

## SHORT COMMUNICATIONS

### TERRITORIES OF THE AUSTRALIAN MAGPIE *GYMNORHINA TIBICEN* IN SOUTH-EAST QUEENSLAND

The function of animal territoriality is discussed by Brown (1975); Fretwell (1972); Pyke (1979) and Verner (1977). Although there is no general agreement, it is usually assumed that the benefits accrued to an individual that defends a territory must be greater than the costs required to maintain it.

Early workers (e.g. Brown 1964) hypothesized that the size of a territory should be that which provides sufficient food resources for survival and reproduction of territorial owners. This suggestion implies that, within a species, all territories will have the same amount of food resources per individual. This "sufficient-resource hypothesis" would predict that, for a given group size, territories would be smaller where the food supply was more abundant (i.e. in high quality territories).

Ebersole (1980) suggested that this idea of fixed amount of energy intake is unrealistic, and claimed that individuals should maximise the energy gain, relative to the costs of maintaining the territory. This "food-maximiser hypothesis" assumes that by increasing the difference between energy gains and losses, the reproductive success of the territory owner (or owners) will be increased, which appears to be true in some cases (e.g. Schoener 1971).

If territory size for a given group of birds is determined by the area that can be defended, and if a larger group is capable of defending a larger area, then group size and territory size should be positively correlated. By defending the largest area possible, then other individuals may be excluded from the resources and so the relative fitness of the territory owners will be maximised. We will refer to this suggestion as the "area-maximiser hypothesis".

The Australian Magpie *Gymnorhina tibicen* is a ground-feeding omnivorous bird, which eats mainly insects (Vestjens & Carrick 1974). For feeding, areas of ploughed, grazed or mown grassland are preferred; for nesting, tall trees are required (Carrick 1972). Magpies live in territorial groups of from two to thirty birds (Robinson 1956; Carrick 1963; Shurcliffe & Shurcliffe 1974). These groups are composed of varying combinations of adult males, females and immatures.

Shurcliffe & Shurcliffe (1974) state that territory quality was very difficult to measure and therefore

made no attempt to do so. In the present study, we have made use of the observations of Robinson (1956) and Carrick (1972) who state that Magpies prefer areas of green grass for feeding and that cultivation of an area apparently increases its carrying capacity for Magpies. We have assumed that the area of short green grass per hectare in a territory can be used as an index of quality. Tall trees, required for nesting, were not a limiting resource in the present study and therefore were not included in the assessment of quality.

From each of the three hypotheses stated earlier, it is possible to produce a set of predictions concerning the relationships between the following variables: area of grass per hectare of territory, area of grass per territory, territory size and group size. This study investigates these relationships for the Magpie, and then compares observed relationships with predictions from each of the three hypotheses.

The study was carried out in the Brisbane area (153°03'E, 27°33'S). Nineteen Magpie groups were chosen from a range of different habitats, which included suburban, parkland, rural and bushland areas.

To find the number of males, females and immatures in each territory we played recordings of Magpies' territorial carolling to attract the birds and induce an aggressive response. We determined territorial boundaries by following birds until they reached the limit of their territory and doubled back (Shurcliffe & Shurcliffe 1974) and by noting where boundary disputes between neighbouring groups occurred. Territory boundaries were recorded on 1:10,000 and 1:4,000 orthophoto maps and total territory areas and areas of short grass were calculated from these by overlaying a grid.

The rank correlation coefficient, Spearman's rho, was calculated for comparisons between territory area, grass per hectare, birds per territory, birds per hectare and grass per territory, in order to identify significant correlations.

## RESULTS AND DISCUSSION

The mean territory area was  $9.34 \pm 1.40$  ha and the number of birds per territory ranged from 2 to 5. The mean area of territory per Magpie was  $3.64 \pm 0.66$  ha and the mean area of short grass per Magpie was 1.17

$\pm 0.15$  ha. The coefficients of variation were 80.8% and 56.0% respectively, which were not significantly different ( $p > .05$ ), when compared using the  $t$ -test described by Dow (1976).

There is a negative relationship ( $p < .001$ ) between the area of grass per hectare and the area of the territory (Table I, Fig. 1), indicating that "poor quality" territories tend to be larger than "good quality" territories. There is no correlation between the number of birds in a group and the area of the territory ( $r = -0.11$ ). A positive correlation ( $p < .001$ ) exists between birds per hectare and grass per hectare, indicating that better "quality" areas support a higher density of birds (Table I, Fig. 2).

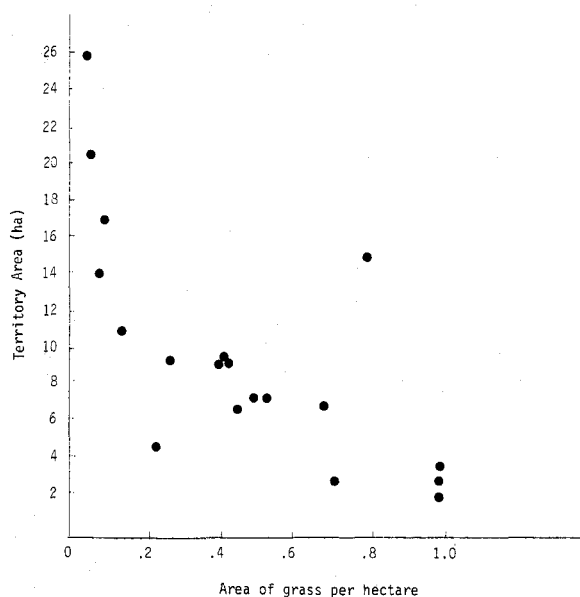


Figure 1. Relationship between size of territory and area of grass per hectare (territory 'quality').

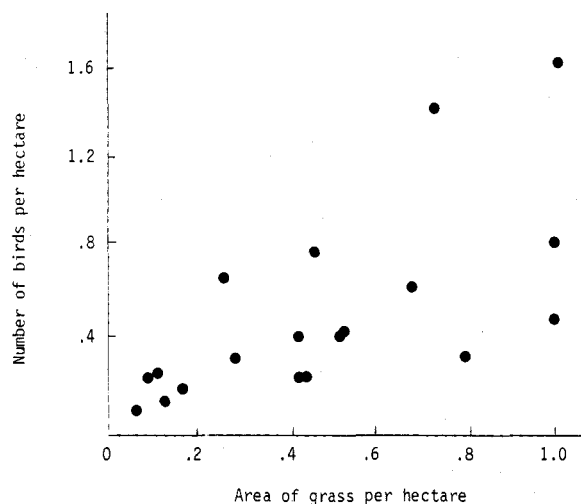


Figure 2. Relationship between area of grass per hectare and number of Magpies per hectare for each territory.

No relationship ( $r = 0.09$ ) exists between the group size and the area of grass per territory or between group size and the area of grass per hectare (Table I).

From each of the hypotheses described earlier, predictions can be made about relationships between the variables examined in this study. These predictions are summarised in Table II and explained in more detail below.

The area-maximiser hypothesis would predict a positive correlation between territory size and group size, but no correlation between territory size and territory quality, nor between the amount of available food in the territory and the number of birds in it.

Previous work on Magpie territoriality has produced conflicting results. Shurcliffe & Shurcliffe (1974) found

TABLE I

Values of Spearman's rank correlation coefficients between each pair of variables.

\* significant  $p < .05$

\*\* significant  $p < .01$

	Territory area	Area of Grass per territory	Area of Grass per hectare	Number of Magpies per territory	Number of Magpies per hectare
Territory Area	1.000				
Area of grass per territory	-.141	1.000			
Area of grass per hectare	-.775**	.575**	1.000		
Number of Magpies per territory	-.112	.094	.191	1.000	
Number of Magpies per hectare	-.807**	.287	.716**	.274	1.000

TABLE II

*Some predictions arising from each of the three hypotheses about relationships between variables measured in this study.*

	Territory size and group size	Territory size and area of grass per hectare of territory	Area of grass per territory and group size
Area-maximiser hypothesis	positive correlation	no correlation	no correlation
Sufficient-resource hypothesis	no correlation (unless territories of uniform quality)	negative correlation	positive correlation
Food-maximiser hypothesis	no correlation (unless territories of uniform quality)	no correlation or negative correlation (see text)	no correlation

that group size and territory size were positively correlated (Pearson's  $r = .51$ ,  $N = 25$ ). However, when we calculated the correlation coefficient for Carrick's (1972) data, territory size and group size were not correlated ( $r = .047$ ,  $N = 372$ ). Similarly, in the present study, no correlation was observed between the two variables. Therefore the area-maximiser hypothesis was not supported.

From the sufficient-resource hypothesis, a negative correlation between territory area and territory quality would be expected. If, as the hypothesis states, the area defended is just sufficient to support the group, then a positive correlation between the amount of available food (estimated here by area of short grass) and group size would be predicted because there would be a set area of short grass for each bird. Unless territories were of uniform quality, no correlation between territory size and group size would be expected, because the number of birds able to be supported would depend on the quality of the territory as well as its size.

The strong negative correlation between territory area and the area of grass per hectare (Fig. 1) agrees with predictions from the sufficient-resource hypothesis. Similar results have been reported by other workers, for territorial pairs or individuals (e.g. Ovenbirds, Stenger 1958; iguanid lizards, Simon 1975; a Red Wattlebird, Ford 1981). The positive correlation between area of grass per territory and group size, which would be predicted from this hypothesis (Table II), was not observed here. Therefore the sufficient-resource hypothesis was not supported.

Predictions from the food-maximiser hypothesis are not so clear-cut. Where territories vary significantly in quality, no correlation between territory size and group size would be expected. According to Ebersole (1980) in many cases no correlation between territory quality and territory size would be expected. However, under certain conditions, a negative relationship may be expected. For example, if the pressure from intruders increased drastically with increasing territory quality (as

has been shown in some studies, e.g. Gass *et al.* 1976), then higher quality territories would be much more difficult to defend, and it may be economical (in terms of energy gains and costs) to defend a smaller area. Ebersole (1980) claims that such a relationship is likely in insectivorous birds. Because this hypothesis assumes that both the total amount of food available and the concentration of food (i.e. territory quality) are important, no clear relationship between amount of available food and group size would be predicted.

The results in Table I appear consistent with predictions from the food-maximiser hypothesis (Table II). There is a negative relationship between territory size and area of grass per hectare of territory and there is no correlation between territory size and the number of birds, nor between the area of grass in the territory and the number of birds.

We should point out that there are other explanations for the lack of correlation between area of grass and group size. First, area of grass may not be a reliable estimate of territory quality and different grass areas may vary considerably in "quality", with better quality grass leading to more birds per territory. Secondly, the lack of correlation in the present study may be because neither variable covers a wide range and there are a large number of ties.

From the present study it is also possible to suggest explanations for disparities between Carrick's (1972) and Shurcliffe & Shurcliffe's (1974) results. If territory size depends on the quality of the area (in terms of grass per hectare), and not on the number of birds available for defence, then a direct relationship between territory size and number of birds would not be expected, especially if territories varied widely in quality (as was the case in Carrick's study). Shurcliffe & Shurcliffe (1974) studied Magpie groups around the Flinders University campus, consisting of "undulating grasslands with patches of eucalypts". From the territory maps, all territories appear to have about the same proportion of mowed grassland, so that the larger

the territory the more grass there would be (N.B.: This was not the case in the present study (Table I) and probably not in Carrick's study). In such areas, where quality is uniform, because there was a positive correlation between grass per hectare of territory and birds per hectare of territory (shown in Fig. 2) a positive correlation between territory size and group size may be expected.

The average area of grass per hectare of territory was probably higher in the Adelaide area of undulating grasslands (.75 - .80 ha), than in either the present study (.44 ha) or the Canberra area, which included areas of uncleared bushland. This relatively high "quality" of the Adelaide territories may account for the difference in the mean area per bird observed in the two studies. Shurcliffe & Shurcliffe (1974) report the mean area per Magpie to be 1.34 ha, whereas the mean area per Magpie in the present study is 3.64 ha. This larger area probably reflects the generally poorer "quality" of the territories studied here. This suggestion is supported by the smaller mean group size in the Brisbane area, (about 3) compared with southern (3.8 - 4.8) and south-western (7.8 birds per group) populations (Hughes 1980).

We conclude that territory size is not determined by the number of birds available to defend it, because group size and territory size are not correlated. Because there is no correlation between area of grass and the number of birds per territory, the sufficient resource hypothesis is not supported. Although no conclusive evidence is available, results of the present study seem to agree best with Ebersole's (1980) "food-maximiser" hypothesis. In order to reach firm conclusions about the factors affecting territory size in the Magpie, investigations of the time spent in defence, feeding and resting, in territories of varying size and quality are required.

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J.M. HUGHES, B.J. PEARCE and K. VOCKENSON, *School of Australian Environmental Studies, Griffith University, Nathan, Queensland 4111.*

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