OBSERVATIONS OF BREEDING BEHAVIOUR OF SPOTLESS CRAKE *(Porzana tabuensis)* AND MARSH CRAKE *(P. pusilla)* AT PUKEPUKE LAGOON

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ABSTRACT

Spotless Crakes and Marsh Crakes were studied by R. Lavers, April 1971-July 1972, and by G. Kaufmann, September-December 1982, at Pukepuke Lagoon, Manawatu. Eleven Spotless Crake nests were found. Eggs were laid between 30 August and 19 December. Earlier nests usually contained 3 eggs; later nests contained 4-5 eggs, and the eggs were larger. Copulation and major calls are described. One male incubated 40%, the female 60%, of the 35 hours observed. Eggs of 4 nests were eaten by predators. Two Marsh Crake nests were found, containing 4 and 6 eggs. Both nests were unsuccessful. Analysis of museum skins highlighted similarities in bill size and structure, suggesting that interspecific competition occurs.

INTRODUCTION

The breeding behaviour of the Spotless Crake *(Porzana tabuensis)* and Marsh Crake *(P. pusilla)* has remained unknown because of the birds' secretive nature, their dense habitat, and their lack of obvious sexual dimorphism. The presence of two species of *Porzana* so similar in size and shape in the same wetlands in New Zealand is intriguing because it seems to violate the ecological rules of competitive exclusion or character displacement. Aggression between Spotless Crakes and Marsh Crakes, although believed uncommon, has been observed (Howard 1962). Our study sought to record aspects of their little-known biology from a single wetland in which both species occurred.

STUDY AREA AND METHODS

Pukepuke Lagoon is an 86 ha game management reserve of the New Zealand Wildlife Service in the Manawatu. It is a swampland within the coastal sand dune area. The dominant emergent plants are raupo *(Typha orientalis)*, flax *(Phormium tenax)*, tussock sedge *(Carex secta)* and cabbage tree *(Cordyline australis)*. The vegetation, climate, and history of the lagoon have been described by Ogden & Caithness (1982).

The crakes were studied by R. Lavers from 28 April 1971 to 25 July 1972 and by G. Kaufmann from 13 September 1982 to 29 December 1982. Drift traps, described by Lavers (1971), were placed in the swamp before the nesting season in an attempt to mark crakes and monitor their movements. In 1971 up to four traps were placed along wire mesh leads in five sites; in 1982 up to four traps were widely scattered in the swamp and attended for long periods. We measured the exposed culmen, tarsometatarsus, and middle toe plus claw of all crakes captured. Coloured

plastic bands and numbered metal bands were placed on the crakes. Tape recordings of Spotless Crake calls were used to lure birds toward the traps. Nest traps were placed on active nests to capture incubating birds.

In 1971 a tower hide was placed beside a large patch of willows (*Salix* spp.) west of the main lagoon before the nesting season. From this R. Lavers observed two Spotless Crake nests. Hides were also placed near two Spotless Crake nests in 1971 and two Spotless Crake nests and one Marsh Crake nest in 1982. We used tape recordings and whistling imitations of their calls to find where crakes were and to find nests. Nest searching was concentrated in the areas that included tussock sedge. The names used to describe Spotless Crake vocalisations were taken from the descriptions by Hadden (1970 and pers. comm.). Sonograms were made on a Kay Elemetric Sona-graph.

G. Kaufmann measured study skins at the National and Canterbury Museums. Only those taken from the North and South Islands were measured. The length, width, and depth of Marsh Crake bills were compared with Spotless Crake bills. Specimens with reliable sex identification were used to compare the lengths of male and female culmens and metatarsi.

RESULTS

Trapping

Nineteen Spotless Crakes and five Marsh Crakes were captured and banded during the study period. Five Spotless Crakes were recaptured once; one Marsh Crake was recaptured three times.

In autumn 1971, 13 crakes were caught in 65 trap days. Thereafter few were trapped and the capture rate during the breeding season was particularly low, only four Spotless Crakes and Marsh Crake being captured during 233 trap-days between 21 September and 24 December 1982. Tape recordings did not lure birds at this time.

Nest trapping was unsuccessful, Spotless Crakes would not enter nest traps consisting of a trapdoor with three sides of nylon mesh. Several entered a small clap trap placed on one nest but it failed to spring. G. Kaufmann caught one Marsh Crake by hand after it made repeated attempts to attack his hand.

Marsh Crake calls

The repertoire and function of the calls of both species is incompletely known. Both species give a loud call of many short notes. The loud call of the Marsh Crake is a *creak*, reminiscent of a fingernail being drawn against the teeth of a comb. According to Feindt *in* Cramp & Simmons (1980) and Glutz *et al.* (1973), it is the song or territorial call, given only by the male. At Pukepuke it was the only Marsh Crake call heard, usually given in response to tapes of both species.

Spotless Crake calls

The high-pitched trilling *purr* of Spotless Crakes appears to be its song. It consists of a rapid series of notes, about 25 per second, with a slight and rapid initial decrescendo of pitch (Fig. 1A). It was louder than any other call, but occasionally was given softly. Often both members of the pair were

present, as evidenced by duetting of soft calls, but only one member, presumably the male, uttered *purr* and *pit-pit*.

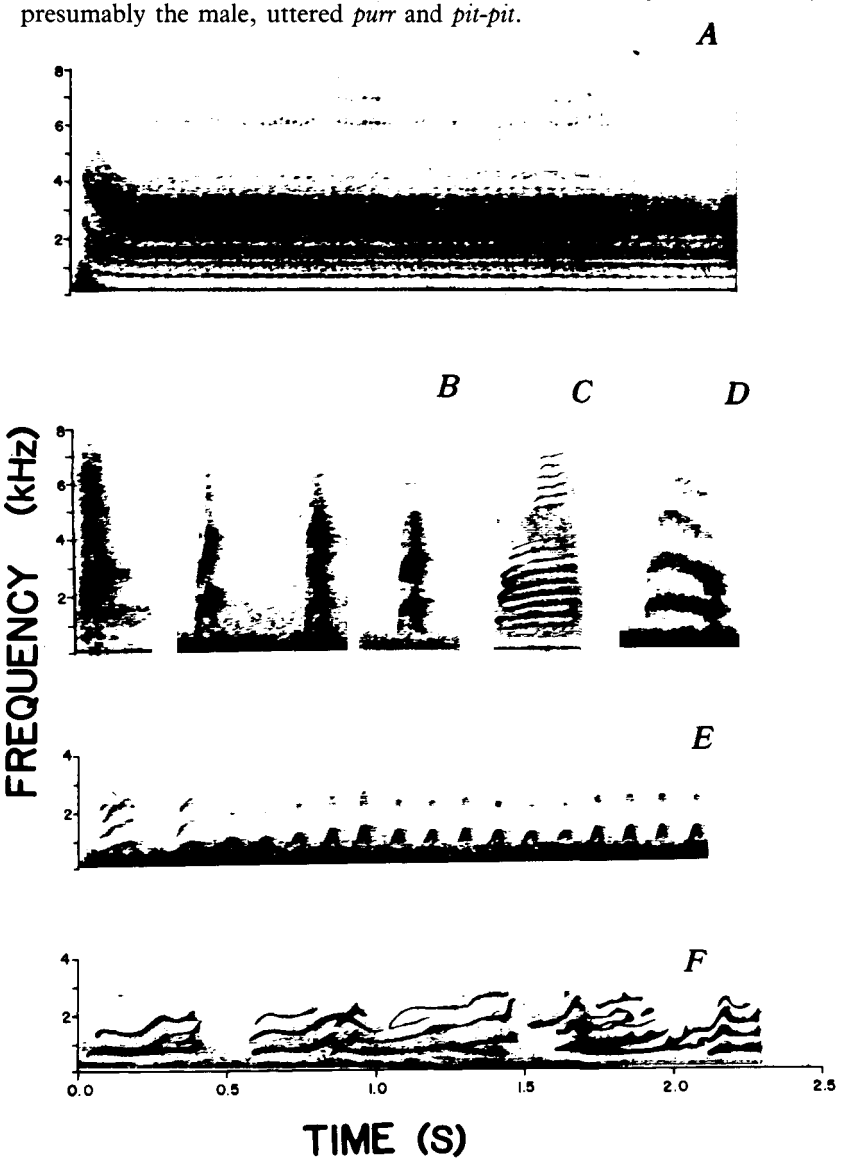


FIGURE 1 — Calls of Spotless Crake: A. high-pitched trilling "purr"; B. variations of loud 'pit'; C. nasal "harring" (slightly retouched); D. a short trilling whistle; E. a "mook" call, and intermediate "mook-bubble" and a series of bubbling; F. two birds duetting a "murmuring" (slightly retouched).

Pit-pit was a loud call lasting only 0.1-0.3 s, covering a wide band of frequencies but typically loudest at 1.75 and 3 kHz (Fig. 1B). It appears to be the 'harsh, scolding crack-crack' described by Falla *et al.* (1981).

On several occasions, both members of the pair approached the tape recorder, and then retreated to the centre of the territory and called *purr*. On other occasions, a crake responding to *pit-pits* on the tapes stopped calling, as if intimidated, when *purrs* were played on the recorder. At times crakes gave *purrs* and *pit-pits* as they approached the recorder, and presumably trespassed a neighbour's territory. These birds gave loud, short calls interrupted by splashing and fighting. Birds near four nests gave the most vociferous and prolonged responses to tapes during the two weeks before incubation began. Loud calls ceased during incubation and birds of adjoining territories came closer to the recorder, presumably "trespassing". No responses were ever given by a fifth pair. The loud *purrs* and *pit-pits* began in mid-July and persisted through to December.

Pit-pits were sometimes interspersed with other short, loud calls. These included *harr* and a short trilling whistle (Fig. 1C and 1D). The trilling whistle was also given in response to a human whistle.

Soft calls, which were low in pitch and amplitude, appeared to function in pair contact. *Bubbling* and *murmuring* were frequently given in duet by two birds near each other, presumably the pair. They seemed to be a milder form of reaction to taped calls, and were commoner after incubation. Occasionally the *mook* graduated into *bubbling*, but *murmuring* appears to be distinct from bubbling (Fig. 1E and 1F).

Sexual behaviour of Spotless Crakes

Few observations of territorial and courtship behaviour have been made because of the dense vegetation. The few observations, such as a chase and calls, are hard to interpret because the sexes are alike.

One pair of Spotless Crakes was seen copulating about 18 metres from their nest. A *purr* and *pit-pit* were heard immediately before the birds came out into the open. The male followed the female around a *Carex* pedestal, which was about at the level of the water. The female circled the pedestal several times and then stood on it, arching her body with her bill pointing downward. After a few seconds the male mounted and, balancing with outstretched wings, slowly lowered himself. Intromission took a few seconds, after which he dismounted and walked into the vegetation. The female stretched her head up and followed the male. This pair was in the middle of egg laying. The clutch was completed two days later and contained five eggs.

Nest site and construction

Eleven Spotless Crake nests, two Marsh Crake nests, and a large number of empty nests were found at Pukepuke in tussock sedge. They were usually in tussocks with well-covered pedestals, with the nest beside the pedestal in tillers two or more years old and on the lee side where wind had laid a thick sheath of tillers over the nest. Several nests of Spotless Crake were on the crown of tussock sedges, on tillers which stretched between two tussocks, or on tillers windblown into raupo. The two Marsh Crake nests were 40 cm

above the water, and most Spotless Crake nests were 40-50 cm (range 7.5 to 70.0 cm) above the water. Some nests slipped down with use, and one nest was barely above the water. The nest bowls of both species were usually made of pieces of sedge cut or broken into 1.5-2.0 cm lengths. Several nests included pieces of adjoining raupo. The bowls of some Spotless Crake nests were so loosely woven that, if they had not contained eggs, they would have been judged incomplete.

Most, but not all, Spotless Crake nests were within a few metres of other apparent nests. The functions of these presumptive nests are not known. They were made before egg laying, as they were present during laying. They were used for brooding chicks, and we recorded a pair using one that another pair had made.

Laying and incubation

Active nests of Spotless Crakes have been found from 23 August to 31 January in New Zealand (Hadden 1970, Fraser 1972). Spotless Crake nests found at Pukepuke were active from 30 August to 4 January (Table 1). The many empty nests found later in the season indicated that more had nested in September-October than is reflected by our findings, which got better as the season progressed.

Less is known of the nesting season of Marsh Crakes. The Marsh Crake nest at Pukepuke found on 4 October had a full clutch being incubated. It was destroyed five days later. The inactive nest found in December had rotten eggs that soon burst by themselves. They contained partly developed embryos. In Southland, one brood has been seen on 6 November and an active nest has been found on 25 November (Barlow & Sutton 1975).

The later clutches of Spotless Crakes were larger than earlier ones, increasing from 3-egg clutches in August and September to 5-egg clutches in December (Table 1). Other workers have had similar findings. Hadden (1970, 1972) found five clutches of 2 and 3 eggs, which hatched in September and October, and a clutch of 5 eggs, which hatched on 5 December. Fraser (1972) found two clutches of 3 eggs, of which one hatched in September and one on 31 January, and a clutch of 4 eggs, which hatched in January.

Eggs laid later in the nesting season were significantly larger than those laid earlier (Table 2). The eggs of nests 9, 10, and 11 were 4-5% larger than those of nests 4, 5, and 7.

The shape of Spotless Crake eggs varied greatly within a clutch (Table 2). The eggs of nest 6 weighed 9.0 g, 9.1 g, and 9.5 g; the eggs of nest 11, weighed on a less precise scale, were 8, 8, 9, 9, 9 g $\pm$0.5. These eggs were each approximately one-fifth of the female's body weight. The Marsh Crake eggs were slightly smaller than the average of Eurasian birds but well within their size range (Cramp & Simmons 1980).

Some Spotless Crake nests hatched slightly asynchronously, and others hatched synchronously. Asynchronous hatching was observed by Hadden (1970, 1972) in two 3-egg clutches and one 5-egg clutch, by Fraser (1972) in a 4-egg clutch, and by us in a 4-egg and a 5-egg clutch. Synchronous hatching was observed by Hadden (1970, 1972) in a 2-egg and a 3-egg clutch and by us in two 3-egg clutches.

The extent of asynchronous hatching was hard to find out because the birds often left an infertile egg in the nest or an abandoned one after disturbance. We assumed that incubation began when the last egg was laid, in synchronous hatchings, and when the second (three cases) or third (two cases) egg of the clutch was laid, in asynchronous hatching.

Incubating birds were difficult to study because they are monomorphic, approach the nest from opposite the hide, and build a canopy over the nest. We had to part the canopy before each observation period. One member of a Spotless Crake pair which nested beneath R. Lavers' hide had been banded and was presumed to be a male because of its size (Table 3). He was observed in the nesting area 8 days before nest building began. This male incubated for 40.4% and the female incubated 59.6% of 35.4 hours of observed daylight time (Fig. 2). The longest uninterrupted spells of incubation were 106 min by the male and 160 min by the female. The actual bouts of incubation were longer for both sexes and characterised by 1-4 breaks. Three long bouts for the male were 116, 145, and 225 min with 1-2 breaks of 5-21 min. Five long bouts for the female were 130, 138, 154.5, 179, and 189 min with 1-4 breaks of 1-26 min.

TABLE 1 — Nesting and incubation period, clutch size, and hatching results of Spotless Crake and Marsh Crake nests at Pukepuke Lagoon

Nest No.	Laying	Hatching	Clutch Size	Hatching Results
Spotless Crake				
1	30/8 to 1/9/71a	22/9	3	3 chicks
2	14 to 16/9/71	6/10	3	2 chicks 1 unhatched egg
3	Before 22/9/82	---	1(+?)	egg predation
4	30/9 to 1/10/82a	22/10	3	3 chicks
5	31/9 to 1/10/82a	23/10	4	4 chicks
6	3 to 5/10/71a	26/10	3	3 chicks
7	17 to 20/10/82a	10/11	4	4 chicks
8	Between 10/10 and 8/12/82	---	4	egg predation
9	6 to 10/12/82	31/12	5	egg predation
10	12 to 16/12/82	4/1	5	5 chicks
11	15 to 19/12/71	---	5	egg predation
Marsh Crake				
12	Before 4/10/82	---	6	egg predation
13	Before 1/12/82	---	4	deserted?

a = estimated from the date of hatching as 1 egg laid per day and 21 days of incubation.

TABLE 2 — Egg sizes of crakes at Pukepuke Lagoon

Nest No.	Egg Sizes	Mean Size	SD
Spotless Crake			
4	28.9 x 23.3	29.4 x 22.8	0.87 x 0.47
	30.4 x 22.4		
	28.9 x 22.6		
5	29.3 x 22.3		
	28.9 x 22.5	28.9 x 22.5	0.39 x 0.17
	29.1 x 22.4		
	28.4 x 22.7		
7	28.0 x 20.2		
	26.8 x 20.6	28.1 x 20.6	1.31 x 0.28
	27.6 x 20.8		
	29.9 x 20.8		
9	29.5 x 23.2		
	28.1 x 22.3	29.2 x 22.7	0.66 x 0.50
	29.5 x 22.0		
	29.3 x 23.0		
	29.8 x 22.8		
10	30.2 x 23.3		
	30.6 x 23.1	30.3 x 23.1	0.63 x 0.15
	31.3 x 23.0		
	29.8 x 23.1		
	29.8 x 22.9		
11	30.9 x 22.3		
	31.1 x 22.5		
	31.3 x 23.3	31.0 x 22.8	0.30 x 0.38
	31.3 x 22.9		
	30.6 x 22.8		
Total R 26.8-31.3 x 20.2-23.3		29.6 x 22.4	1.20 x 0.87
Early nests		28.7 x 21.9a	1.02 x 1.05
Late nests		30.2 x 22.8b	0.92 x .39
Marsh Crake			
12	28.5 x 19.8	28.6 x 20.0	.07 x .21
	28.6 x 20.1		
13	27.7 x 19.4		
	26.9 x 18.9	27.4 x 19.5	.89 x .42
	28.4 x 19.9		
	26.5 x 19.6		
Total 26.5-28.6 x 18.9-20.1		27.8 x 19.6	.89 x .43

a,b There was a significant difference between means of a and b from a t-test.

Information on incubating Marsh Crakes was less conclusive. On the first day of observation the nest was hidden by overhanging tillers and a canopy. After 23 min a crake went to the nest. After 20 more min a bird left, and no more birds were seen in the next 90 min. Either one bird had returned, incubating for 20 min and left, or a bird already incubating was joined by its mate in the tussock after 23 min and the incubating bird left after 20 min. The next day G. Kaufmann captured and banded one bird, presumably the female because of her size and defensive behaviour. The tillers overhanging the nest were cut and the canopy parted; however, the birds were still hard to see because they had added to the rim of the nest. Two hours later, when observations were resumed, the female was on the

nest, and crouched low in the nest. The male came to the nest 63 min later and both remained in the tussock. The female continued to incubate while the male alternated between breaking off pieces of sedge and presenting them to the female and resting near the nest in overhanging tillers. After 52 min the male began to incubate. As darkness approached, the female left the tussock 26 min later and began to feed. The next morning the male was observed incubating for 2 hours. By the following day, the nest had been preyed upon.

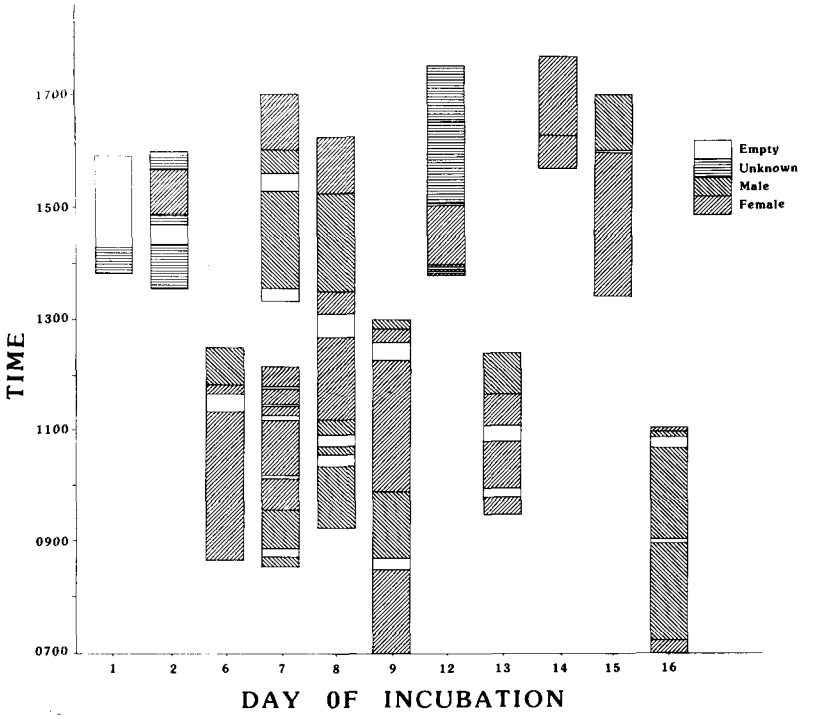
TABLE 3 — Comparison of male and female culmen and tarsometarsus from museum skins of New Zealand specimens. Measurements in mm ($\bar{x}$;n)

	Male	Female
Spotless Crake		
Culmen	18.2-20.8 (19.6; 8)	16.3-17.1 (16.6; 3)
Tarso-metatarsus	31.3-33.1 (28.2; 8)	29.0-33.5 (30.6; 5)
Marsh Crakes		
Culmen	17.4-18.9 (18.1; 5)	15.7-19.2 (17.1; 9)
Tarso-metatarsus	28.0-30.7 (29.1; 5)	24.6-29.1 (26.9; 10)

Nest defence

Spotless Crakes reacted to intrusion by leaving the nest when the vegetation above it was disturbed. The bird remained nearby and just out of sight in the vegetation. Usually a definite splashing could be heard. Hobbs (1967) suggested "falling stone display" to describe this action; however, it may be homologous to "churning" observed in the Sora *(Porzana carolina)* and American Coot *(Fulica americana)* (Gullion 1952, Kaufmann 1983). Often the bird also slowly fluttered its wings, which produced an audible sound. The birds of nest 10 consistently displayed whenever the canopy was parted for observation. Once, the incubating bird rapidly flitted from ground to raupo, a display similar to the "swanning" of Virginia Rails *(Rallus limicola)* (Kaufmann 1983). The crake held its head and neck at normal position, the back horizontally straight, the tail pointed upward, the wings held out with their edges close to the ground, and the primaries and secondaries fanned out and pointing nearly upward.

The Marsh Crake also gave a display that included wing fanning. Once, when the tussock was parted, the bird was not on the nest but gave a chirp from within the tussock. It jumped down into the open water and began to leave, but returned to the tussock, drooping the wing nearest the observer so that the wing tip touched the water. Similar Marsh Crake displays with both wings have been reported by Hobbs (1967) and Glayre & Magnenat (*in* Cramp & Simmons 1980).



FIGUREE 2 — Incubation of eggs by a pair of Spotless Crakes

Chick rearing

We are uncertain how long Spotless Crakes remain in the nest with their chicks, as they abandoned the nest when we inspected it. One brood, near the tower hide, remained on the nest for 20 hours, while heavy rain fell, before leaving when R. Lavers disturbed them. These chicks left when the nest was approached, moved to the vicinity of one of the presumptive nests a few metres nearby, and remained there for several days. Adults could be seen carrying food items back to this nest. Sixteen days after hatching the adults and chicks were seen moving from this area into the flax. The chicks were not observed with the adults again, and juveniles seen in this area later were of unknown origin.

We did not see Marsh Crakes with young.

Intraspecific competition

Direct evidence of competition between Spotless and Marsh Crakes is limited to a few observations of Spotless Crakes chasing Marsh Crakes (Howard 1962). Reactions to taped calls gave the opposite impression at Pukepuke Lagoon. Marsh Crakes actively answered taped calls of Spotless Crakes; one Marsh Crake came out on to an open mudflat and approached within 2 metres of the observer. Recordings of Marsh Crakes played at active territories of Spotless Crakes produced a few weak responses, as if they were intimidated or unstimulated.

The bill sizes and shapes of the two species are strikingly alike (Tables 4 and 5), the bill of the the Marsh Crake averaging slightly smaller. The ratios of bill sizes varied from nearly 1:1 in length to 1:1.1 in depth.

The location of museum specimens collected indicates that Spotless Crakes are more abundant in the North Island and Marsh Crakes are more abundant in the South Island. There were 11 skins of Spotless Crakes in the National Museum taken from the North Island and none recorded from the South Island. There were 5 skins of Marsh Crakes taken from the North Island and 27 skins taken from the South Island in the National and Canterbury Museums.

TABLE 4 — A comparison of bill sizes (mm) of Spotless Crakes and Marsh Crakes from Museum skins ($\bar{x}$; SD; n)

	Spotless Crake	Marsh Crake	Ratio of Spotless/ Marsh	T-test
Length	15.3- 20.6 (18.1; 1.45; 19)	15.7- 19.5 (17.8; 0.98; 36)	1.017	s.d.
Width	3.9- 6.5 (4.9; 0.81; 18)	3.7- 5.9 (4.6; 0.48; 35)	1.065	n.s.
Depth	5.9- 8.4 (7.0; 0.68; 18)	5.4- 7.7 (6.3; 0.47; 34)	1.111	s.d.

TABLE 5 — Weights (g) and lengths (mm) of exposed culmen, tarsometatarsus, and middle toe plus claw of Spotless Crakes and Marsh Crakes captured at *Pukepuke Lagoon*.

	Weight	Culmen	Tarso-metatarsus	Middle toe & Claw
Spotless Crake				
	$\bar{x}$ 47.5	18.2	29.9	35.7
	R 37.0-60.5	16.3-20.2	23.6-32.6	32.1-38.3
Marsh Crake				
	$\bar{x}$ 41.7	17.4	29.0	37.2
	R 40.0-46.0	15.6-18.9	26.6-30.8	34.3-39.7

DISCUSSION

Nesting

Many species of rails build more than one platform or nest some time during the breeding season. Those of the crakes appear to have been built before incubation, but other rails, such as males of Sora and Virginia Rail, build extra nests when incubation has finished. A variety of functions for such nests has been suggested for different species of rails: to synchronise the breeding cycle of the pair; to make the territory more attractive to females; to provide a substrate for copulation; to confuse and frustrate egg predators; as a second nest or a renest; for roosting by the mate not incubating or

brooding part or all of the young. Until such functions have been defined for each species, perhaps a more general term such as "presumptive" nest should be used instead of using labels of presumed function.

Why most Spotless Crakes nest from mid-September to mid-October, when the early spring is cool and insect numbers are low and when they have smaller eggs and fewer eggs per clutch, will remain unknown until we know if crakes renest or have double broods. If the crakes do have two broods, they probably retain their territory through the breeding season. The first clutch would be smaller because of a lower food supply for egg production as well as brood rearing.

Field observations are inconclusive on the number of broods per year. Below the tower hide a pair began laying on 15 December 1971 in one of the presumptive nests of the first pair, whose eggs had hatched on 10 October. The male of the first pair was colour-marked with plastic leg bands, but neither bird of the second pair was marked. Perhaps the male had lost his bands, or the female had taken a new male, or the second pair was using one of the nests of the first pair. In 1982, two adjacent empty nests were found on 10 October, but on 8 December, an active nest was found nearby, indicating that the pair either was renesting or was using the territory of a pair that had finished nesting.

Intraspecific competition

Current ecological theory states that, if species require similar resources such as food or breeding sites, they are likely to compete. This competition may lead to one species excluding the other or to characters such as bill size being displaced to partition the resources. Such species exhibit a gradient of bill sizes, each successively larger species having a bill about one-third larger (Schoener 1965).

Marsh and Spotless Crakes certainly appear to violate the rules of competitive exclusion or character displacement. The bills are alike in shape and very alike in size; both probably feed on the same foods. Both nest in tussock sedge at Pukepuke. Marsh Crakes at Pukepuke responded to the taped calls of Spotless Crakes, but not vice versa, and Howard (1962) observed Spotless Crakes chasing Marsh Crakes.

One explanation could be that the two species differ subtly in breeding sites. For example, Spotless Crakes may require an overstorey of raupo or other tall emergents above the tussock sedge, whereas Marsh Crakes may require pure stands of tussock sedge. This could explain the preponderance of Spotless Crakes in the North Island and Marsh Crakes in the South Island.

Another example may be that the effect of competition between species has been exaggerated and is more complicated than formerly believed, especially in unstable environments (Weins 1983). We hope this will stimulate further study of crake competition and distribution in New Zealand.

Variation in clutch size, egg size, and hatching interval

The size of Spotless Crake clutches and size of eggs increased as the breeding season progressed. In addition, the larger clutches were more likely to hatch asynchronously. The larger size and number of eggs may simply

reflect the increased availability of food and better condition of the female later in the season. However, it has been assumed that variation in clutch size, egg size, and hatching interval has adaptive value (Lack 1968, Kaufmann 1981, Slagsvold 1984). Hatching asynchrony in altricial birds is considered a brood reduction strategy. However, semi-precocial species such as those of *Porzana* require only a few days of parental feeding until the young can feed themselves. Their hatching asynchrony should be considered a mechanism of increasing brood survival. For example, Soras with larger clutches have a greater hatching interval to ensure brood survival. In North America, Sora clutches of 7-8 eggs hatched over a 2 day span, whereas clutches of 10-15 eggs hatched over 5-17 day spans.

We do not consider the long breeding season and the difference in clutch sizes to be prima facie evidence that the Spotless Crakes of New Zealand are double brooded. We hope our study will stimulate others to continue work on crakes. Our suggestions would include summer banding, when juvenile birds can be distinguished from adults, and nest research the following spring. Perhaps then the date of nesting can be associated with the age of a crake, an attempt to renest, or a second nest. We also encourage continued measurements of eggs as they are laid. We hope more data will support our observation of larger eggs in November to January. In addition, we would like to see if the smallest egg in each clutch was laid last, as a means of brood reduction.

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SHORT NOTE

Petrels nesting in the Tutamoe Range, Northland, 1916-1923

M. J. Imber (1987) has given a comprehensive account of the past and present status of the Black Petrel *(Procellaria parkinsoni)*, including the inset of his Figure 6, which shows former breeding sites of this petrel on the main islands of New Zealand.

The information in his report has brought into focus some events which I have long thought should be placed on record. Perusal of Imber's account confirmed that this information was not in the literature.

From 1916 to 1923 I lived, as a schoolboy, on a bush farm on the Tutamoe Range. My father, H. A. Olsen, was manager and part owner of this farm of 750 ha. As well as being a bush farmer, he was very interested in anything related to the bush and the wildlife in it. He had been brought up in the Seventy Mile Bush in southern Hawke's Bay, and his father, A. Olsen, was one of an enthusiastic band of amateurs, led by Henry Hill, who collected botanical specimens for Colenso in 1880-1890.

One of H. A. Olsen's jobs in running the farm was to round up cattle which had wandered into the bush. For this purpose he had two, sometimes three, dogs with him, one of which, Sandy, was an enthusiastic forager. Soon after we moved on to the farm, probably in early 1917, Sandy surprised H. A. Olsen by rushing in under a big rata *(Metrosideros robusta)* and coming out with a struggling bird which was completely new to him. He was familiar with the birds of the bush. Kaka *(Nestor meridionalis)* were then quite common in the Tutamoe Range. Red-crowned Parakeet *(Cyanoramphus novaezelandiae)* were present and, in the evening, Brown Kiwi *(Apteryx australis)* could be heard calling adjacent to the farmhouse. On one occasion, probably in 1919 or 1920, H. A. Olsen saw a pair of Kokako *(Callaeas cinerea)* to the south of the farm block in heavy bush of what is now the Kaihu State Forest. At this time Kokako were considered to have gone from Northland by about 1900 (Oliver 1955), which surmise has happily proved incorrect.

Meanwhile the identity of the birds which Sandy used to drag from under the tree roots continued to elude H. A. Olsen. Sandy would catch three to five each year; sometimes the dog would be restrained when it was realised in time what he was after, and sometimes he was unable to get at the birds because of the length of their tunnel. Almost always the birds Sandy caught were adults, and only once or twice were they obviously well-grown immature birds. H. A. Olsen employed a few regular farmhands, and in 1919 two ex-sailors came to work on the farm. When they were shown one of the birds