

**THE ORANGE-FRONTED PARAKEET**  
**(*Cyanoramphus malherbi*)**  
**IS A COLOUR MORPH OF THE YELLOW-**  
**CROWNED PARAKEET (*C. auriceps*)**

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ABSTRACT

*Cyanoramphus malherbi* (Souance 1857) is relegated to synonymy with *C. auriceps* (Kuhl 1820) after cross-breeding in captivity showed that both are colour morphs of one species. The resulting parent-offspring data can be most simply explained by the Mendelian theory of dominant/recessive inheritance at a single locus, the factor for yellow-crowned being dominant.

INTRODUCTION

The Orange-fronted Parakeet differs markedly in plumage coloration from the Yellow-crowned Parakeet. In the Orange-fronted Parakeet, the feathers of the frontal band above the bill and small coloured patches on either side of the rump are orange rather than red, the general body plumage is cold bluish green and the crown is pale lemon-yellow, in contrast to the yellowish green and golden yellow of the Yellow-crowned Parakeet

Orange-fronted Parakeets are very rare, having been recorded at fewer than 10 localities on South and Stewart Islands during the present century (Harrison 1970, Read & McClelland 1984).

In September 1980, some were found by the New Zealand Wildlife Service near the confluence of the Hope and Kiwi Rivers in Lake Sumner Forest Park, North Canterbury, where they occurred in a ratio of about one orange-fronted bird to 12 Yellow-crowned Parakeets. During visits to the area by Wildlife Service field parties between 1980 and 1983, both forms were often seen in small mixed flocks (Gray 1982), and nests of a pair of Orange-fronted Parakeets, of two pairs of Yellow-crowned Parakeets and of a mixed pair were found (A. Cox and D. Crouchley, pers comm., Taylor 1985a & b). More recently, in February and April 1984, orange-fronted birds were recorded in comparable concentrations among the parakeets of the Hawdon Valley, Arthur's Pass National Park (Read & McClelland 1984). However, in many other parts of New Zealand where Yellow-crowned Parakeets occur in good numbers, orange-fronted birds are much more rare, or unknown (Taylor 1985a & b).

The Orange-fronted Parakeet was first described by Souance (1857) and redescribed by Buller (1869). At first, Finsch (1869) considered it to be the immature form of the Yellow-crowned Parakeet, but later he was convinced of its specific status (Finsch 1875), and it has since been treated as a valid species by most authorities (Oliver 1955, Kinsky 1970, Harrison 1970, Falla *et al.* 1979, Taylor 1985a)

### SPECIES OR COLOUR MORPH?

The first real doubts this century that the Orange-fronted Parakeet was not a good species were cast by Holyoak (1974) who, after studying the literature and museum specimens, concluded that it was probably a colour morph of the Yellow-crowned Parakeet, although direct proof was lacking. He found that the often-quoted differences between the two forms in body size and bill structure were based on too few specimens, mostly of unknown sex. He also considered that the colour differences could be explained in terms of small changes in carotenoid pigmentation, probably under simple genetic control.

In an attempt to clarify whether any real differences in size and shape could be found between Orange-fronted and Yellow-crowned Parakeets, Nixon (1981) used multivariate statistical techniques to re-examine measurements of all museum specimens of both birds available in New Zealand. He found no significant differences that would support the view that the two forms were separate species. He considered that the absence of orange-fronted birds from generations of Yellow-crowned Parakeets bred in aviaries was not contrary to the colour-morph hypothesis because caged birds may have originated from a small and geographically biased sample and thus lack rare alleles. Nixon (1981) also discussed the many other distinctions between the two birds that had previously been reported, and he concluded that "the differences between Orange-fronted and Yellow-crowned Parakeets appear to be not as great as once thought, but further field and aviary studies are needed to resolve fully the question of taxonomic status".

### AVIARY STUDIES

During 1981 and 1982, the New Zealand Wildlife Service obtained five male and two female Orange-fronted Parakeets for breeding in aviaries at Hope, near Nelson. The reason for aviary breeding was two-fold. Firstly, if the Orange-fronted Parakeet was indeed a distinct species, the ability to manage and breed captive birds could be important for its long-term survival. Of more importance, however, was the need to resolve the bird's taxonomic status before considerable manpower and money could be invested in its conservation as a rare species. We therefore attempted not only to breed Orange-fronted Parakeets but also to cross-breed them with Yellow-crowned Parakeets.

All of the Orange-fronted Parakeets originated from the Hope/Kiwi Rivers area. Four were caught with mist nets, and three were hatched and reared by captive Yellow-crowned Parakeet foster parents from eggs removed from the nest of a pair of Orange-fronted Parakeets in the wild.

The first matings of two male orange-fronted birds with yellow-crowned females, of long-standing aviary stock, produced offspring that were all morphologically indistinguishable from Yellow-crowned Parakeets. This was strong evidence that one species only was involved because, when two morphologically and genetically distinct populations are crossed, the F1 offspring should show mixed characteristics sufficient for them to be recognisable as hybrids (Short 1969).

### Genetic model

As well as supporting the colour-morph theory, the results of this initial cross-breeding suggested a further hypothesis: that the polymorphism follows the simple Mendelian theory of dominant/recessive inheritance at a single locus, the factor for yellow-crowned being dominant over the factor for orange-fronted.

The Mendelian theory of assortment at a single locus, applied to these parakeets, assumes that each egg or sperm contains a single factor linked to plumage pigmentation. As the factor for yellow-crowned birds is presumed to be dominant it is designated here by a capital Y and that for orange-fronted by a small o. An individual bird (zygote) formed by the union of sperm and egg contains two such factors, and its genetic constitution (genotype) may be Y/Y (homozygous for yellow), Y/o (heterozygous) or o/o (homozygous for orange). When Y is dominant over o, individuals that contain at least one Y factor will have the appearance (phenotype) of Yellow-crowned Parakeets, while those that contain no Y factor will be orange-fronted.

This hypothesis is illustrated in Fig. 1. It predicts the following events:

- (a) If two yellow-crowned birds from New Zealand's long-established aviary lineage are mated, they will breed true and the offspring will be yellow-crowned.
- (b) If two orange-fronted birds are mated, they will also breed true.
- (c) If an orange-fronted bird is crossed with a yellow-crowned bird from stock that has bred true for many generations, the first generation offspring (F1) will all be yellow-crowned.
- (d) If two of these F1 birds are mated together, both yellow-crowned and orange-fronted birds will be produced in approximate proportions of three yellow-crowned to one orange-fronted — the familiar Mendelian 3:1 ratio.
- (e) If the yellow-crowned birds from the F1 generation are crossed back to their parental yellow-crowned stock, the offspring will all be yellow-crowned.
- (f) If the yellow-crowned birds from the F1 generation are crossed back to orange-fronted, they will have yellow-crowned and orange-fronted young in about equal numbers.

### Observed results

In the aviaries, birds have been paired to give all possible combinations of crossings between the three inferred genotypes (Y/Y, Y/o and o/o). Many pairs, including two of Orange-fronted Parakeets, have yet to breed, but some information is now available on the phenotypes of young produced by examples of all combinations. The data are as follows:

- (a) "A century's experience (more or less) of aviary breeding of *C. auriceps*" in New Zealand has produced only yellow-crowned chicks (Fleming 1980).
- (b) One brood resulting from an orange-fronted x orange-fronted mating in the wild produced three orange-fronted chicks.
- (c) Three broods resulting from orange-fronted x domestic yellow-crowned matings produced 11 yellow-crowned (F1) chicks.
- (d) Six broods resulting from F1 x F1 matings produced 18 yellow-crowned and 4 orange-fronted chicks.

- (e) One brood resulting from an F1 yellow-crowned x domestic yellow-crowned mating produced 3 yellow-crowned chicks.
- (f) Six broods resulting from orange-fronted x F1 yellow-crowned matings produced 13 yellow-crowned and 8 orange-fronted chicks.

Table 1 compares these results with those expected from the Mendelian theory of inheritance at a single locus. In all possible combinations of crossings, the observed frequencies of yellow-crowned and orange-fronted offspring provide a good fit with those expected.

### CONCLUSION

The findings from cross-breeding Orange-fronted Parakeets with Yellow-crowned Parakeets are totally at variance with the argument that the orange-fronted birds are a distinct species. Not only are the F1 offspring indistinguishable from Yellow-crowned Parakeets, but also dimorphic phenotypes are produced from some backcrosses and in the F2 generation. In contrast, first-generation hybrids and intergrades (F2 or backcrosses) from the interbreeding of two distinct populations always show mixed characteristics, never dimorphism (Huxley 1964, Short 1969, Taylor 1975).

The parent-offspring data now available are, however, in complete agreement with the suggestion of Holyoak (1974) that the two forms are colour morphs of a single species. The data also provide a close fit with the hypothesis that the polymorphism follows the simple Mendelian theory of dominant/recessive inheritance controlled at a single genetic locus, the factor for yellow-crowned being dominant.

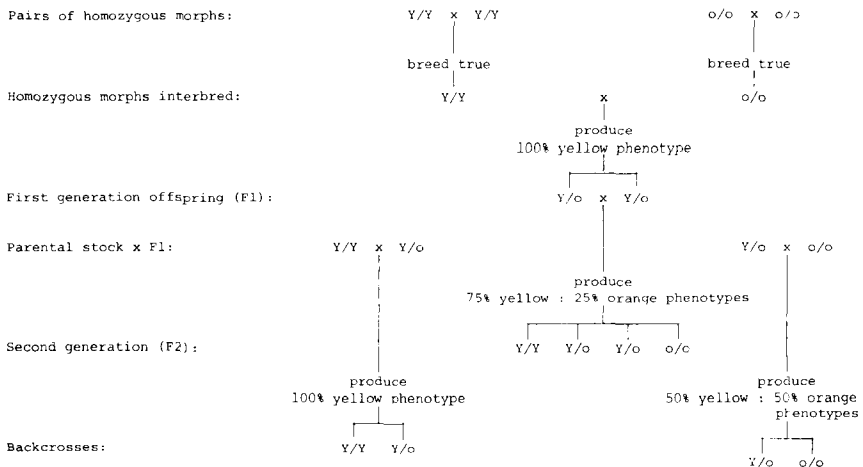


FIGURE 1 — Hypothetical model applying Mendel's theory of dominant/recessive inheritance at a single locus to the question of polymorphism in Yellow-crowned Parakeets. Y = yellow-crowned factor (dominant), o = orange-fronted factor (recessive)

TABLE 1 — Expected and observed frequency of yellow-crowned and orange-fronted offspring from various mating combinations (see text)

Forms crossed	Parents		Offspring frequencies						
	Inferred genetic factors	Genotype (%)	Expected		Observed		N		
			Yo	Yy	orange	yellow		orange	yellow
a) domestic yellow-crowned x domestic yellow-crowned	Yy x Yy	0	0	100	0	100	100	0	100
b) orange-fronted x orange-fronted	yy x yy	100	0	0	100	0	3	100	0
c) orange-fronted x domestic yellow-crowned	yy x Yy	0	100	0	0	100	11	0	100
d) F1 crossbred yellow-crowned x F1 crossbred yellow-crowned	Yy x Yy	25	50	25	0	75	22	18	82
e) F1 crossbred yellow-crowned x domestic yellow-crowned	Yy x Yy	0	50	50	0	100	3	0	100
f) orange-fronted x F1 crossbred yellow-crowned	yy x Yy	50	50	0	50	50	21	38	62

The combined findings of Holyoak (1974), Nixon (1981) and the present study clearly demonstrate that Orange-fronted Parakeets and Yellow-crowned Parakeets are colour morphs of one species. Consequently, *Cyanoramphus malherbi* (Souance 1857) should be deleted from the list of New Zealand birds and be relegated to synonymy with *C. auriceps* (Kuhl 1820).

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