> sp. x2	?	Sept. x2	eggs/ nestlings	?	9
Riverine W	dead eucalypt	8	Sept.	egg	C/1	10
Eucalypt W	<i>Eucalyptus</i> sp.	15	Sept.	nestling	B/1	11
?	?	?	Sept.	'nesting'	?	12
Acacia W	dead tree	10	Oct.	nestling	B/1(C/2)	13
Queensland:						
?	?	?	July	building		14
Riverine W	?	18	Aug.	building		15
?	?	?	July-Sept.	eggs	?	16
Riverine W	<i>E. microtheca</i>	9	Oct.	hatchling	B/1	17
?	?	?	Nov.	nestling	B/1	18
Eucalypt W	<i>Eucalyptus</i> sp.	22	Aug.	nestling	B/1	19
Central Australia:						
Riverine W	<i>E. camaldulensis</i>	'very high'	Nov.	egg	C/1	20
South Australia:						
?	Box <i>Eucalyptus</i> sp.	8	Oct.	nestlings	B/2	21
Riverine W	<i>E. camaldulensis</i>	20	Aug.	pre-laying		22
Riverine W	?	?	Nov.	fledglings	B/2	23
Riverine W	<i>E. camaldulensis</i>	15	Aug.	incubation	?	24
Riverine W	<i>E. microtheca</i>	11	Oct.	fledgling	B/1	25
Riverine W	dead <i>E. microtheca</i>	?	Sept.	building		25
Riverine W	<i>E. microtheca</i>	7	Sept.	incubation	?	25
Riverine W	dead <i>E. microtheca</i>	7	Sept.	eggs	C/2	25

Table 2 continued

Habitat	Nest tree species	Height (m)	Month	Stage	Clutch/brood size (n)	Source
South Australia (continued)						
Riverine W	dead <i>E. microtheca</i>	8	Sept.	eggs	C/2	25
Riverine W	dead tree	8	Aug.	eggs	C/2	25
Riverine W	dead tree	7	Sept.	incubation	?	25
Riverine W	live tree	8	Sept.	building		25
Riverine W	<i>E. microtheca</i>	12	Aug.	building, copulation		26
			Sept.	eggs	C/2	26
			Oct.	hatching	B/1	26
Riverine W	dead <i>E. microtheca</i>	?	?	nestlings	B/2	26
Riverine W	dead <i>E. microtheca</i>	?	Aug.	building		26
		?	Oct.	hatching	B/2	26
?	?	6-20	?	eggs, nestlings	C/1 x1, C/2 x6, B/1 x6, B/2 x1	26
Riverine W	<i>E. microtheca</i> x4	?	Sept. Oct.	building eggs	C/2 x5	27 ^a
			Nov.	nestling	B/1	27 ^a
?	<i>E. camaldulensis</i>	12	Oct.	egg	C/1	28
?	?	?	Oct. x4	nestlings x4	B/1 x1, B/2 x2	28
?	?	?	Sept.	egg(s)	?	29
New South Wales:						
?	dead tree	18	Sept.	?	?	30
Riverine W	<i>E. camaldulensis</i>	21	Sept.	eggs	C/1 x2, C/2 x2	20
?	?	6	Sept.	hatching	C/2	20
W	?	?	Aug.-Nov.	eggs	C/1 x1, C/2 x2	20
?	?	?	Oct.-Dec.	nestlings	B/1 x3	20
			?	nestlings	B/2 x2	20
?	?	?	Sept. x3	eggs	C/2 x2	20
			Oct.	eggs (repeat)	C/2 x1 C/1 x1	20
?	?	?	Aug.	eggs	C/2	20
			Sept.	egg	C/1	20
?	?	?	Sept.	hatching	?	31
Riverine W	<i>E. camaldulensis</i> x2	?	Sept. x2	building x2		32
			Oct.	building (repeat?)		33
Riverine W	<i>E. camaldulensis</i>	16	Aug.	building		26
?	?	?	Oct.	fledgling	B/1	34
?	<i>E. microtheca</i>	9	Sept.	eggs	C/2	28
?	live tree	6	Aug.	laying	C/2	25
?	?	?	Sept.	'nesting'	?	35
W (dead)	dead tree	?	Nov.	chick(s)	B/1+	36

^a same nests as observed by Cupper & Cupper (1981).

Hunting and feeding behaviour

The hunting behaviour of the Black-breasted Buzzard has not been studied in detail, but it appears to most commonly use transect hunting, coursing its habitat at low to medium altitudes in rapid gliding flight (Hollands 1984, Baker-Gabb 1990, SJSD, GVC; terminology follows Baker-Gabb 1980). For instance, a Buzzard sailed out of sight along a tree-lined watercourse and returned along the same path, characteristically 'rocking' as it went (A. Ley pers. comm.), and another glided at 30 m for 1 km (Start & Start 1992). Such transect hunting is deceptively fast, covering a long distance in a short time; it is probably very effective as areas traversed have negligible relief (inland Queensland: GVC).

Some transect hunting is done in low, harrier-like beating and gliding (Brooker & Wombey 1980, Badman & Debus 1987, SJSD, GVC). It also uses high quartering (Baker-Gabb 1990), and perhaps low, slow quartering, described as 'peculiar floating flight when hawking over the treetops' (Campbell & Barnard 1917) and 'quartering the ground' (Davies in Boswall 1983). It frequently soars in spirals at moderate to great heights, perhaps mainly in display (SJSD, GVC), but soaring and prospecting may also enable it to spot carrion (Baker-Gabb 1990). It appears to use mainly aerial searching methods, and the few reports of attacks from a perch (Schodde 1976, Baker-Gabb 1990) may be opportunism while the bird is loafing. There is one report of a Buzzard 'hovering... as lightly as a Kestrel [*Falco* sp.]' (Salter 1979), but the term is often used loosely and perhaps the bird was wind-hanging without wing movement as described by Baker-Gabb (1990).

The Black-breasted Buzzard does some ground hunting and stalking, for insects (P.A. Bourke in Wheeler 1968; Schodde 1976), and also perhaps for other small prey, eggs of ground-nesting birds, reptiles in crevices, and small items of carrion. Johnstone (1983) recorded several Buzzards feeding on a beach in north-western Australia. Morris (1973) speculated that the Buzzard's frequently blunt claws and abraded primaries and tail may be attributable to terrestrial pursuit of prey, and it seems that claw and tail wear is indeed a consequence of the considerable amount of time spent foraging on the ground. The Buzzard may scratch in soil, like captive Brown Falcons *Falco berigora* (GVC). Primary and tail wear may also be attributable to frequent contact with foliage when robbing nests or taking birds from the tree canopy. Large prey is often eaten on the ground, and small prey is carried to a tree perch (e.g. Berney 1905, McGilp 1934); old nests are used as feeding platforms (Macgillivray 1914, Beruldsen 1969).

The Black-breasted Buzzard may on occasion use mediated flushing to detect or capture prey. Garnett (1985) described how a Buzzard appeared and robbed Little Tern *Sterna albifrons* nests after the adults flushed and mobbed a human intruder, and Storr et al. (1975) and Johnstone et al. (1977) observed Buzzards at tropical grassfires or in recently burnt areas. Another example of opportunism concerns a flying Buzzard that rolled and snatched a mobbing Australian Magpie *Gymnorhina tibicen* (Hardy 1985).

McGilp (1934) described co-operative hunting, apparently by a pair of Buzzards, to capture a juvenile kangaroo: the birds made repeated strikes with their feet before grappling with the prey. There are other reports of pairs of Buzzards sharing a kill (e.g. Bennett in North 1912; Barrett 1989), and in at least one such case (Australian Bustard: Maher 1988) it seems likely that the pair co-operated in the capture of large prey.

Attacks on mobile or agile prey are swift: 'rapid, swooping dives' at a young kangaroo (McGilp 1934); a 'swoop' at a duck on the ground (Berney 1905); 'hurtling'

through trees to snatch a bird on a branch (Hollands 1984); a low, fast tail chase after a Varied Lorikeet (Hayward 1988); and a 'swoop' at a bird perched in a tree (Baker-Gabb 1990).

Despite statements by Aboriginal informants and considerable circumstantial evidence that the Black-breasted Buzzard uses stones to break eggs (e.g. Bennett 1881, Berney 1905, North 1912, Campbell & Barnard 1917, Moriarty 1972, Slaverty & Whittell 1976), the notion was scorned by Davies (in Boswall 1983 and Berneys et al. 1984) on the basis that a captive Buzzard could break Emu *Dromaius novaehollandiae* eggs with its bill. Marchant & Higgins (1990, citing S.J.J.F. Davies) stated that Buzzards 'possibly take [Emu] eggs... but this has not been witnessed', despite the fact that Buzzards have been seen eating Emu eggs (Berney 1905, Lane in North 1912, Moriarty 1972). Aumann (1990), Pepper-Edwards & Notley (1991b) and Debus (1991b) have independently confirmed that the Black-breasted Buzzard does pick up stones in its bill and hurl them at large eggs much in the manner of the Egyptian Vulture *Neophron percnopterus* (e.g. Thouless et al. 1989).

Courtship and advertisement displays

The Black-breasted Buzzard's displays have been described and reviewed by Baker-Gabb (1990). The significance of whirling with locked claws in this species (Hollands 1984, Baker-Gabb 1990) remains to be determined. It may be performed in aggression only, and not in courtship as in the milvine kites (*Milvus* and *Haliaeetus*) and sea-eagles (*Haliaeetus*). The Buzzard performs the usual accipitrid components of display, including some not performed by the milvine kites (undulating dives: SJSD).

Copulatory behaviour has been described and discussed by Cupper & Cupper (1981), Hollands (1984) and Baker-Gabb (1990). Copulation may occur up to a month or more before laying. A feature of the Buzzard is its relatively long bouts of mounting, some of the time without cloacal contact, and the close bond and lack of aggression between mates (Baker-Gabb 1990). The related Square-tailed Kite behaves similarly (Debus et al. 1992).

Breeding biology

Baker-Gabb (1990) discussed known breeding densities of the Black-breasted Buzzard in South Australia and the Northern Territory, generally c. 6-20 km between nests in linear habitat (watercourses). Cupper (1976) found two nests 3-4 km apart in western New South Wales, and SJSD observed two adult pairs c. 6 km apart on the lower Darling River in western New South Wales in spring 1986. These data, and Bennett's comments (in North 1912), suggest higher densities in the better-watered north and south-east than in the arid inland. The Buzzard's density in favourable areas is considerably lower than that of the Little Eagle (cf. Baker-Gabb 1984b, Debus 1984). Home ranges appear to be large, birds travelling at least 3 km from their nest (e.g. Baker-Gabb 1990).

In arid areas the Buzzard is apparently sedentary where conditions permit (Cupper & Cupper 1981, Hollands 1984). Its breeding density varies according to seasonal conditions, with aborted breeding or non-breeding and eventual desertion of nesting areas in progressively worsening conditions (Beruldsen 1972, Cupper & Cupper 1981, Hollands 1984). The converse of this is a return to higher densities in good seasons (Baker-Gabb 1990), with birds arriving and breeding in immature plumage (Hollands 1984). This raises the question of the fate of birds that leave in poor years, and it appears that adults leave permanently if their home range will no longer support them. It also raises the question of the origin of wandering immatures that find favourable

inland conditions and settle. It seems that inland breeding is episodic, related to rainfall, and that repopulation after exceptionally bad years is initially by immatures, which may come from elsewhere if there is no local recruitment during drought.

The Black-breasted Buzzard's mean nest height is 12 m above ground (6-22 m, $n=25$: Table 2); Cupper & Cupper (1981) stated 6-20 m, usually 6-11 m for the Cooper Creek Basin. Trees used for nesting are the tallest available, with stout limbs (e.g. North 1912, Beruldsen 1969). Nests are often placed in dead or partly dead trees, generally about half-way up the tree (Cupper & Cupper 1981, Hollands 1984, Angus 1992), although the Buzzard is also recorded as building a nest within the foliage canopy, less conspicuous than the nests of the Whistling Kite *Haliastur sphenurus* or Little Eagle (Beruldsen 1969). The Buzzard usually builds its own nest, used in successive years, or a new one is built annually in the same nesting territory (e.g. North 1912, Cupper & Cupper 1981, Hollands 1984); there is one record of Buzzards using an old Wedge-tailed Eagle *Aquila audax* nest (McGill 1923, 1934).

Beruldsen (1980) claimed that the Black-breasted Buzzard's laying season is August to October in the south, May to July in the north, and any time after abundant rain in arid regions. There is no published evidence for such a pattern, and regardless of latitude or rainfall all recorded layings have been in late winter and spring, with a peak in September. There is no discernible geographic pattern in laying date or clutch size: the number of records of eggs in each month is June 1, July 0, August 5, September 34, October 24, November 3 (Olsen & Marples in press). In the Cooper Basin, laying is from early August to late September (Cupper & Cupper 1981). In New South Wales egg-laying extends to October-November, at least some late clutches being replacements for first clutches that had been robbed (North 1912). The clutch size is 1-2 eggs, mode two (C/1 x 13, C/2 x 58; mean 1.8: Olsen & Marples in press), with only one record of three eggs in a clutch (one in 20 clutches: Bennett in North 1912). If the eggs are taken, the birds sometimes lay a replacement clutch in the same or a new nest (North 1912, Hollands 1984); a robbed nest may be permanently deserted (frequently robbed population: Bennett in North 1912). The incubation period is c. 36-40 days (Cupper & Cupper 1981, Hollands 1984).

The modal brood size is one (B/1 x 19, B/2 x 9; mean 1.3: Table 2). This suggests some brood reduction during the nestling period, although one egg in a clutch is occasionally added (Cupper & Cupper 1981). Hollands (1984) stated that no competition occurs between siblings, and he attributed the size disparity in one pair of nestlings to an estimated hatching interval of 10 days, rather than to food stress. However, such a long laying and hatching interval is probably unusual and may have been less than estimated. In one case, Cupper & Cupper (1981) recorded a hatching interval of five days, with the elder chick claiming most of the food and pecking the younger (which survived). Hollands himself recorded a hatching interval of about a week on two occasions. Nevertheless, dominance and food deprivation by the elder could be an explanation for the retarded development of the younger nestling (even allowing for an age difference of a few days) in broods of two. Fledging success in the Cooper Basin 1976-1979 was 0.76 young per pair per year, with higher success in good than in poor years (13 fledged in 17 pair years: data from Cupper & Cupper 1981, Hollands 1984). Reasons for nesting failure included added eggs, and robbery of eggs and a nestling by humans (Cupper & Cupper 1981).

The nestling period is 'at least eight weeks' or c. 60 days (Cupper & Cupper 1981, Hollands 1984), comparable to that of small eagles (e.g. Little Eagle: Debus 1984). Cupper & Cupper (1981) stated, and illustrated, that Buzzard nestlings quickly feather up first on their dorsal surfaces (head, nape and wings): those parts exposed to the



Adult female Black-breasted Buzzard on nest, Sturt National Park, N.S.W., November 1990.

Plate 37

Photo: R.J. Angus

sky in open, unshaded nests. A similar phenomenon has been noted in African eagles that build nests exposed to the sky (e.g. Steyn 1973). An early covering of dorsal feathers would provide some insulation against the hot sun, which can kill chicks in the parents' absence. Little has been recorded on the post-fledging period, but two nestlings fledged in about November were still with their parents in the nest area in April, c. 5 months later (Cupper & Cupper 1981).

Black-breasted Buzzard nests are usually attended closely, throughout the incubation and nestling period, by the parents (Cupper & Cupper 1981, Hollands 1984). However, many adults seem easily alarmed by human presence, even passive disturbance without the nest tree being climbed. They sometimes desert a newly lined nest if it is inspected before laying (Macgillivray in North 1912, Cupper 1976, Beruldsen 1969, 1977). Breeding birds are shy and wary (Bennett in North 1912); incubating or brooding birds often flush and fly about voicing obvious alarm or distress if the nest is approached, and seem anxious to return to downy chicks but reluctant while an observer is present (Cupper & Cupper 1981, Baker-Gabb 1990, A. Ley pers. comm., SJSD; but see Buchanan 1992, Angus 1992). A visit by humans kept the adults off a nest with downy chicks for two hours (Cupper & Cupper 1981). Such exposure to the desert or tropical sun is a potentially significant cause of mortality in chicks in typically unshaded nests, if human activity continually disturbs the adults.

The Buzzard's parental behaviour has been regarded as unusual among raptors, on the basis that in some pairs parental duties were shared almost equally (Cupper & Cupper 1981, Hollands 1984, Baker-Gabb 1990). This is not always the case: at one nest there was a clear division of roles, with the female doing all the feeding, brooding and shading (Angus 1992). There may be some individual variation in the male's contribution to the brooding and feeding of chicks. Some males of the related Square-tailed Kite also take an active role in chick attendance (Debus et al. 1992).

Much has been made of a pair of Black-breasted Buzzards 'kidnapping' and fostering Australian Kestrel *Falco cenchroides* chicks (Cupper 1977-78, Cupper & Cupper 1981, Hollands 1984). The simplest explanation is that some nestling raptors of other species survived the trip to the Buzzard nest, because in some hunting forays the Buzzard failed to get a killing grip on its prey (perhaps owing to worn, blunt claws in an old bird, or the species' general weak-footedness). Presumably, the initial surviving nestling was simply dumped in the Buzzard nest and it then begged, thus eliciting a maternal response from an apparently infertile (or at least eggless) female Buzzard towards it and to subsequent surviving chicks.

Cupper & Cupper (1981) described one case of a possible polyandrous trio in the Black-breasted Buzzard. This trio persisted for over three months in the pre-laying period. Both males copulated with the female, after which the second male soared with the first with no sign of aggression. No further observations on this trio were published. This is a sketchy and inconclusive observation, and cuckoldry is common in raptors (e.g. Olsen 1989). This case may have been no more than persistent cuckoldry. Nevertheless, polyandry cannot be ruled out. Exceptional or aberrant polyandrous trios are recorded occasionally in several other raptor species (Newton 1979). Polyandry is, however, common in two other desert-adapted raptors, the Galapagos Hawk *Buteo galapagoensis* and Harris' Hawk *Parabuteo unicinctus*. It occurs under specific environmental conditions (poor food supply where one male is unable to provision the female sufficiently), and is characterised by peaceful co-existence and intimate behavioural interactions (e.g. perching on the back of another) within the group, and lack of aggression towards conspecifics (Newton 1979). The Black-breasted Buzzard fits most of these conditions, and although intraspecific aggression has been observed (Baker-Gabb 1990), it seems rarer than in many other raptor species.

Discussion

From its size, structure and feeding ecology it appears that in the ancient Australian raptor fauna, the Black-breasted Buzzard performed the role of a buzzard (*Buteo*) in the woodlands, savannas, plains and deserts. Other surviving remnants of the old endemic raptor fauna include a specialised aerial hunter of the tree canopy (Square-tailed Kite) and a bird specialist like a large *Accipiter*/small *Hieraaetus* (Red Goshawk *Erythrotriorchis radiatus*) in the open forests and woodlands of Australia, and a variety of rainforest species in New Guinea (Debus & Czechura 1988, 1989, Olsen & Olsen 1989). The Buzzard seems more of a generalist, opportunist and scavenger than the other Australian endemics. It may be a relatively recent derivative in response to aridity, as it does not have the peripheral distribution of the others.

The Buzzard's similarities to the African Bateleur Eagle include habitat structure, and extend to its partly reptilian diet (cf. Bennett in North 1912, Hollands 1984, Steyn 1982). Its 'coarse' tarsi and toes (Brown & Amadon 1968) may be similarly related to the capture of venomous snakes. The Buzzard's present-day diet raises questions about the mammalian component of its diet in pre-European times: presumably it ate small macropods and native rodents, many of which are now rare or extinct in the arid zone (Strahan 1983). The Buzzard has successfully capitalised on the introduced rabbit, a food supply that would seem assured, but other aspects of its conservation status are of concern.

The Buzzard has already been shown to have retreated from settlement and habitat destruction in the south of its range. The wave of development that has spread across southern Australia now seems poised to spread from south to north (Recher 1990), with possible adverse consequences for a bird that is sensitive to habitat destruction and to human disturbance (even passive) around the nest. The Buzzard's main breeding strongholds are probably now in the tropics, but there are locally important areas in the riverine woodlands of western New South Wales and north-eastern South Australia. These are threatened by egg collectors and, in South Australia, by development proposals that could devastate key areas of the Channel Country (Beruldsen 1972, Cupper & Cupper 1981, Baker-Gabb 1986). Tropical savannas in Queensland, e.g. Mitchell Grass plains, are threatened by overgrazing and are largely unreserved (Woinarski 1991). Given the fragility of the arid zone, and the potential for further desertification through overgrazing, the Buzzard's existence in Central Australia may

be precarious. A combination of severe drought and overgrazing could cause further local extinctions, perhaps unnoticed until too late, given the current focus of forest conservation issues at the expense of the arid zone. For the present, the Buzzard's biology, conservation status and management requirements warrant investigation in Queensland, New South Wales and South Australia at least.

This review has summarised knowledge on the Black-breasted Buzzard and highlighted areas for further attention. Additional work is required on moult and plumage changes of known-age individuals, and to that end a captive immature is being monitored from its first year (SJSJ, R. Webb). Quantitative diet studies in different parts of the Buzzard's range, and quantification of hunting behaviour, are required, as is field investigation of egg-breaking behaviour. Further data are needed on breeding density, home range size and fledging success in different parts of its range. A physiological study of the Buzzard's bulbous cere (large nasal passages for heat exchange/evaporative cooling?) may reveal a role in heat or water regulation, advantageous for a desert bird. Finally, the possibility of co-operative polyandry, including co-operative group hunting to capture large and difficult prey, deserves careful study with individually marked birds. Cupper & Cupper (1981) noted that the characteristics of other polyandrous hawks and their environment, i.e. dense hawk populations in desert areas with unreliable food supplies, apply to the Buzzard in some areas and seasonal conditions.

An unusual aerodynamic shape, stone-throwing, possible polyandry and other behavioural peculiarities, examples of which can be found among various other species in the hawk family, are all combined in the Black-breasted Buzzard. This makes it a unique raptor, and one that would repay detailed study.

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References

- Angus, R.J. (1992), 'Notes on nesting Black-breasted Buzzards and other raptors in Sturt National Park', *Aust. Birds* **26**, 13-16.
- Aumann, T. (1990), 'Use of stones by the Black-breasted Buzzard *Hamirostra melanosternon* to gain access to egg contents for food', *Emu* **90**, 141-144.
- (1991), 'Notes on birds of the upper and middle reaches of Kimberley rivers during the dry season, 1989', *Aust. Bird Watcher* **14**, 51-67.
- Badman, F.J. & Debus, S.J.S. (1987), 'Field identification of the Black-breasted Buzzard and Square-tailed Kite', *Aust. Bird Watcher* **12**, 112-117.
- Baker-Gabb, D. (1980), 'Raptor Prey Record Scheme — an ARA project proposal', *Australasian Raptor Assoc. News* **1**(4), 9-12.
- (1984a), 'Morphometric data and dimorphism indices of some Australian raptors', *Corella* **8**, 61-63.
- (1984b), 'The breeding ecology of twelve species of diurnal raptor in north-western Victoria', *Aust. Wildl. Res.* **11**, 145-160.
- (1986), 'The Strzelecki Creek: a positive view and a code of practice', *Australasian Raptor Assoc. News* **7**, 1-3.
- (1990), 'Breeding and other behaviour of the Black-breasted Buzzard *Hamirostra melanosternon*', *Aust. Bird Watcher* **13**, 231-235.

- & Fitzherbert, K. (1992), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **13**, 10-11.
- Barnard, C.A. (1925), 'A review of the bird life on Coomoooolaroo Station, Duaringa district, Queensland, during the past fifty years', *Emu* **24**, 252-265.
- Barnard, H.G. (1914), 'Northern Territory birds', *Emu* **14**, 39-57.
- Barnett, L. (1980), A checklist of the birds of Kakadu National Park and the Alligator Rivers region of the Northern Territory, Australian National Parks & Wildlife Service.
- Barrett, B. (1989), 'Raptor notes from northern Australia', *Australasian Raptor Assoc. News* **10**, 34.
- Bennett, K.H. (1881), 'Notes on the habits of the Black-breasted Buzzard, *Gypoictinia melanosternon*, Gould', *Proc. Linn. Soc. New South Wales* **6**, 146-148.
- Berney, F.L. (1905), 'Field notes on birds of the Richmond district, north Queensland', *Emu* **5**, 15-20.
- Beruldsen, G.R. (1969), 'Birds of Marrapinna Station, New South Wales', *Aust. Bird Watcher* **3**, 201-208.
- (1972), 'Return to Marrapinna', *Aust. Bird Watcher* **4**, 144-147.
- (1977), 'A comment on nest desertion by Black-breasted Buzzards', *Aust. Bird Watcher* **7**, 61.
- (1980), *A Field Guide to Nests and Eggs of Australian Birds*, Rigby, Adelaide.
- Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984), *The Atlas of Australian Birds*, Melbourne University Press, Melbourne.
- Boswall, J. (1983), 'Tool-using and related behaviour in birds: more notes', *Avicult. Mag.* **89**, 94-108.
- Brooker, M. (1982), 'Raptors in Nocoleche Nature Reserve, Wanaaring, N.S.W.', *Australasian Raptor Assoc. News* **3**(2), 10.
- & Wombey, J. (1980), 'A Black-breasted Buzzard at the Macquarie Marshes, New South Wales', *Aust. Birds* **15**, 4.
- Brown, L. & Amadon, D. (1968), *Eagles, Hawks and Falcons of the World*, Country Life, London.
- Buchanan, B. (1992), 'Raptors and spiders', *West. Aust. Bird Notes* **61**, 5.
- Cade, T.J. (1982), *The Falcons of the World*, Collins, London.
- Campbell, A.J. (1900), *Nests and Eggs of Australian Birds*, Wren, Melbourne (facsimile 1974).
- & Barnard, H.G. (1917), 'Birds of the Rockingham Bay district, north Queensland', *Emu* **17**, 2-38.
- Condon, H.T. & Amadon, D. (1954), 'Taxonomic notes on Australian hawks', *Rec. S. Aust. Mus.* **11**, 189-246.
- Cooper, R.M. (1989), 'N.S.W. bird report for 1985', *Aust. Birds* **22**, 1-52.
- Cox, J.B. & Pedler, L.P. (1977), 'Birds recorded during three visits to the far north-east of South Australia', *S. Aust. Ornithol.* **27**, 231-250.
- Cupper, J. (1977-1978), 'Black-breasted Buzzards rearing and preying on Kestrels simultaneously', *Aust. Bird Watcher* **7**, 69-73; 157.
- & Cupper, L. (1981), *Hawks in Focus*, Jaclyn, Mildura.
- Cupper, L. (1976), 'Black-breasted Buzzards on Marrapinna Station, N.S.W.', *Aust. Bird Watcher* **6**, 150-151.
- Debus, S.J.S. (1984), 'Biology of the Little Eagle on the Northern Tablelands of New South Wales', *Emu* **84**, 87-92.
- (1991a), 'Black-breasted Buzzard and Square-tailed Kite sunbathing', *Australasian Raptor Assoc. News* **12**, 27.
- (1991b), 'Further observations on the Black-breasted Buzzard *Hamirostra melanosternon* using stones to break eggs', *Aust. Bird Watcher* **14**, 138-145.
- & Czechura, G.V. (1988), 'The Red Goshawk *Erythrotriorchis radiatus*: a review', *Aust. Bird Watcher* **12**, 175-199.
- & ——— (1989), 'The Square-tailed Kite *Lophoictinia isura*: a review', *Aust. Bird Watcher* **13**, 81-97.
- , Earle, R.D., Millard, G.J. & Parker, C.R. (1992), 'Breeding behaviour of a pair of Square-tailed Kites', *Aust. Birds* **26**, 1-13.
- Dickison, D.J. (1932), 'Black-breasted Buzzards near Melbourne', *Emu* **32**, 112.
- Draffan, R.D.W., Garnett, S.T. & Malone, G.J. (1983), 'Birds of Torres Strait: an annotated list and biogeographical analysis', *Emu* **83**, 207-234.
- Frith, H.J. (1977), *Waterfowl in Australia*, Reed, Sydney.
- Garnett, S. (1985), 'Black-breasted Buzzard robbing Little Tern nests', *Aust. Bird Watcher* **11**, 64-65.
- Gearing, G. (1986), 'Aerial display of the Black-breasted Buzzard *Hamirostra melanosternon*', *Aust. Bird Watcher* **11**, 239-240.
- Hardy, J. (1985), 'An unexpected meal for a Black-breasted Buzzard', *Australasian Raptor Assoc. News* **6**, 15.
- Hayward, R. (1988), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **9**, 71.
- Hobbs, J. (1984), 'Raptor road count', *Australasian Raptor Assoc. News* **5**(1), 9.
- Hollands, D. (1984), *Eagles, Hawks and Falcons of Australia*, Nelson, Melbourne.
- Hooper, G. & Wells, B. (1988), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **9**, 11-12.
- Jakes, K. & Jakes, K. (1988), 'Interesting and unusual sightings', *Qld Ornithol. Soc. Newsl.* **19**(1), 9.
- Johnstone, R.E. (1983), 'Wildlife of the Dampier Peninsula, south-west Kimberley, Western Australia. Part V. Birds', *Wildl. Res. Bull. West. Aust.* **11**, 54-69.

- , Dell, J., Smith, L.A. & Fuller, P.J. (1977), 'Birds of the Drysdale River National Park, North Kimberley, Western Australia', *Wildl. Res. Bull. West. Aust.* **6**, 87-96.
- Kingston, D. (1988), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **9**, 11-12.
- Macgillivray, W.D.K. (1912), 'Near Broken Hill (N.S.W.)', *Emu* **11**, 213.
- (1914), 'Notes on some north Queensland birds', *Emu* **13**, 132-186.
- (1929), 'Through a drought-stricken land', *Emu* **29**, 113-129.
- McGill, J.N. (1923), 'Birds of Lake Frome district, South Australia', *Emu* **22**, 237-243.
- (1934), 'The hawks of South Australia', *S. Aust. Ornithol.* **12**, 261-293.
- McLaren, N. (1992), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **13**, 10-11.
- Maher, P. (1988), 'Observations on Black-breasted Buzzards', *Australasian Raptor Assoc. News* **9**, 72.
- Marchant, S. & Higgins, P.J. (Eds) (1990), *Handbook of Australian, New Zealand and Antarctic Birds*, vol. 1, Oxford University Press, Melbourne.
- Mathews, G.M. (1910), 'Birds of north-west Australia', *Emu* **10**, 103-110.
- (1916), *The Birds of Australia*, vol. 5, Witherby London.
- Moriarty, T.K. (1972), 'Birds of Wanjarri, W.A. (27°25'S, 120°40'E)', *Emu* **72**, 1-7.
- Morris, F.T. (1973), *Birds of Prey of Australia*, Lansdowne, Melbourne.
- Newton, I. (1979), *Population Ecology of Raptors*, Poyser, Birkhamsted.
- North, A.J. (1912), *Nests and Eggs of Birds Found Breeding in Australia and Tasmania*, vol. 3, Australian Museum, Sydney.
- Olsen, P. (1989), 'Cuckoldry: how important is it to raptor ecology?', *Australasian Raptor Assoc. News* **10**, 67-68.
- & Marples, T.G. (in press), 'Geographic variation in egg size, clutch size and date of laying of Australian raptors (Falconiformes and Strigiformes)', *Emu*.
- & Olsen, J. (1989), 'Aussie raptors are Aussie raptors: a call for a regional raptor identity!', *Australasian Raptor Assoc. News* **10**, 21.
- Pepper-Edwards, D.L. & Notley, E. (1991a), 'Plumage changes of a captive Black-breasted Buzzard *Hamirostra melanosternon*', *Corella* **15**, 77-78.
- & —— (1991b), 'Observations of a captive Black-breasted Buzzard *Hamirostra melanosternon* using stones to break eggs', *Aust. Bird Watcher* **14**, 103-106.
- Ramsay, E.P. (1867), 'Note on the nidification of *Baza subcristata*', *Proc. Zool. Soc. London* **1867**, 392-394.
- Recher, H.F. (1990), 'Wildlife conservation in Australia: state of the nation', *Aust. Zoologist* **26**, 5-11.
- Reid, J. & Gordon, M. (1988), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **9**, 11-12.
- Salter, B. (1979), 'Notes from a short trip', *Bird Observer* **576**, 80-81.
- Schodde, R. (1973), 'Birds', in *Alligator Rivers Region Fact-finding Study*, 17-95, CSIRO Div. Wildl. Res.
- (1976), 'Black-breasted Kite', in *Reader's Digest Complete Book of Australian Birds*, Reader's Digest Services, Sydney.
- Serventy, D.L. & Whittell, H.M. (1976), *Birds of Western Australia*, 5th edn, University of Western Australia Press, Perth.
- Slater, P. (1970), *A Field Guide to Australian Birds, Volume 1, Non-passerines*, Rigby, Adelaide.
- , Slater, P. & Slater, R. (1986), *The Slater Field Guide to Australian Birds*, Rigby, Sydney.
- Start, J. & Start, H. (1992), 'From the BOPWatchers', *Australasian Raptor Assoc. News* **13**, 10-11.
- Steyn, P. (1973), *Eagle Days*, Sable, Sloane Park.
- (1982), *Birds of Prey of Southern Africa*, David Phillip, Cape Town.
- Storr, G.M. (1977), 'Birds of the Northern Territory', *Spec. Publ. West. Aust. Mus.* **7**.
- (1980), 'Birds of the Kimberley Division, Western Australia', *Spec. Publ. West. Aust. Mus.* **11**.
- (1984a), 'Birds of the Pilbara region, Western Australia', *Rec. West. Aust. Mus. Suppl.* **16**.
- (1984b), 'Revised list of Queensland birds', *Rec. West. Aust. Mus. Suppl.* **19**.
- (1985), 'Birds of the Gascoyne region, Western Australia', *Rec. West. Aust. Mus. Suppl.* **21**.
- , Johnstone, R.E., Dell, J. & Smith, L.A. (1975), 'Birds of the Prince Regent River Reserve, north-west Kimberley, Western Australia', *Wildl. Res. Bull. West. Aust.* **3**, 75-83.
- Strahan, R. (Ed.) (1983), *The Australian Museum Complete Book of Australian Mammals*, Angus & Robertson, Sydney.
- Thompson, H.A.F. (1977), 'Notes on birds in the Darwin and northern areas of the Northern Territory', *Sunbird* **8**, 83-91.
- Thouless, C.R., Fanshawe, J.H. & Bertram, B.C.R. (1989), 'Egyptian Vulture *Neophron percnopterus* and Ostrich *Struthio camelus* eggs: the origin of stone-throwing behaviour', *Ibis* **131**, 9-15.
- Wheeler, R. (1968), 'Bird notes 1967-1968', *Bird Observer* **442**, 7-8.
- Wilson, M. (1974), 'Birds of the Simpson Desert', *Emu* **74**, 169-176.
- Woinarski, J. (1991), 'Major threats to the avifauna of Australian tropical savannas: perspectives for Queensland', *Old Ornithol. Soc. Newsl.* **22**(8), 6-7 [abstract of paper, QOS conference, Brisbane, July 1991].