

BREEDING TERRITORIES, NESTING AND THE TIMING OF BREEDING OF THE DOUBLE-BANDED PLOVER *Charadrius bicinctus*

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The breeding of Double-banded Plovers *Charadrius bicinctus* was examined at the Cass River Delta and Kaitorete Spit in Canterbury, New Zealand. Breeding territories were mapped and the mean distance between nests was similar at both localities. Of the nests found, 80 per cent were on vegetated shingle. Laying began in mid-August and reached a peak in early October. The nest site, nest materials, and size and colouration of the eggs are described. The median clutch size was three and the average clutch size was 2.81. The adaptive significance of some of these aspects of the breeding is discussed, and compared with *Charadrius* species that breed in Australia.

INTRODUCTION

The Double-banded Plover, an abundant charadriiform bird in the high-country of New Zealand, is of particular interest because some of its population migrates across the Tasman Sea to Australia. Although the breeding ecology and behaviour of the Double-banded Plover have been studied (Phillips 1980; Bomford 1986, 1988; Pierce 1989), some aspects of its breeding biology are still not well known. This paper provides additional information on breeding territories, nests, eggs and the timing of breeding.

STUDY AREAS AND METHODS

The breeding of plovers was examined from late September to early December 1978 in two study areas in the South Island of New Zealand: Kaitorete Spit (43°50'S, 172°30'E) and the delta of the Cass River at Lake Tekapo (43°53'S, 170°30'E). Kaitorete Spit is 30 km south of Christchurch (Fig. 1). It forms a barrier of about 32 km long and 2 km wide between Lake Ellesmere and the Pacific Ocean. For much of its length it is dominated by a shingle ridge 8 m high. The shingle is made up of rounded stones of greywacke, mostly 40-70 mm in diameter. Most

of the Spit consists of grassland, chiefly *Poa*, *Stipa*, *Agrostis* and *Juncus* species interspersed with large patches of bracken *Pteridium*, and is grazed by sheep. The mean annual rainfall is 650 mm and the mean annual temperature is 11°C. The winters are cool with frequent frosts (Tunnicliffe 1973).

The Cass River forms a delta where it flows into Lake Tekapo, about 700 m above sea level. The Cass River is typical of the shingle rivers of the South Island, being wide and braided. Because of braiding, the riparian vegetation is a mosaic of patches of different age, due to regeneration after scouring or past changes in the course of the river. These patches range from bare shingle banks to tussock grassland (Fig. 4). The lower reaches of the Cass River include extensive terraces of vegetated shingle surrounded by undulating tussock grassland. These are dominated by native and introduced plants, including *Discaria*, *Poa* and *Raoulia*. Much of the area is grazed by sheep. The mean annual rainfall is 606 mm, and the mean annual temperature is 9.1°C (Anon. 1972). Frosts and snowfalls are frequent in the winter and may extend into spring. Pierce (1983) gave a full account of the area.

Breeding territories were mapped at Kaitorete Spit and the Cass Delta in early October by noting the aggressive displays (Bomford 1986) of adjoining pairs or, for isolated pairs, how far breeding birds moved from the nest in all directions. Most adults at the Cass Delta were individually recognizable as they had been banded by M. Bomford and R. Pierce during behavioural studies. During this study additional adults were caught at the Cass River with drop-traps over nests and colour-banded. Individuals were not banded at Kaitorete Spit. Occasionally, a non-incubating bird was observed to fly a long way from the nest to the shore of the nearby lake (Ellesmere or Tekapo) and feed. These flights were not included in the calculations of territory size. Nests were observed from a car, and most groups of territories were watched all day. The vegetation cover was estimated within a 3 m radius of the nest.

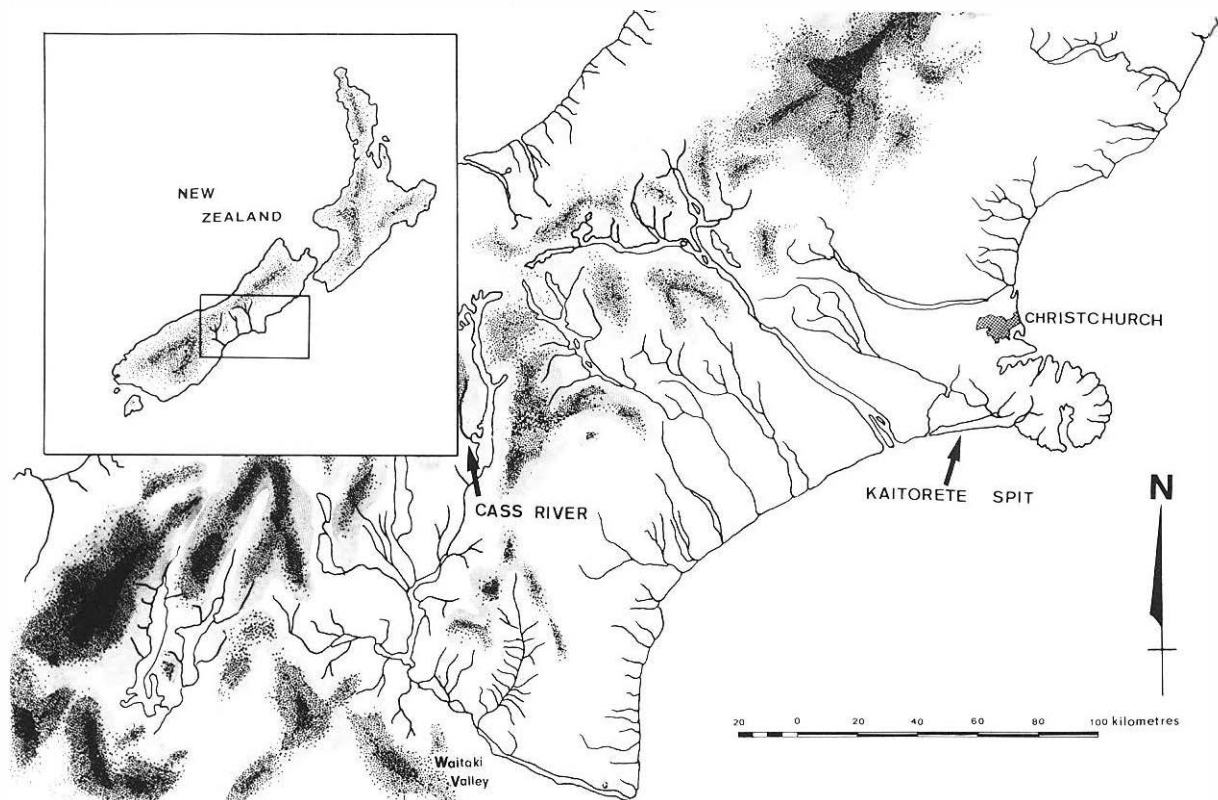
Clutch size was noted only when the number of eggs in a nest did not change for three days after egg-laying was last recorded, but this may have

underestimated clutch size, as final eggs may be laid 5–6 days after the penultimate egg (R. Pierce, pers. comm.). Weights of females were obtained from 17 birds caught on their nests with drop-traps.

RESULTS

Territories

Some territories at Kaitorete Spit were isolated and some were in groups of 2–7 territories (Fig. 2). The mean distance between nests in adjacent territories was 112.5 m (SD±61.7, range 25–250 m, n=20). At the Cass Delta, where territories were similarly arranged, the mean distance was 122.7 m (SD±43.6, range 70–220 m, n=11). The difference between the two study areas was not significant ($t=0.484$; d.f. 29, $p>0.05$). The density of breeding birds was about 101 pairs per 100 ha at Kaitorete Spit and 85 pairs per 100 ha at the Cass Delta.



Nest sites were categorized by substrate (e.g. shingle, sand) and the per cent cover of vegetation (Table 1). Vegetated shingle (cover exceeding 10%) accounted for 80 per cent of the 55 nest sites found, the rest being divided between ocean beaches (7.3%) and bare shingle (12.7%). At Kaitorete Spit, breeding plovers did not use the tussock areas and large tracts of grassland (Fig. 2).

Foraging plovers at the Cass Delta and Kaitorete Spit seemed to feed mainly on surface invertebrates, as did chicks, which also fed on seeds and fruits. Several chicks caught for banding had the seeds and fruits of Creeping Pohuehue *Muehlenbeckia axillaris* in their mouths. Chicks were observed pecking continually around patches of cushion plants *Raoulia* spp., where Creeping Pohuehue often grows. Adults favoured the vegetated shingle and rarely fed on bare shingle or along the edge of streams during this study.

Nest

The nest depression became filled with material during laying and incubation, occasionally until only the tops of the eggs were uncovered. Moss (in 54.6% of 116 nests), pebbles (45.5%) and twigs (32.7%) were the commoner elements. The situations of nests were examined in relation to their immediate background. A preference for positioning the nest on the edge of a discontinuity (e.g. a patch of *Raoulia* bordering on shingle) was apparent in 38 sites (69.1%) or adjacent to a

TABLE 1

The base material and vegetation cover within 3 m of 55 nests of Double-banded Plovers at Kaitorete Spit and the Cass Delta.

Base material	Vegetation cover	Number	Frequency (%)
Shingle	<10% (bare)	7	12.7
	10-30%	8	14.6
	31-60%	10	18.2
	61-90%	13	23.6
	>91% (pasture)	13	23.6
Beach sand	<10% (bare)	4	7.3

conspicuous object (e.g. stick, bone or rock) in 12 of the remaining 17 sites (21.8%). Nests placed near a conspicuous object were all on an otherwise homogeneous background such as shingle or sand.

Eggs

The eggs were pyriform and variably marked with black or brown spots, streaks and blotches, usually more so at the larger end. Ground colour was similar within a clutch but varied between clutches, and most of the 55 clutches examined were of three base colours: pale greyish blue (36.4%), olive-green (61.8%) and brown (1.8%). There was some association between the base colour of the eggs and nest-site: greyish blue eggs with shingle and olive-green eggs with patches of

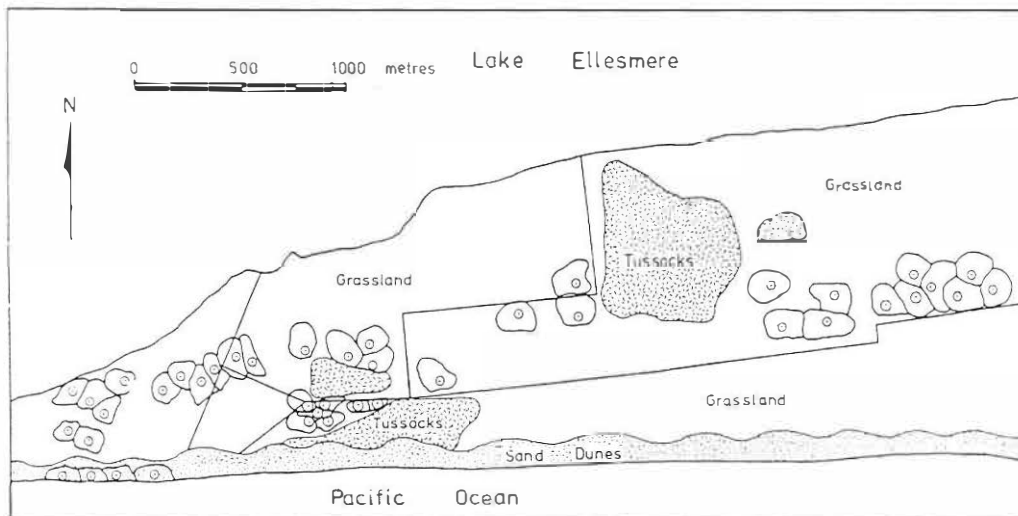


Figure 2. Territories of Double-banded Plovers on Kaitorete Spit. The dot and circle in each territory represent the nest site.

Raoulia. The eggs in six of the seven nests on bare shingle were greyish blue, with the seventh clutch being brown. Of the ten clutches in nests on grassland underlain by shingle, five were greyish blue and five olive-green. Most nests (69.1%) were on the edges of patches of vegetation in shingle beds, and their base colour of greyish blue or olive-green thus matched a background colour. In contrast, the four nests on grey beach sands were olive-green and did not match the background.

Clutch

The median clutch size was three and the average clutch size was 2.81 (range 1–4; $n=16$). The dimensions (mean \pm SD) of 139 eggs were 34.4 ± 1.2 mm \times 24.9 ± 0.6 mm (ranges 31.4–37.4 mm and 22.6–26.4 mm). Average weight (mean \pm SD) of 88 eggs at various stages of incubation was 10.5 ± 0.8 g (range 8–12 g), which would be lower than the average weight of newly laid eggs because of weight loss during incubation. A clutch of three eggs of average weight during incubation (10.5 g each) is about 51 per cent of female body weight (mean 61.6 g, $n=17$).

Time of breeding

Chicks found early in October in 1978 were estimated to be from clutches laid in mid-August. No older chicks, indicative of earlier breeding, were found in either study area. The number of clutches laid each week showed a peak of laying in early October and a decline throughout late October and November (Fig. 3). The last clutch found was laid in late November, at which time the searches for nests were stopped, but later laying probably did occur. Lesser peaks of laying were in late October and early November.

Chicks

As noted for eggs, the downy chicks showed different colour phases. The two common phases had either golden or grey upperparts, usually with traces of black or white, and all had white underparts. Insufficient information was collected to examine whether these colour phases were associated with the greyish blue or olive-green egg colours.

DISCUSSION

Territories

Pierce (1989) also recorded some individuals leaving the breeding territory to feed some distance away during the incubation period. In this study, it was noteworthy that these feeding areas outside the territories were on shores of lakes, areas apparently unsuitable for breeding, although providing food.

The pattern of territories at Kaitorete Spit contained both isolated pairs and groups restricted to grazed grassland other than the tussock areas. This pattern possibly reflected either differences in visibility of potential predators or small-scale changes in the availability of food, although the latter may be moderated by the use of feeding areas outside the territories.

Nest and eggs

The filling of the nest scrape with material during laying has been noted by Bomford (1988) and during laying and incubation by Soper (1976). This habit appears less frequent in other Charadriinae than it is in the Double-banded Plover. Graul (1975) stated that material was added to the nest of the Mountain Plover *C. montanus* as incubation proceeded; and the White-fronted Plover *C. marginatus* covers its eggs on sunny days but not on dull days (Shewell 1951). The

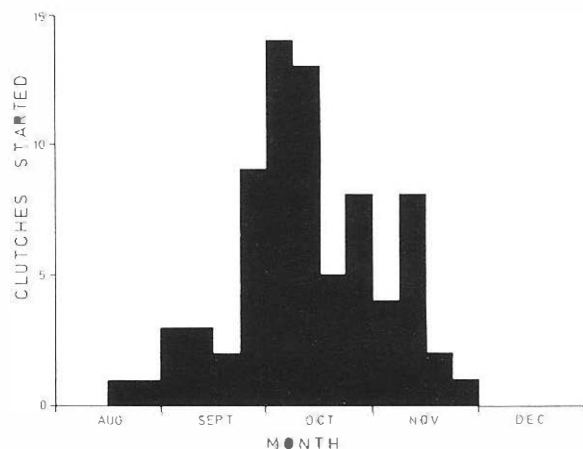


Figure 3. The number of clutches started at Kaitorete Spit and Cass Delta from August to November. The data are grouped in weekly intervals.

packing may serve to enhance nest camouflage by breaking up the outline of the eggs or reducing shadows cast by eggs (Cott 1940). Alternatively or in addition, it may have an insulative function in either hot or cold weather. Double-banded Plovers were observed standing over eggs to provide shade on hot days.

Other aspects of the nest and eggs appear to be responses to significant levels of predation. Bomford (1988) recorded a hatching success of only 44 per cent on the Cass River Delta, and she believed that most of the egg loss was due to predation. The high incidence of nests on discontinuities, such as the edge of a patch of shingle or vegetation (69% of nests), or near conspicuous objects (22% of nests), is likely to make the nest and eggs more cryptic by disrupting their outlines. The correspondence between the two main base colours of the eggs and the colours of shingle and the cushion plants provides additional camouflage by blending with the surroundings. The third base colour (brownish green) matches the colour of Creeping Pohuehue in the Cass Valley (R. Pierce, pers. comm.).

The clutch size (2.81) was not significantly different from the 2.85 reported by Bomford (1988) on the Cass River Delta in 1977. Both this study and Bomford (1988) recorded early clutches in August and peaks of laying in the first half of October.

Chicks

Bomford (1988) noted chicks of three colour phases, including a grey and gold combination not seen during this study. There appear to be no published records indicating whether chick colouration also varies between siblings. The potential association between the three base colours of the eggs and the colouration of the newly hatched chicks warrants further investigation, particularly if the chick colouring matches background colours common in the natal area.

Comparison with *Charadrius* breeding in Australia

Of the three species of *Charadrius* breeding in Australia, the Red-capped Plover *C. ruficapillus* is most similar to the Double-banded Plover in breeding areas (Table 2). The Double-banded Plover is considered a close relative of the Red-capped Plover (Bock 1958), and these traits possibly have a common origin. The three *Charadrius* plovers breeding in Australia show limited overlap in their use of breeding habitats (Table 2) and, in some circumstances, where the Red-capped Plover and Hooded Plover *C. rubricollis* coexist, interspecific aggression is apparent (pers. obs.). Although circumstantial, such evidence is often considered indicative of past or present competition (Orians and Collier 1963) and may suggest limited availability of suitable habitats in Australia for plovers during the breeding season.

TABLE 2

A comparison of some aspects of breeding in the Double-banded Plover with congeneric species breeding in Australia.

	Species			
	Double-banded Plover	Red-capped Plover	Hooded Plover	Black-fronted Plover
Median clutch size (average in brackets)	3 (2.81)	2 ^a	3 (2.73) ^d	3 ^b
Breeding Habitat (in order of importance)	shingle rivers, grazed pastures, beaches	beaches ^d , saltmarshes, freshwater habitats	ocean beaches ^b , salt lakes (West Aust. only)	freshwater habitats ^d
Breeding Dispersion	usually aggregated	solitary ^d or aggregated ^a	usually solitary ^d	usually solitary ^d
Breeding Season Range (peak in brackets)	Sept.–Jan. (Oct.)	Inland: May–Sept. (Aug.) ^c Coastal: Sept.–Feb. (Oct.) ^c	Oct.–Jan. (Oct–Dec) ^d	South: Sept.–Dec. North: Apr.–Sept.
Residency of Breeding areas	migratory in autumn/ winter ^e or some sedentary ^d	sedentary or migratory ^c	sedentary with occasional local movements ^d	sedentary ^b

Sources: a, Hobbs (1972); b, Serventy and Whittell (1976); c, Berulksen (1980); d, Dann (pers. obs.); e, Lane (1987); f, Pierce (pers. comm.).



Figure 4. The breeding habitat of Double-banded Plovers at Lake Tekapo in the South Island of New Zealand. The mosaic of bare and vegetated shingle banks is a feature of braided river systems and provides extensive areas suitable for breeding plovers.

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