

moulting wing and rectrices before migration, most undergo complete moult in winter quarters (Ginn & Melville 1983). We can find no information on the moult of the Pallid Cuckoo, but the extensive moulting of this chick suggests that it was well past fledging. It is possible that it was already partly independent and was being opportunist in accepting food from other species.

4. Why did the Robins feed the Cuckoo? It is not unusual for birds other than the foster parents to feed young Cuckoos. They presumably respond to the begging behaviour of the young bird in the same way as they do to the stimulus provided by their own young. The size of the chick and its large gape may have provided a stronger stimulus than that provided by their own chick. Unfortunately we do not know whether they fledged their remaining chick. It seems unlikely that it could have left the nest by 13 November.
5. The remaining questions relate to the behaviour of the Cuckoo chick at the Robins' nest. The response of the chick to being fed by the Robins was not unusual. The fact that the female Robin was still feeding it on November 13th suggests that it stayed in the area and was continuing to obtain food for several days at least. What is unusual is the behaviour of the Cuckoo chick toward the Robin chick. We saw the Cuckoo pick up the remaining chick. It seems likely that the death of the other Robin chick occurred as the result of being displaced by the Cuckoo, which was perhaps testing it as a possible food item. It could have killed the second chick in the same way; indeed it is not beyond the bounds of possibility that it ate the chick.

While it is well known that young Cuckoos eliminate

competition by heaving out the other contents of their foster parents' nest, we can find no record of a fledged Cuckoo chick behaving in this way toward chicks of another species. There are several records of adult Cuckoos removing eggs and chicks from the nests of other species; these are summarised by Marchant (1972). Wyllie (1981) refers to host-nest predation by seven Cuckoo species, usually resulting in the eggs being eaten, though he has seen an adult European Cuckoo eating nestlings of Reed Warbler *Acrocephalus scirpaceus*. He suggests that it is most likely that either the eggs provide a useful source of nutrients, or that nest destruction results in re-nesting and hence the provision of new nests for egg laying. Such behaviour could be normally latent in the young but occasionally expressed.

We can see no likelihood that even if the Pallid Cuckoo fledgling did remove the Red-capped Robin chicks this is other than a rare and accidental occurrence.

These observations were made while we were resident at the Middleback Field Station of the University of Adelaide, at which S.R.J. Woodell was a Distinguished Visiting Scholar. We wish to thank Andrew and Don Nicolson, of Middleback and Roopena Stations, for free access to their land. Special thanks are due to Mr S. Marchant, whose penetrating comments on an earlier draft have given us much food for thought, and greatly improved this paper.

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16 July 1984

BREEDING SEASONS AND DOUBLE BROODING OF THE LITTLE PENGUIN *EUDYPTULA MINOR* IN NEW ZEALAND

There are six recognised subspecies of the Little or Blue Penguin *Eudyptula minor*, five confined to New Zealand (Kinsky 1970, 1980) and one to Australia. The distribution and subspecific status of *E. minor* have been reviewed by Kinsky & Falla (1976). The Australian subspecies *E. m. novaehollandiae* has been the subject of the most extensive research and the breeding biology

of this subspecies has been reviewed by Reilly & Cullen (1981).

In comparison, the five New Zealand subspecies have been studied in much less detail. The ecology of the Northern Blue Penguin *E. m. iredalei* has been studied by Jones (1978) in Auckland and Kinsky (1960) has

described the annual cycle of the Cook Strait Blue Penguin *E. m. variabilis* in the Wellington area. The breeding habits and general characteristics of the White-flippered Blue Penguin *E. m. albosignata* have been recorded by O'Brien (1940) and published information on the Chatham Island Blue Penguin *E. m. chathamensis* is essentially restricted to external measurements of adult specimens (Kinsky & Falla 1976). The Southern Blue Penguin *E. m. minor* was observed in Otago by Richdale (1940) who presented a narrative, but valuable description of the breeding of a small number of birds.

In the present study *E. m. minor* were banded in a small colony at Taiaroa Head (45° 46' S, 170° 44' E), on the east side of the entrance to Otago Harbour, south-eastern New Zealand. This colony was visited and all burrows checked at one to three day intervals during the 1982/83 breeding season and at least once a week during the following winter and during the 1983/84 breeding season. This investigation provided data on the annual cycle of the subspecies to compare with the breeding biologies of the other subspecies. This account reports on the variation in breeding seasons and the incidence of double brooding in Little Penguins in New Zealand.

RESULTS AND DISCUSSION

During the 1982/83 breeding season at Taiaroa Head twelve nest sites were used as breeding sites by *E. m. minor* and a total of nineteen clutches were laid. Five nests received only one clutch and all were successful to the fledging stage. Second clutches were laid in each of the other seven nest sites during the season, in four where the first clutch or brood had been lost and in three after at least one fledgling from the first clutch had fledged.

The chance of a nest receiving a second clutch after at least one nestling was successfully fledged from the first clutch decreased through the season and was highest when the first clutch was initiated early in the season. The mean initiation date of clutches in nests which received only one clutch was 11 September 1982 (range 22 August 1982 to 24 October 1982) but the mean initiation date of successful first clutches in nests which received two clutches was three weeks earlier (mean date: 21 August 1982, range 16 August 1982 to 24 August 1982). The mean interval between the failure of the first clutch in a nest and the initiation of the second clutch was 28 days (range 9–52 days; $N = 4$). When a clutch was successful the mean interval between the departure of the fledglings until the initiation of the next clutch in the nest was 11 days (range 1–19 days; $N = 3$) and the mean interval from the laying of the first clutch until the laying of the second was 98 days (range 84–108 days; $N = 3$).

The adult Penguins at Taiaroa Head were not banded early enough in the 1982/83 breeding season to determine if the same pair of adults was responsible for the two clutches being laid in each of the seven nests. This left the question whether double brooding was occurring or, alternatively, nest sites were being used by two pairs during the breeding season. In 1982 there was no apparent lack of available nest sites as there were five burrows in the colony which were not used for breeding.

In the 1983/84 breeding season at Taiaroa Head all adults were banded and all pairs which had initiated a first clutch before 3 September 1983 had laid a second clutch by 5 November 1983. Eight first clutches were initiated between 1 July 1983 and 3 September 1983, of which three were successful to the fledging stage. All five unsuccessful pairs failed at the egg stage and had relaid by the end of September. The three successful pairs had all laid a second clutch by 5 November 1983 with a mean maximum interval of 16 days ($SD = 2.9$) between departure of first clutch fledglings and initiation of the second clutch. These occurrences of double brooding were considered sufficient evidence to substantiate that double brooding also occurred in the 1982/83 breeding season. Double brooding has been reported for the Australian subspecies of *E. minor* (Reilly & Balmford 1975; Reilly & Cullen 1981). The occurrence of a second clutch being laid by a pair after successfully rearing at least one fledgling from the first clutch, as recorded in this study, constitutes the first record of double brooding in any of the five New Zealand subspecies of *E. minor*.

Comparisons of the timing of egg-laying in *E. minor* illustrate the characteristic extended breeding season and the spatial and temporal variations in the breeding cycle (Table I). The Australian subspecies exhibits both the minimum (Tasmania) and maximum (Victoria) durations of breeding season recorded for the species. Unfavourable conditions in Tasmania are considered by Reilly & Cullen (1981) to account not only for the difference in duration of breeding season but also for the occurrence of double brooding in Victoria but not in Tasmania. The three New Zealand subspecies which have been investigated exhibit prolonged breeding seasons which are intermediate between those of the one Australian subspecies. In all New Zealand locations the protracted breeding season affords sufficient time for the occurrence of double brooding. At both Auckland and Wellington second clutches were occasionally laid by birds that had lost their first clutches but no pairs that had successfully raised broods re-nested (Jones 1978; Kinsky 1960). At Christchurch second clutches were never observed, even after the first clutch failed (O'Brien 1940). The occurrence of double brooding in Otago in the 1983/84 breeding season not only contrasted with the other New Zealand records but was also

TABLE I

Initiation dates and durations of egg laying seasons of *Eudyptula minor* by latitude

Location subspecies (Reference)	Latitude	Year	Initiation of egg laying	Duration of laying season (weeks)
Auckland, N.Z. <i>E.m. iredalei</i> (Jones 1978)	36°S	1976	15-21 Aug.	16
Victoria, Aust. <i>E.m. novaehollandiae</i> (Reilly & Cullen 1981)	39°S	1969	30 Aug.	17
		1970	12 July	13
		1971	10 July	13
		1972	20 May	28
		1973	29 Sept.	13
		1974	29 June	21
		1975	19 July	21
		1976	26 July	20
		1977	3 Aug.	22
		1978	27 May	26
(Montague 1982)		1979#	Aug.	20
		1980#	Aug.	16
Wellington, N.Z. <i>E.m. variabilis</i> (Kinsky 1960)	41°S	1956	15-20 Aug.	14
		1957	1-4 Aug.	14
Tasmania, Aust. <i>E.m. novaehollandiae</i> (Hodgson 1975)	43°S	1960	1-8 Oct.	11
		1961	1-8 Oct.	8
		1962	16-23 Sept.	10
Otago, N.Z. <i>E.m. minor</i> (This study)	46°S	1982	16 Aug.	17
		1983	1 July	26

Source reference presents only the month in which the first clutch was laid

more frequent in this study than in Victoria (38% and 16% respectively). In both Otago and Victoria the likelihood of a successful nest receiving a second clutch decreased through the season.

From this comparison it is clear that within *E. minor*, the timing of the breeding season and extent of parental commitment varies between localities and this variation does not appear to be related to latitude. Reilly & Cullen (1981) considered that lower sea temperatures around Tasmania were the most likely reason for the shorter breeding season and the later date of initiation of breeding in Tasmania relative to Victoria. The results of this study cast doubt on their conclusion as sea temperatures around the southern coastline of New Zealand are considerably lower than those around Tasmania (Stonehouse 1967).

The foraging regime of penguin species has profound effects on breeding biology (Williams 1980). While *E. minor* is the only penguin that exhibits double brooding, its daily foraging range, of approximately 30 km (Montague 1982), is similar to that of the other genera

of inshore foraging penguins: *Megadyptes*, *Pygoscelis* and *Spheniscus* (Williams 1980). In the Galapagos Penguin *S. mendiculus* a single fledgling is usually raised from the two-egg clutch but two fledglings may be raised in years when changes in the Humboldt current result in greater food availability (Boersma 1976, 1978). Changes in oceanographic conditions which effect food availability have also been shown to have an important affect upon the breeding success of Gentoo Penguins, *P. papua* (Williams 1980). Local weather patterns and variations in ocean currents with concomitant effects on food availability, may also account at least in part, for the temporal and spatial variations in eudyptulid breeding seasons which transcend differences in latitude and sea temperatures.

ACKNOWLEDGEMENTS

My thanks to Dr Chris Lalas (Portobello Marine Laboratory, University of Otago) and Ms Priscilla Ralph (Taiaroa Head) for valuable discussion and participation in the field.

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13 August 1984

DO NEW HOLLAND HONEYEATERS *PHYLIDONYRIS NOVAEHOLLANDIAE* BREED REGULARLY IN SPRING AND AUTUMN?

In general, birds breed when food resources are sufficient for young to be raised successfully (Lack 1950). In temperate regions, most species start laying in spring and have young in late spring and early summer, the period when food is assumed to be most abundant. In the Northern Hemisphere there are some species that may have an additional laying period in autumn, separated from spring breeding by moult and gonadal regression. This second breeding season is usually attributed to the renewed sexual activity that follows the refractory period (Immelmann 1971). In unusually mild years some species succeed in raising young (e.g. European Starling *Sturnus vulgaris*, Immelmann 1971).

In temperate Australia, members of one family of birds appear to breed regularly in autumn and in spring. Australian honeyeaters (Meliphagidae), particularly the nectarivorous genus *Phylidonyris*, are described as breeding at any time of the year with peaks of breeding activity in spring (July–October) and autumn (February–May; Bell 1966; Recher 1971, 1977; Ford 1980). These conclusions are based largely on observations which have been collected over large areas and over many years (e.g. Recher 1977; Ford 1980). Such broad surveys may be misleading and not represent the periods of breeding activity that occur within a single area or population of birds. Such analyses may also obscure the frequency with which honeyeaters breed in autumn. Ford (1980) notes that the incidence of autumn breeding seems frequent in some years and rare in others. Rooke (1979), in a three-year study near Helena Valley, WA, found that pairs of New Holland Honeyeaters *Phylidonyris noveahollandiae* produced up to four clutches of eggs each spring, but only once did a pair produce eggs in autumn.

In this paper I document breeding by New Holland Honeyeaters in two areas in Victoria during a three year period. In one area the birds bred only in spring, while in the other they bred in autumn and spring of each year. The two areas were the Royal Botanic Gardens

Annexe at Cranbourne, 40 km SE of Melbourne and Golton Vale, 265 km NW of Melbourne. Cranbourne consisted of coastal heath with emergent eucalypts, while Golton Vale was a sclerophyll woodland with a heathy understorey. Further information on the vegetation of these areas can be found in Gullan (1978) and Paton (1985a). I visited Cranbourne about six days a month between September 1975 and June 1978, and Golton Vale for six days every 6–8 weeks, between August 1976 and October 1978. During these trips I noted any breeding by New Holland Honeyeaters and made detailed observations, including time-budgets, of colour-banded individuals. In addition I mist-netted and weighed birds at intervals of 3–4 (Cranbourne) and 6–8 (Golton Vale) weeks and scored their moult and breeding condition (e.g. brood patches for females). In both areas there was a year-long cycle of flowering plants and carbohydrate food sources, and many individual New Holland Honeyeaters were permanent residents, switching from one resource to the next as each came into bloom (Paton 1980, 1982a, 1985a).

At Cranbourne and Golton Vale, New Holland Honeyeaters bred as monogamous pairs, with individuals usually breeding with the same mate in consecutive years, unless their mate disappeared (Table I). Occasionally females changed mates and bred with another bird, even though the previous male still resided in the original area. Male New Holland Honeyeaters defended the nectar sources used by the pair, while the female built the nest, incubated the eggs and brooded the young. Females developed extensive brood patches just prior to, and during, incubation. Brood patches subsided after incubation, but the abdomen remained bare of feathers long after breeding, and was often scratched. Both sexes fed nestlings and fledgelings, and fledgelings reached independence when about 40 days old, or about four weeks after leaving the nest. At this age fledgelings were no longer fed by their parents, but were still often present near the breeding area. Pair-bonds were not maintained outside the breeding