Ecology and Reproductive Biology of the North Island Brown Kiwi *(Apteryx australis mantelli)*

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FRONTISPIECE: **Six-day old North Island brown kiwi chick at the entrance to its nest, Paerata Wildlife Management Reserve, Tangiteroria, Northland. February 1987.**

To Acta

You gave much and
knew not that you gave
at all.

(Modified from K. Gibran 1923)

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ABSTRACT

The spacing behaviour, habitat use, pair bonding, breeding biology and reproductive endocrinology of the North Island brown kiwi (*Apteryx australis mantelli*) are investigated. Twenty-six kiwi (10 males and 16 females) were fitted with radio transmitters and tracked for two and a half years in a forest remnant in Northland.

Spacing behaviour: Home ranges overlapped extensively. One 1-ha grid square was used by at least 13 different kiwi. All range-estimate methods were sensitive to the number of fixes obtained. The average range size calculated by the field worker method was 30.7 ha. Males and females had similar home range sizes.

Habitat use: Kiwi spent over 80% of days in burrows or natural earth cavities when roosting with their mate - over twice the proportion of days spent in these types of roosts when alone. Pairs roosted together on 22% of days. This increased to over 35% of days between April-July, up to four months before females started laying. Eighty-three percent of the kiwi made use of the numerous bush remnants scattered over farmland outside the reserve. All remnants isolated by less than 100 m of pasture were used by kiwi. The maximum distance kiwi ever walked between bush remnants was 330 m. Longer migrations of up to 1.2 km from the reserve were made by kiwi using small bush remnants as "stepping stones".

Pair bonding: The kiwi were sequentially monogamous and had an extraordinarily high annual divorce rate of around 50%. Most divorces occurred between January and April - the non-breeding season. No relationship was apparent between the breeding success of a pair and their likelihood of divorce. The forest contained an unbalanced sex ratio with females outnumbering males by 1.3-1.4 : 1.

Breeding: Eggs were laid over eight months of the year from July to February. Males were found incubating in all months except May and June. Pairs averaged 1.5 eggs/pair/year and no females laid more than two eggs in a season. Clutches that failed were not immediately replaced. Eighteen of 20 nests were in burrows 45-125 cm long. Males did all the incubating and emerged every night to feed except one to two days before their chicks hatched. Incubating males spent an average of 3.6 hours off their nest each night - less than half the active time of non-incubating kiwi. In both sexes body weights tended to peak in winter at the start of breeding. Females lost about 9% of peak body weight for each egg they laid, while males that incubated full-term lost about 17% of peak body weight. Only six of 26 eggs laid over three seasons hatched. Five chicks fledged. At fledging three of these chicks were known to be 15-20 days old. The average productivity was 0.3 chicks/pair/year.

Endocrinology: Plasma samples were collected from the radio-tagged kiwi and analysed by radioimmunoassay for testosterone (T), progesterone (P) and estradiol-17β (E). Male T concentrations increased sharply in Autumn, rising from near basal levels in April to peak at over 2.2 ng/ml in May. Male T levels remained high through winter and then declined to low levels (0.15-0.42 ng/ml) between October and the following April. Plasma T levels peaked (1.8-2.8 ng/ml) in males 12-4 weeks before their mates laid, and dropped significantly (to 0.21 ng/ml) during the four weeks before egg laying. Females showed no significant monthly variation in T levels. Plasma T concentrations were highest (0.21 ng/ml) in females 4-2 weeks before laying, but even during this period T levels in females did not significantly exceed minimum (brooding) levels in males. Plasma P levels did not vary significantly between months or reproductive stages in either sex. P levels were almost always higher in males than in females. Males also obtained extraordinarily high plasma E levels. Both sexes showed an enormous increase in E in autumn, with plasma concentrations rising from near minimum detectable levels (6 pg/ml) in March to average over 1.6 ng/ml in males and 2.6 ng/ml in females in April. E levels were higher in incubating males (0.30 ng/ml) and males during the 12 weeks before egg laying (0.60-1.40 ng/ml) than in non-breeding males (27 pg/ml), suggesting that E may facilitate the development of incubating behaviour in these birds. Breeding females had significantly higher E levels than non-breeding females from 16 weeks before egg laying until two weeks after egg laying. Males and females E levels did not differ significantly from each other during any reproductive stage prior to egg laying. These results indicate that sex-role reversal in the brown kiwi is not accompanied by a reversal of the normal male/female androgen levels, but that male kiwi have remarkably female-like estrogen cycles.

Management: Recommendations on the conservation and management of the North Island brown kiwi are presented. Kiwi reserves need to be large if they are to contain populations with long-term viability (500-1000 individuals). Just how large may vary between 750-1500 ha in different regions. Smaller populations also are of conservation value and should not be neglected. Bush corridors and "stepping stones" can be used to reconnect separated islands of habitat. Regular predator monitoring and control programmes must be instigated in prime kiwi refuges.

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