Chapter 4
SOCIAL BEHAVIOUR
4.1. INTRODUCTION

Animal societies are complex structures formed by the relationships of individuals with the members of their own species, and with those with which they share the habitat. These relationships result from a series of behavioural interactions which take place during different phases of their annual cycle, or due to a change in the environment (McBride in Lehner 1979). Although much of the behavioural repertoire in an animal comes from its ancestors or from its parents or neighbours through learning, the way it behaves (i.e. feeds, avoids predators, communicates, cares for its young, etc.) critically affects its own survival, and its chances of contributing its genes to future generations (Krebs & Davies 1987).

Behaviour of animals, particularly of those that are shot for sport, provides the frame-work within which manipulations can be made to produce surpluses for harvest (Avery & Ridley 1988). One of the two main aspects of the management of game populations is the provision of supplementary feed during inclement weather or in years of less abundant natural food, as is regularly practiced for game-bird species. In this case the dispersion pattern and the mating system of the species guides the number and position of the feeding outlets as well as the amount of food to be provided.

The second aspect is determination of the harvest, in particular the proportion of different age classes of
each sex that can be shot, so that the remaining stock has a balanced sex/age structure to ensure continued future production of surpluses. A third aspect that facilitates management is estimating the density or the number of animals in a population. This is yielded by listening to the calls of animals, usually during the breeding season, when they call either to establish or defend territories, or to attract mates. Animal calls also yield information on the types of habitat they use (see section 5.4).

Like other aspects of its biology, not much information exists in the literature on the social behaviour of kalij. About its calling behaviour, Ali & Ripley (1983) quote an anonymous source who describes the crowing call of kalij as 'a loud whistling chuckle or chirrup'. Gaston (1980) reports that the major calling period in kalij is from March to May, which according to Johnsgard (1986) corresponds to the laying period.

Roberts (1970) writes that 'they are noisy and capable of a quite astonishing repertoire of clucks and calls', but does not mention any particular call type or the context in which these calls are given. Baker (1930) states that the birds, when not disturbed, give out contact signals which he described phonetically as 'kurr-kurr-kurrcchi-kurr'. Bump & Bohl (1961) also make mention of this call as a 'low tweet in a conversational tone when birds are not alarmed', and Ali & Ripley (1983) write 'Both sexes cluck in soft undertone when scratching among the thickets for food.'
The two other call types mentioned in the literature seem to be an alarm call and a flushing call. About the former, Bump & Bohl (1961) write that 'when excited or alarmed either sex may utter a long squealing whistle often followed by loud and deep clucking noises'. Ali & Ripley (1983) in reference to Whistler write 'when flushed gives vent to a series of guinea-pig like squeaks and chuckles'.

There are no reports on aggressive behaviour of kalij, and its courtship behaviour has been mentioned in only two sources. Ali & Ripley (1983) write 'In breeding season male makes a peculiar drumming noise like shaking or flapping a thick piece of cloth in the wind' which according to A.E.Jones (in the same source) is 'produced partly by rapid vibrations of wings and partly by the vocal organs'. A slightly more detailed account of the courtship behaviour is given by Johnsgard (1986) who in reference to Delacour (1977) writes 'Besides wing-whirring display, kalij pheasants perform a fairly simple lateral courtship, spreading the tail, expanding the facial wattles, waltzing around the female, shaking the tail, and making clucking or booming noises.' He further writes that 'Tidbitting behaviour certainly also is present in the kalij pheasants, but does not seem to have been described in any detail.'

The above account gives only a rough idea of the calling and courtship behaviour of kalij. To gain a full understanding of these and of its aggressive behaviour,
the present study was designed to yield the following information:

(i) The types of calls given by the sexes and the context in which they are given; the chorusing behaviour of kalij and the feasibility of using this and play-back of calls for estimating the population density of kalij.

(ii) The time spent by sexes on activities such as feeding and vigilance, in groups of different sex and age composition to study their effect on these activities, and how this changes with the seasons.

(iii) The type and context in which different courtship and aggressive behaviours are made.

In this chapter I present firstly an account of the methods used in data analysis i.e. data segregation, transformations, and the statistical tests carried out. The results obtained follow this, and in the final section I discuss the findings in the light of studies on other game-birds.

4.2. ANALYTICAL METHODOLOGY

The methods employed to collect data in the field on social behaviour are given in detail in Chapter 2; here I explain the methods used to analyze the data on the three major aspects of social behaviour studied.

4.2.1. Vocalizations

The following analyses were performed on the vocalizations or calling behaviour of kalij: (1) seasonal
changes in the overall rate of calling in the different years; (2) seasonal changes in the rates for different call types; and (3) the context in which different call types were given.

Before proceeding to discuss the various methods of analysis the data were subject to, it is important to define terms which have been mentioned repeatedly in this section. A 'call type' refers to any one of the 11 types of calls comprising the vocal repertoire of kalij. A 'bout type' signifies an utterance of one or more than one call type in a sequence, with an interval of less than five seconds between successive call types. A 'chorus' means a period of time at dawn or dusk during which 90% of all the bouts given by the member(s) of different home ranges in a session were heard.

In order to work out the seasonal changes in the rates of calling over different years, the data from each year were segregated into fortnightly periods, based on the calendar relative to the onset of incubation (see section 3.2.1. for details). The number of different bout types (except those given by the birds when flushed) heard was standardised for differing amounts of time spent listening during each fortnight, to yield the rate of calling per unit of fieldwork effort (calls 10hr⁻¹). The call rate thus derived was plotted against date to look for seasonal patterns.

The analysis of seasonal changes in the rates of different bout types was carried out on the data collected at the terracings study site at Ghanahaati in
1989, as this was the only year in which continuous and
detailed data were taken. The call data were segregated
into six major bout types all of which were heard
relatively frequently and could be distinguished easily
in the field. Their rates were computed relative to the
chorus length, in the same way as for the contextual
analysis of various call types (see below). The
standardised number of bouts of different types was
plotted against time in fortnights.

The spring data from 1989 were used to explore the
context in which different types of calls were given by
the birds. As a first step in this analysis, an attempt
was made to determine the bout criterion interval by
constructing a log survivorship curve of the inter-bout
intervals pooled for dawn and dusk choruses from the
entire season (Bateson & Martin 1986, Lehner 1979). This
technique, however, failed to give an objective estimate
of the minimum interval between successive bouts, and an
alternative arbitrary definition of chorus length was
therefore required. The data were segregated into months,
and for each dawn and dusk chorus therein the number of
calls heard during 15 minute intervals was plotted
against time. The length of dawn/dusk chorus each month
was taken as the period during which 90% of bouts were
given by the birds. Calls heard outside the dawn and dusk
choruses defined in this way were excluded from further
analysis. The rates of different bout types heard were
computed for each chorus using the time and number of
calls corrected for the chorus length.
The next step performed was to ascertain whether there were differences between rates of calling during dawn and dusk chorus. This was carried out by splitting all data on any given bout types into dawn and dusk categories, and conducting Mann-Whitney U test between the two groups.

Data on bout types that did not show significant differences between mornings and evening were pooled; otherwise the morning and evening data were used separately. The Spearman rank Correlation coefficients were calculated for comparisons of several different types of bouts.

The contextual analysis of the two types of flushing calls was performed by constructing 2 x 2 contingency tables and conducting Chisquare tests on them. However, to test the association of these types of calls with the flushing distances, the Kolmogorov-Smirnov test was used.

The transition probabilities of different call types i.e. whether the different call types followed each other randomly or had some kind of temporal order to them were worked out using 1st order Markov analysis (Martin & Bateson 1986). A transition was defined as having taken place if a successive bout occurred within 5 seconds of a preceding bout. Since most of the transitions took place between only two given call types, a transition matrix was constructed for the major call types heard. An element 'silence' was added to the matrix as different call types often followed from or led to silence. The kinematic diagram (Fig. 4.8) was constructed
from the probabilities deduced from this matrix (Table 4.1). The thickness of the arrows showing transition from one element to another represents the row percentage (as opposed to the column percentage) for any given transition.

The faster, audible wing-whirring was subject to the same analysis as the different bout types in order to determine the seasonal changes in its pattern over different years. For the contextual analysis the data were subject to the same procedure as the different bout types above. Only the corrected number of bouts and field time were used for the analysis. The data from mornings and evenings were analyzed separately as the Mann-Whitney U test revealed significant differences between the rates at which it was given out in the mornings and evenings.

4.2.2. Time budgets

The two main types of analyses performed involved working out differences in the time budgets of males and females in different social groupings and at different times of year.

The proportion of time spent by the birds on activities of major importance (i.e. feeding, vigilance), and the rate of the instances of look-ups were found to be non-normal, mainly because of many instances in which the values for these activities stood at zero. A negligible value of 1 was added to the data, and to make it possible to use parametric tests, the data were transformed to achieve normality.
Although all the three standard transformations of the data were attempted (i.e. arcsine, $\log_{10}$ and square root), only the data on vigilance, and look-up rates could be normalized by square root transformation. The data on feeding could not be normalized by any of the above transformations. For the analyses where the data could be normalized and where the sample size was adequate, the two-sample T tests were used for comparisons. Otherwise, the Mann-Whitney U test was employed.

For analysis of sequential records i.e. the records of activity patterns that preceded and followed such events as a change in the group size or a change in the habitat of the focal bird, the data of lesser magnitude were arranged on one side and that of greater magnitude on the other side irrespective of the sequence in which the change took place in the field. The two main sequential records were arranged for analysis as thicker habitat v's thinner habitat, and smaller group size v's larger group size. The Wilcoxon matched-pair signed-rank test for small samples (Siegel 1956, p 68) was used to test for differences between the two matched sets of data.

4.3. RESULTS

4.3.1. Vocalizations

Kalij were heard giving at least 11 different call types. Although not the complete calling repertoire of
kalij, the following list contains all the commonest call types. The description of some of the calls may not be very adequate as good recordings of all the call types could not be obtained.

The descriptions are not based on any systematic sampling of calls, and therefore do not take into account the variations that calls of different individuals may have. They are true of recorded specimens only.

4.3.1.1. Cluck call

This call consists of a series of monosyllables or clucks given at different rates (Fig. 4.1). Although clucking of intermediate rates was heard sometimes, the majority of the instances of this call type were perceived in the field as being either of high rate (10-12 per second) referred to as fast clucking, or of low rate (about 6 per second) referred to as slow clucking.

The spectrographic structure of a cluck varies with the speed at which it is emitted. A cluck given at a low speed consists of two bursts of energy ranging in frequency from 1.6 to 3.5 KHz and 3.8 to 5.5 KHz. (Fig. 4.1). The clucks are distinct and are of an average duration of 0.06 seconds. The successive clucks are given after a gap of 0.3 second at the start, but with an increasing gap between successive clucks as the bout progresses.

The fast clucks on the other hand, are not so distinct from one another, and are of an average duration
Fig. 4.1 Spectrograph of the slow cluck call of kalij showing frequency and duration of the individual clucks. The wave-form window (A to B) at the bottom is the profile of the whole recording of 5 seconds, of which only a segment of 1 second (C to D, indicated by the black band above it) is shown above. The duration of the segment displayed is shown on the top of the figure.
of 0.08 seconds (Fig. 4.2). The bout appears as a uniform burst of energy ranging in frequency from 3.5 to 5 KHz.

Clucks are also given in combination with a number of other call types, principally the whistles. Bouts of whistling are usually interspersed with a varied number of clucks. The basic structure of the cluck in these mixed calls remains the same as in slow clucking.

4.3.1.2. Whistle call

The whistle consists of a series of syllables the durations and complexity of which are variable (Fig. 4.3). A pure whistling bout consists of a series of syllables of longer and shorter duration. Both types of syllables start with a broad frequency range of up to 5.5 KHz. The duration of the longer syllables varies between 0.4 to 0.5 seconds, and their frequency modulates between approximately 4.5 to 5.5 KHz. The shorter syllables may occur in variable number in between the longer ones, and their duration varies between 0.10 to 0.14. These syllables have fewer less rapid modulations. A bout of whistling may end in a long diffuse syllable of the same frequency as the preceding syllables.

In mixed bouts of clucking and whistling, the duration of the whistle syllable may be shorter or longer, ranging between 0.16 to 0.70 seconds. It starts as a broad band of frequencies ranging between approximately 0.5 and 5.5 KHz rising to about 6 KHz whence it undergoes modulations and drops off to 4 KHz or even further in the process.
Fig. 4.2 Spectrograph of the fast cluck call of kalli.
Fig. 4.3 Spectrograph of the whistle call of kalij.
4.3.1.3. Purr call

This call consists of a series of syllables of a broad frequency range of up to 2.5 KHz arranged as an initial cluster of 2 to 4 identical low frequency syllables followed after a duration of 0.04 to 0.07 seconds by the terminating syllable (Fig. 4.4). This syllable is of longer duration than the others, and ends in a higher frequency (5KHz). Successive purrs are repeated at intervals ranging from 0.14 to 0.44 seconds. The duration of each purr decreases towards the end of the bout, when the amplitude with which the syllables are emitted, also falls.

4.3.1.4. Fighting call

This call is given by males in conflict, and almost always during a fight. Good recordings of this call could not be obtained. A typical bout consists of series of bisyllabic calls of a broad frequency range. The first syllable peaks at about 2.5 KHz, and the following syllable at about 3 KHz dropping sharply after that (Fig. 4.5). The time between successive calls in the two recordings analyzed was found to be 0.77 and 0.25. Each call lasted about 0.13 to 0.21 seconds.

4.3.1.5. Wing-whirring call

This call usually follows the wing-whirring which male kalij perform during the breeding season, but may also be given by itself. This call, like the fighting
Fig. 4.4 Spectrogram of the purr call of kalij.
Fig. 4.5 Spectrograph of the fighting call of kalij.
call, was difficult to record in the field at a distance on account of the low amplitude at which it is given. The description given here is based on a single recording, and may, therefore, not be adequate.

The call consists of three syllables (Fig. 4.6). The first syllable is of the longest duration (0.31 seconds), and consists of a broad frequency range of up to 4.5 KHz. The second and third syllables are of lesser duration, and are made up of a broader range of frequencies than the first syllable. Most of the calls heard were more or less of the same duration (about 0.75 seconds), but occasionally longer calls were also heard.

4.3.1.1. Flushing call

Upon flushing, kalij males and females emitted two types of calls. The type of call given depended upon the distance at which birds were flushed (see section 4.3.5.2.). The call given at longer distances was soft, and could not be recorded in the field. It usually sounded as a 'Ka Ka'.

The 'short distance flushing call' consists of a series of syllables of broad frequency range, which at the start of the call are indistinguishable, but become separate as the call progresses (Fig. 4.7). The initial syllables are of higher amplitude; the upper range of their frequency rises to about 7.5 KHz, but as the call progresses it drops gradually to about 5 KHz with an increase in the duration between successive syllables. The syllables in the middle of the call have most energy
Fig. 4.6 Spectrograph of the wing-whirring call of kalij.
Fig. 4.7 Spectrograph of the close distance flushing call of Kalij.
at 2 to 5 KHz. When the bird is flushed at a distance of less than 5 metres, the call is preceded by an act of very high speed wing-beating/ fluttering, which in the Figure 4.7 appears as a diffuse tone at 3.5 to 4.5 KHz at the start. The call may last for about 4 seconds, and usually ends just before, or when the bird lands on the ground.

4.3.1.7. Other call types

It is probable that a number of other call types were heard, but could not be recorded. For instance, on two occasions, when a kestrel and a mountain eagle attacked kalij feeding in the open, the birds ran into nearby cover giving a call which was a mixture of clucks and whistles, but were certainly of different frequency and duration than the commonly heard whistling and clucking.

Males were, on occasions, heard giving a soft bisyllabic call to females, probably as a part of the courtship ritual called tid-bitting. On a few other occasions, birds were seen to suddenly take off from a spot and land further away, emitting a series of very fast sounds in flight; these resembled clucks, but had individual syllables of lesser duration.

On one occasion, after a fight between two rival males, one of the males was heard giving monosyllabic calls somewhat similar to those heard during tidbitting. The individual syllables appeared to be given at a constant rate.
4.3.2. **Transition Probabilities of Call Types**

The above call types were emitted by kalij either as isolated bouts (preceded and followed by a period of silence) or in combination with other call types.

In order to see whether different call types followed each other randomly or had some order to them, a transition matrix was constructed. (Table 4.1). The elements of the matrix consisted of the four call types commonly given by kalij. However, the clucks and whistles were both given at low and high rates, and were therefore kept separate. 'Silence' was added as a seventh element to the matrix in order to identify the call types that initiate or terminate bouts.

Care must be exercised when interpreting the results of this analysis, the main aim of which was to get an idea of more common transitions between different call types. The data probably lack stationarity, and have been pooled for individuals from several home ranges who may have been interacting.

Table 4.1 shows the number and percentage of transitions that took place between different call types. The kinematic diagram (Fig. 4.9) shows the frequency (thickness of arrows) of transition between different call types, which have been derived from the row percentages of transitions in the matrix.

A total of 877 transitions were recorded between different call types. Of the six call types, slow clucking and fast clucking accounted for 75% of the bouts.
Table 4.1. Transition probabilities between various call types of kalij (N = 877). Numbers in italics are percentage frequency of each type of transition as a proportion of the total number of transitions in that row. Fig. 4.8 is a kinematic representation of these transition percentages.

<table>
<thead>
<tr>
<th>Call types</th>
<th>Slow clucking</th>
<th>Fast clucking</th>
<th>Slow whistling</th>
<th>Fast whistling</th>
<th>Purring</th>
<th>Fighting call</th>
<th>Silence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow clucking</td>
<td>0</td>
<td>0</td>
<td>42</td>
<td>0</td>
<td>8</td>
<td>5</td>
<td>169</td>
</tr>
<tr>
<td>Fast clucking</td>
<td>11</td>
<td>7.2</td>
<td>0</td>
<td>15</td>
<td>8</td>
<td>5</td>
<td>114</td>
</tr>
<tr>
<td>Slow whistling</td>
<td>42</td>
<td>40.0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>61</td>
</tr>
<tr>
<td>Fast whistling</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>Purring</td>
<td>2</td>
<td>55.1</td>
<td>0</td>
<td>1</td>
<td>2.0</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>Fighting call</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3.1</td>
<td>44</td>
</tr>
<tr>
<td>Silence</td>
<td>110</td>
<td>89</td>
<td>16</td>
<td>7</td>
<td>11</td>
<td>33</td>
<td>41.4</td>
</tr>
</tbody>
</table>


initiated. The major transitions evident from the figure are 'slow whistle to slow cluck and 'fast whistle to fast cluck'.

Figure 4.8 also shows that, of the 42 transitions possible between the seven elements of the matrix, only 30 transitions occurred, and that 16 (38.1%) of these occurred with a frequency of 6% or less. The fighting call mostly followed the other call types and led only to fast clucking, and fast whistle followed only from fast clucking. All other call types were involved in two or more transitions. All the call types except slow and fast whistling were usually followed by silence.

4.3.3. Chorusing Behaviour

This behaviour was studied in 1989 in the five closely monitored home ranges at the terracing study site in Ghanahaati. The frequency with which the holders of the ranges called in the mornings and evenings was found to vary among the ranges. Although the ranges were monitored on approximately equal number of occasions (N = 82 and 76 respectively), the frequency with which birds called in the mornings was found to be far higher than during the evenings. The morning frequency ranged between 54.4 - 86.5% among different home ranges.

The frequency of choruses, however, showed a similar trend in all the five ranges as the breeding season advanced. It increased and reached its highest point in all the ranges in the month before the onset of incubation (Fig 4.9), and came down as the incubation
Fig. 4.8 Kinematic representation of transitions between various call types of kalij. Thickness of the lines between call types indicates degree of probability of transition between them, and is based on the row percentages of the transition matrix shown in Table 4.1.
Fig. 4.9: Percentage frequency of choruses in five intensively monitored home ranges in spring 1989 at the terracing study site in Ghanahaati. N denotes the number of occasions on which the home ranges were monitored in each fortnightly period. Abbreviations: CPGA = Chir Pine Grove Area, NA = Northern Area, MA = Middle Area, KRA = Khalyani Ridge Area and SA = Southern Area.
started. The slight decline in period -1 is probably due to the low number of occasions on which birds were observed in this period. However, the frequency with which the birds from different ranges called varied widely over the periods except in the fortnight after the onset of incubation (p 1) when it differed only by a margin of 13.6 - 31.8%.

4.3.4. Play-back Experiments

Pre-recorded calls of kalij were played to birds inhabiting various ranges on the terracing site. Such experiments, 108 in all, were carried out using different call/bout types of varying duration (10-120 seconds). The birds responded on only 14 (13%) occasions. The birds were considered to have responded, if they called back within 30 seconds of the play-back. The birds did not show marked response to any particular call type.

Since the experiments failed to elicit enough responses from birds, no conclusions could be drawn. Probably the reason for the failure was that the area where the speaker was placed was neutral ground as far as range boundaries were concerned. On one occasion, however, when the speaker was placed on the presumed border between two home ranges, two groups of birds came near to the speaker. One group retreated from the speaker, but the other consisting of a male and a female came to within 5 metres, and both called intensively whilst coming closer. Their range centre was probably closer to the speaker. They, however, retreated some
distance as a result of some movement on my part, but kept on calling from there.

4.3.5. Contexts of Calls

Although the calls were given by birds all seasons of the year, they were heard more frequently during the spring. Figure 4.10 shows that the call rates (pooled for all types except flushing calls) in 1987 rose sharply in period -2, and continued at a high rate for a month. In 1988, the lack of continuous data in this season prevents drawing any definitive conclusions about the trend in call rate, but from Fig. 4.10, it can be perceived that the rate increased from period -3 to -2, and perhaps rose further before coming down in period 1. In this year, calls continued to be given after the onset of incubation also. In 1989, it increased gradually and reached a peak in period -1 just before the onset of incubation (Fig. 4.10).

4.3.5.1. Contexts of different bout types

The four most commonly heard bout types, slow clucking, fast clucking, slow whistling and clucking, and fast whistling and clucking, were looked at to examine the context in which different bout types were given.

The rate of most of the bout types was found to increase gradually as the breeding season progressed, and significantly so in case of fast clucking and fast clucking and whistling ($r_s = 0.943$, $p=.001$ for both bout types), but dropped after the onset of incubation.
Fig. 4.10 Fortnightly trend in the calling rates of kalij during spring 1987 at Waacham and in 1988-89 at Ghanahaati. ND indicates no data for those periods.
However, in the case of slow and fast clucking, the rates increased till after the onset of incubation when these call types ceased to be given. For slow cluck and whistle, the rate of calling declined as the season progressed.

In this study, a small number of interactions were observed, which either resulted in a fight or in one of the rivals being chased away. However, the majority of such instances were not observed directly, but were indicated by fighting calls. The presence of an intruder in the area was expected to cause the neighbours to guard their home ranges by announcing the occupancy of their ranges through increased call rates. This was tested by comparing the calling rates during times when fighting calls were heard from the area versus times when there were no fighting calls.

Occurrences of all bout types were pooled and tested for differences in the rates at which these were given in the mornings and evenings, and during two main types of weather, sunny & breeze and cloudy & still, prevalent in the study area during spring. No significant differences were found in the bout rate either between the mornings and evenings or during the two types of weather (p > .05, Mann-whitney U tests).

The two-sample T test (on log$_{10}$ transformed data) revealed that, the calling rate was significantly higher when fighting calls were heard in the area, than when no calls were heard (p < .0001).
The rates of individual bout types were also tested for differences between mornings and evenings. No significant differences were found except in case of slow clucking, which was given at higher rates in the morning (p<.03 Mann-whitney U test). The morning and evening were pooled for all bout types except slow clucking.

Of the four major bout types tested, the rate of fast clucking was found to increase significantly during times when a fighting call was heard (p<.05 Mann-whitney U test). No significant differences occurred in any of the other bout types. Thus fast clucking is perhaps used as a 'keep out' signal by the occupants of the neighbouring ranges.

No significant correlations were found between the different bout types, except between slow clucking in the evening and slow clucking and whistling (Spearman rank correlation, \( r_s = 0.47, t = 4.235, N = 67, p<.001 \)), otherwise their rates varied independently.

Alarm calling by kalij was observed on four occasions. On two occasions, respectively involving a mountain eagle and a kestrel, the birds ran into cover giving a similar call on both occasions. These were responded to by birds in the neighbouring ranges with same call. On the third occasion, alarm calls consisting of fast clucking and whistling were given by the birds in an area where a Langur was feeding on a tree. On the fourth occasion, three birds were heard calling in the same way for more than five minutes, probably in response to presence of a cat in the area.
4.3.5.1. Context of flushing calls

During transects along the road in Ghanahaati, birds sometimes gave a call upon flushing. From a total of 284 occasions when birds were flushed either singly or in a group, only 67 (23.6%) involved calling. The birds flushed at short distances (<10m) were significantly more likely to call ($X^2 = 10.227$, $df = 1$, $p < .01$).

There were no marked differences between callers and non-callers in the proportion of the most frequently flushed group types. Single males and females were equally likely to call when flushed ($X^2=0.3$, $N=179$ $df=1$, $p>.05$), but birds in pairs called significantly more often than single individuals ($X^2=7.1$, $N=327$, $df=1$, $p<.01$). The males and females in pairs called on equal number of occasions ($N=46$).

Of the 67 occasions on which birds called upon flushing, one type of flushing call was given on 44.7% occasions, and another type on 34.3%, and calls heard in other contexts on the remaining (21%) occasions. The 'short distance flushing call' was found to be given significantly more often at a distance of less than 10 metres (Kolmogorov-Smirnov test, $p<.001$). The other type was equally likely to be given from all distances (2-60 metres) (Fig. 4.11). Birds as singles or in pairs were equally likely to give either of the flushing calls ($X^2=2.11$, $N=54$, $df=1$ $p>.05$), and males and females did not differ significantly in their tendency to give the two call types ($X^2=0.75$, $N=33$, $df=1$ $p>.05$).
Occasions on which Birds Called upon Flushing

Flushing Call Types & Observer Distance

a) Short Distance Flushing Call (N = 27)

b) Long Distance Flushing Call (N = 16)

Fig. 4.11 Percentage frequency of occasions on which kalij emitted the short distance (a) and long distance (b) flushing calls at various distances from the observer.
The short distance flushing call was significantly more likely to be given by individuals in pairs than as singles \( (X^2=4.4, \ N=285, \ df=1, \ p<.05) \), but the long distance call was equally likely to be given by both singles as well as individuals in pairs \( (X^2= .036, \ N=272, \ df=1, \ p>.05) \). Both the call types were equally likely to be given by the males and females as singles and as individuals in pairs \( (p>.05) \).

4.3.6. Wing-whirring

Kalij are known to whirr their wings loudly. During this study male kalij were seen performing this behaviour during the breeding season. To whirr its wings, a male was observed to stand erect with its neck stretched upwards and tail close to the ground; it would then whirr its wings at a very high speed. The bird would raise and spread its crest, and would occasionally give a bisyllabic call (see above) just after whirring its wings. On one occasion a bird was seen to leap into air while whirring its wings.

Bouts of wing-whirring usually consisted of only one such bout of whirrs \( (N=165) \), but occasionally two or three bouts in quick succession \( (N=14 \text{ and } 11 \text{ respectively}) \) were also heard and/or seen. The individual bouts were mostly short \( (N=178) \), but were sometimes \( (N=12) \) of prolonged duration also.

Wing-whirring was heard only during spring. In 1987 and 1989 the rate at which it was given increased as the spring progressed. However, in 1987, it ceased abruptly
in period -2, but continued to be given minimally in the periods after the onset of incubation in 1989 (Fig. 4.12). In 1988 the lack of data for some of the periods at the beginning of the season do not permit any conclusions to be drawn.

Out of the 190 bouts of wing-whirring heard and/or seen in 1989, 153 were recorded at the terracings site. Of these, only 41 (26.8%) were followed by the wing-whirring call. Wing-whirring was actually observed on only 17 (11.1%) occasions. Of the 17 visually observed instances of wing-whirring, the males were alone on 14 (82.4%) occasions, and on the remaining occasions were accompanied by a female. The males were equally likely to call after whirring when they were alone, as they were, when accompanied by a female (Fisher Exact test, N.S., N=17).

Wing-whirring was heard in the mornings as well in the evenings. However, its rate was found to be significantly higher in the mornings compared to evenings (Mann-whitney U test, p<.001).

The frequency with which the occupants of different ranges performed wing-whirring was found to vary among ranges. In three of the five ranges, no wing-whirring was heard in early spring (i.e. Periods -6 to -4), and it began in period -5 and -4 respectively in the two remaining ranges. However, wing-whirring with varying frequency was heard from all the ranges in the period just before onset of incubation.
Fig. 4.12 Fortnightly trend in the wing-whirring rates of kalij in spring 1987 (a) at Waacham and in 1989 (b) at Ghanahaati. Z indicates no wing-whirring heard in those periods, ND indicates no data for that period, and '*' denotes data not representative.
Since wing-whirring was seen only on 11% occasions, it was not possible to fully understand the context in which birds perform this behaviour. However, one of its probable functions was to announce the occupancy of the ranges, as the rate at which it was performed went up in all the ranges if there was an intrusion in any one of the ranges.

This was tested by pooling, separately for mornings and evenings, all the bouts of wing-whirring heard from different ranges during occasions when there was a fighting call and when there was no fighting call. There were significantly higher rates of wing-whirring during mornings when a fighting call was heard in the area \( (P<.0001) \). The rates did not differ significantly in the evenings, however, the number of intrusions recorded was low \( (N=5) \) as against 19 in the mornings.

4.3.7. Wing Flapping

This behaviour differs from wing-whirring in being slow, inaudible, and in not being followed by a call. A bird, while standing, flaps its wings several times in quick succession. This may be followed by a series of body shaking movements. Usually, only one bout of wing flapping is performed at a time, but occasionally two bouts in quick succession may also be performed.

Both males and females perform wing flapping, however, males are significantly more likely \( (N=33) \) to perform this behaviour than females \( (N=4) \) \( (X^2=10.54, p<.01, N=216) \). Wing flapping was performed by males both
in company of females and when alone, and the frequency with which they did so did not differ significantly between the two situations ($X^2 = 1.8$, $p > .05$, $N = 143$).

4.3.8. Time Budgets

The time spent by birds on activities such as feeding and vigilance, and their look-up rates were compared for males and females in social groupings viz. single birds of either sex, in male/female pairs and mixed groups of large size (Table 4.2).

4.3.8.1. Feeding

There were no significant differences in the time spent by males on feeding in any of the above three types (Kruskal-Wallis test $H = 4.85$, df = 2, $p = 0.089$). However, when these group types were compared in pairs, the males in male/female pairs were found to feed for significantly more time than single males (Mann-Whitney U test $p < .04$). The females in male/female pairs fed for more time (median = 74.9% of time) than single females (37.5%), however, the difference was not significant.

Males in mixed groups of larger size fed for significantly more time than males in groups of similar size and composition in spring ($p < .002$ Mann-Whitney U test). Such comparison could not be made for females on account of low sample size.

4.3.8.2. Vigilance

The time spent on vigilance by males in the three group types did not differ significantly
Table 4.2  Number of look-ups per minute and proportion of
time spent by male and female kalij on feeding and vigilance
in different social groupings. Pairs of superscripts identify
samples that differ significantly.

Key: SM = single male, PM = male in male/female pair, LGS =
    male in large group of mixed sex in spring, LGW = male
    in large group of mixed sex in winter, SF = single
    female, PF = female in male/female pair, M = Median,
    Q₁ = First Quartile, and Q₃ = Third Quartile.

<table>
<thead>
<tr>
<th>Social grouping:</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SM</td>
<td>PM</td>
</tr>
<tr>
<td>Sample size:</td>
<td>53</td>
<td>34</td>
</tr>
<tr>
<td>Feeding (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>22.1a</td>
<td>36.1a</td>
</tr>
<tr>
<td>Q₁</td>
<td>0.3</td>
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</tr>
<tr>
<td>Q₃</td>
<td>39.1</td>
<td>66.2</td>
</tr>
<tr>
<td>Vigilance (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>27.8</td>
<td>29.8</td>
</tr>
<tr>
<td>Q₁</td>
<td>18.0</td>
<td>14.8</td>
</tr>
<tr>
<td>Q₃</td>
<td>44.1</td>
<td>44.6</td>
</tr>
<tr>
<td>Number of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>look-ups (per min.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>3.2c</td>
<td>2.7</td>
</tr>
<tr>
<td>Q₁</td>
<td>2.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Q₂</td>
<td>4.6</td>
<td>5.2</td>
</tr>
</tbody>
</table>

a  Mann-Whitney U test, P<0.01
b  Mann-Whitney U test, P<0.002
c  Two-sample T test, T = 2.3, P = 0.03
Further comparison between pairs of group types did not show any significant differences. A weak, nonsignificant correlation was found between the times spent by males in pairs on vigilance with the time spent by females in pairs on feeding. ($r_s = 0.145$, N.S., $N = 11$). The differences between the time spent by males in large mixed groups in spring and in autumn were not significant either.

The single females were more vigilant than females in male/female pairs, but the difference was not significant. The percent time spent on feeding and vigilance by females in pairs showed a negative correlation which, however, was not significant ($r_s = -0.445$, N.S., $N = 11$).

### 4.3.8.3. Look-up rate

There were no significant differences between the look-up rates of sexes in different group types (Kruskal-Wallis test $H = 0.58$, df = 2, $p = 0.748$), or when different group types were compared in pairs using Mann-Whitney U test. However, the two-sample T test of the normalized look-up rate showed that in spring, the single males looked up significantly more often than males in large groups ($p < .03$). No significant differences were found between spring and autumnal rates of look-ups in males. In the case of males and females in pairs, a strong positive correlation was found between the look-up rates in spring ($r_s = 0.785$, $N = 11$, $p < .01$).
4.3.8.4. Sequential records

In these records, the social grouping of the focal bird changed, the bird moved from one habitat type into the other during the course of a time budget, or there was a disturbance. The difference that occurred in the percentage of time spent by a bird (both sexes) when other birds joined or left its group, were found to be non-significant (Wilcoxon matched pair test, $T = 59, N = 16$). In case of males only, this difference was also non-significant ($T = -1, N = 10$).

The look-up rate and the proportion of time spent on vigilance by the birds, which moved from thicker to thinner habitat or vice versa, were also found to differ non-significantly ($T = -6, T = -13$ respectively, $N = 6$).

4.3.9. Conflict

4.3.9.1. Male-male aggression

In all, 22 instances of aggression between males were observed during the three breeding seasons over the study period. These instances ranged in nature from threatening displays, through chases to fights.

The fights, which accounted for majority of the instances of aggressive behaviour, were usually indicated by fighting calls given by the combatants, the constant sound of the beating of their wings, and of shifting of leaf litter. Most of the fights started or took place in cover and were already underway when observed. However,
initiation of such aggression was observed on five occasions, which I describe here.

On one occasion an intruder appeared in the same area in which a male and female were feeding. The male with the female walked down towards him in an arc. He was crouching low, his body feathers fluffed, tail spread and his head moving up and down as if pecking. The looked away, and also started pecking on the ground. The paired male then ran at the intruder, who, after running some distance, flew off. Afterwards, the paired male stood still for some time, his body feathers fluffed.

On another occasion, following some calls in scrub, a male-female pair and another male appeared in the open about 10m apart. They walked towards each other, and when about one metre apart they walked down the slope parallel to each other. The lone male walked further down than the paired male. Soon after, the paired male ran into the bushes from which it had appeared, and the lone male went towards the female and stayed near her. Following some unknown disturbance, the pair ran into the same area as the other male.

On the third occasion a male-female pair was feeding in a terraced crop field. The male then detected an intruder in the scrub nearby, and flew down towards it. The intruder ran some distance and then flew away giving a call.

On the fourth occasion a male was feeding in open in one of the terracings. Another male appeared and chased
the male already present. The first male flew a distance of about 20m.

On the fifth occasion, a pair appeared at the bottom of a set of terracings, and made their way upwards into a terracing where a lone male had just emerged from cover. The paired male ran at him and pecked at his head. The lone male retreated into the scrub. The paired male then fed alongside the female, and were joined by another female who had emerged from cover whilst the males were in conflict.

The fighting males typically crouched low with their feathers fluffed, tail spread, and crown raised and spread. On one occasion, one of the males was seen standing upright moving his head from one side to the other, while the other male was in the usual fighting posture.

The combatants leapt in air to attack each other with their feet; they beat their wings constantly, and emitted fighting calls. Attacks were made by both combatants, but once most of the attacks were made by one male. He was later seen walking with the female after the end of the fight. Once in the middle of a fight the two birds walked parallel to each other, their feathers fluffed and bodies crouching low, and then fought again. Whilst fighting, the birds typically moved quite large distances (about 15 - 40m).

The fights usually ended with the loser walking away. This happened in three of the four fights which were seen concluding. However, in one instance, both the
males remained in the same area, about three metres apart, but with one of them closer to a female.

Males were observed chasing other males on two occasions. On five occasions, however, the males chased their opponents in flight. On two occasions, two males took off suddenly after confronting each other. On two other occasions the two males took off from among trees and after flying in a circle on one occasion and flying some distance on the other, they landed in the same general area. On two other occasions, males flew off from home ranges just before the presumed owner arrived in the vicinity.

Males did not behave aggressively towards other males on all occasions when they were together. On 10 such occasions a group of two males, with a female on nine occasions, were observed feeding close together without any overt sign of aggression.

4.3.9.2. Female-female aggression

Relatively few observations of long duration were made on groups containing two or more females. Of a total of seven such occasions, no aggression was observed in four. Two of these instances consisted of a group of three females and a male who feeding in an abandoned terracing a short distance from each other.

On the third occasion, two females emerged together from cover and climbed into a bush of Rosa sp. to eat its fruit. They were joined after some time by a male-female pair. The birds later separated without any indication of
aggression. On the fourth, two females and a male were seen feeding close together in leaf litter near one of the terracings.

The three instances involving acts of aggression took place in the same home range. On one occasion, a male and a female were feeding on weeds at the edge of a terracing. Five minutes later, another female appeared at the edge after calling for about two minutes amongst the vegetation in the impoundment of the terracing. The new female, as soon as it appeared, started walking slowly towards the paired female who had also started moving away from the male. The paired female flew into the trees on the west of the terracing. The new female also went into the same area after some time. There was some calling in the area which was followed by the sound of shifting litter, probably indicating an interaction. Five minutes later, only one female was seen with the male.

On another occasion a female was feeding on wheat in the same terracing as above. After some time another female appeared, and the one already there walked about five metres away towards east and started feeding there. The new female then advanced towards her, feathers fluffed and crouching low, and broke in to a run as she came closer to the first female. The first female flew away from the area.

On the third occasion a male and a female were feeding on wheat grains scattered on the terracing after the harvest. A female appeared in the terracing from the impoundment below. The paired female ran towards her and
chased her for some distance before she flew into the cover on the west of the terracing. The paired female then rejoined the male, and they went down into another terracing to feed where some time later another female appeared, but this time there was no aggression.

On three other occasions in the same home range, females were seen emerging from cover, running or flying, and without any apparent sign of conflict. In two of these cases a male-female pair also emerged from the areas from where the females ran away. On the third occasion a female appeared in an area where a pair were feeding. The two females took off suddenly, following some fluttering sound, and flew away. On a fourth occasion, recorded in one other home range, a female came running down the slope followed by another female. They stopped briefly and then resumed running.

4.3.10. Courtship

Courtship behaviour between males and females was observed in the later part of spring, mostly in the month before onset of incubation. The majority of the instances of this type of behaviour consisted of tidbitting commonly seen in galliforms (Johnsgard 1986). This behaviour was seen on 12 occasions, and took place mostly in terracings where grains of wheat were scattered on ground after harvest. A male would usually locate a few grains of wheat and would call the female to it. She would usually go running and peck at the grains close to the beak of the male.
On one other occasion, a male appeared at the edge of a terracing in which a female was feeding among wheat plants. The male also started what appeared as feeding, but which actually was just a movement of head up and downwards (bobbing) whilst looking at the female. No call was given by the male during this behaviour.

On another occasion, when a fight had just ended, a lone male standing near a heap of wheat husk was seen moving his head in a similar way as tidbitting, perhaps picking up and dropping grains of wheat from the husk. He was heard giving soft calls at a constant rate.

The lateral courtship display was observed on three occasions. On two occasions it followed copulation, and on one preceded an attempt by the male to mate with the female. During a display, a male typically walked in an arc in front of the female, body feathers fluffed, crouching low, and the wing on the side of the female held low.

Matings were recorded towards the middle of the spring, one as early two months before the presumed onset of incubation. Of the three instances of mating witnessed, one was already in progress when noticed, but in one of the remaining two, the male ran from a distance of about two meters towards the female, and in the other case the male was standing close to the female when he mounted. On all three occasions, however, the male whilst mounted, moved his head from one side of female's nape to the other, probably trying to clutch at it to balance himself or to have a firm grip on her.
After mating, the males performed courtship display on two occasions, but attempted to mount again on only one of these occasions. On the remaining occasions male stood near the female, flapping its wings on one occasion, and shaking its body on the other. The females shook their bodies after the act on two occasions, and on the other walked away from the male.

On four occasions males were observed to detect a female and fly to her or would run at the female feeding nearby and chase it some distance. The female in all cases flew way from the area giving a call.

On two further occasions, males were seen to run at females who were feeding alongside them, but the males did not attempt to mate. The females continued to feed alongside these males, and in one case also responded to a tidbitting call given by the male after running at her.

4.4. DISCUSSION

4.4.1. Vocalizations

Study of the calling behaviour of kalij revealed that they have a repertoire of at least 11 different call types in the wild. However, only two of these account for the bulk of calling heard in spring. The rate of calling increased as the breeding season advanced and reached a peak in the two-week period just prior to onset of incubation. Both calling and wing-whirring rates increased significantly when one of the neighbouring ranges was faced with intrusion. Birds in male/female
pairs were found to give a high frequency call when flushed at short distances.

Kalij have a diverse calling repertoire, the size of which far exceeds those of other intensively studied Himalayan pheasants (e.g. Lelliott 1981, Kaul 1989). Heinz and Gysel (1970 in Johnsgard 1986) found that in the ring-necked pheasant, different call types are associated with the sexes and juveniles. Of a total of 15 call types they found that three were characteristic of chicks, six of females, three of adult males and two were common to adults of both sexes. Although both male and female kalij were seen giving the major call types, over 95% of the calls were given by birds in cover, so that the precise context of many calls could not be judged. Chicks, about 6 weeks old, were heard giving calls on one occasion which superficially resembled the clucks and whistles of adults.

Wood-Gush (1971 in Johnsgard 1986) reported a total of 19 different call types for domestic fowl, a number of which were characteristic of laying or broody females. It is therefore rather likely that some call types which were associated with behaviours not observed during this study were missed.

The ring-necked pheasants have a crowing call which is distinct from other vocalizations (Heinz & Gyzel 1970 in Johnsgard 1986), and which though given throughout the year, is given at higher rates particularly during March to May (Hill & Robertson 1988). The red jungle fowl also has a distinct crowing call which it gives in the
breeding season (Collias & Collias 1967). The cheer pheasant uses a combination of 'chut' and 'cheeweewo' call types during its dawn and dusk choruses (Kaul 1989). The koklas pheasant also has a definite crowing call which it gives during and after the spring season (Sevringhaus 1979, Lelliot 1981). Among the different races of kalij, only the black-backed kalij (Lophura leucomelana melonata) is reported to crow regularly from its roosts at dawn and dusk in the breeding season (Ali & Ripley 1983).

Ali & Ripley (1983), Johnsgard (1986) and Gaston (1980) regard kalij as having a distinct crowing call, which is generally heard from March through May. During this study, it was found that kalij do not have a crowing call per se as none of the four major bout types were given with any regularity as has been observed in the species mentioned above. Calling rates were found to increase significantly when fighting calls were given by birds nearby, suggesting that calling in kalij has a function in preventing the rivals from intruding upon a range. Some more evidence regarding the role of calls in home range defence was obtained from playback experiments (see section 4.3.4.).

Peek (1972) and Krebs (1976) (both in Catchpole 1979) conducted experiments on passerines, and demonstrated that the song was used by these species as a 'first line of defence' against intruders. Of the four major bout types given by kalij, only fast clucking was given at significantly high rates during times of
apparent intrusion. This suggests that fast clucking is used as a 'keep out' signal by the birds.

Another behaviour of kalij that was found to be associated with the vocal announcement of the occupancy of the ranges was wing-whirring; its rates were also found to increase significantly, in all the ranges, when one of the ranges was faced with intrusion. This behaviour is performed by most of the galliforms, and by all members of the genus *Lophura* (Johnsgard 1986). Delacour (1977 in Johnsgard 1986) regards this as a courtship display in case of kalij, but in this study males were seen to do this more often when by themselves than when accompanied by females.

Kaul (1989) regarded wing-whirring as a courtship display in the cheer pheasant. Its rate went down as the breeding season progressed, and it was at its highest in March when territories were being established. However, the fact that pairing in cheer also takes place at the same time at which territories are established, suggests that in this species it may have a dual function of repulsion of rivals and attraction of mates. The ring-necked pheasants whirr their wings after they emit the crowing call (Ridley 1983). Since it carries over a distance of only about 100 metres, Ridley regarded it as a means of communication over short distances.

The transition probabilities of various call types suggest that bulk of calling in kalij occurs as pure bouts of slow and fast clucking, which on a quarter of occasions lead to other call types with varying
frequencies. Transition between call types are known in some other pheasant species. In cheer pheasant, calling bouts begin usually with a few 'chut' calls which are followed by 'cheweewo' call type; the 'sree' call in blood pheasant precedes the 'squeal' call (Lelliot 1981), and the crowing call of koklas pheasant has a number of variants resulting from the change in the sequence of the elements (Severinghaus 1979, Lelliot 1981). In both cheer and blood pheasants, the transition is always one-way, and in case of koklas, the elements which show transition are integral parts of the crowing call, and are never emitted by themselves. In kalij, on the other hand, 30 out of 42 possible transitions were recorded, and with the exception of whistle call, all the call types were given as isolated bouts on occasions as well. It is this that gives the kalij vocal repertoire its tremendous complexity (Roberts 1970). It also leads one to speculate whether these transitions represent different stages in the communication between rivals, neighbours and mates. This, however, needs to be studied further by comparing the transitions between call types of individuals within and across home ranges, during intrusions and otherwise, whilst the birds are under observation.

Whistler (in Ali & Ripley 1983) stated that 'both sexes [of kalij] cluck in soft undertones when scratching among thickets for food', and Baker (1930) reported that the undisturbed birds communicate by contact signals such as 'kurr-kurr-kurrchi-kurr'. In this study most of the
observations of birds were made in the open at distances greater than 40 metres during which no calls were given by the birds. However, the description of the contact call given by Baker resembles slow clucking and whistling, which like the other major bout types, was given by birds in cover. This particular bout type did not show any definite trend during the season, and was probably given by the birds for short distance communication. Soft calls that may have a contact function are given by a number of other pheasants (e.g. Lelliot 1981, Kaul 1989).

The birds gave a number of call types upon flushing. Of these, the one given at long distances was equally likely to be given by both males and females, and by single individuals as often as birds in pairs or groups. This call appeared to be given when the bird was mildly surprised or when faced with an unfamiliar looking object. Another call type, given when flushing distance was short (10m or less) had higher frequency (7.5 KHz) and amplitude than all other call types. This particular call type has been mentioned in most of the reports on kalij (Whistler in Ali & Ripley 1983, Johnsgard 1986, Bump & Bohl 1961). Catchpole (1979) regards such calls as distress calls, and suggests that because they are of high intensity, they might possibly startle or confuse the predator and allow the bird to escape. During this study, however, this call was given significantly more often by individuals in a male/female pair than when
alone, suggesting that it is also given by these birds to warn their mates.

Chorusing behaviour of the birds was found to be highly variable. However, the extent of this variability narrowed considerably in the period after the onset of incubation. Crowing of the ring-necked pheasant has been used to estimate its population density (e.g. studies cited in Ridley 1983), and the estimate of birds from dawn chorus has been suggested as a potentially effective method for use on the cheer pheasant (Young et al. 1987). The chorusing behaviour of the cheer pheasant varies in the early part of the season, but as the breeding season advances, it becomes less variable. Young et al. (1987) suggested that the most appropriate time to estimate the density of cheer is during incubation i.e. the month of June, when the male and female roost separately and call to each other before joining to feed. They provide a correction factor, based on the average chorusing frequency of different groups, for application to the number of calling sites to deduce the number of breeding pairs in a given area.

In case of kalij also, the chorusing frequency was found to vary least (between 13.6 and 31.8%) in the period when incubation was in progress. This period, which may differ slightly from year to year, falls between late-May and late-June at Ghanahaati. Kalij calls during this study were heard up to a distance of 120-150 metres (strip width) on a calm day, and usually only one bird, presumably the male, called from each locality.
This information could serve as the basis for estimating the density of kalij for a given area. However, during times of intrusion, two birds may be heard calling which could be either the rivals or the pair owning the range. The census should be conducted in the morning, as calling frequency was found to be far higher in the mornings than in the evenings.

Play-back is unlikely to be an effective method for censusing kalij, as the birds appear to respond only when the speaker is placed between two neighbouring home ranges. Different call types and bout types recorded from the birds or synthesized artificially from different call types, need to be broadcast in order to determine which call type elicits responses from all or most groups of birds. The fighting calls might elicit response from most groups, perhaps only if the home ranges are contiguous. Most groups responded to a call type given by birds when an aerial predator attacked them; this call type should also be considered for use in the play-back experiments.

In view of the low frequency with which birds call during the incubation, and their probable limited response to broadcasts of calls, these methods are unlikely to be efficient and effective in estimating numbers of kalij. Perhaps the most suitable method to census kalij is to walk along transects through the suitable habitat in a given area. Gaston (1980) also suggested this method (albeit driving instead of walking) as the one likely to produce best results.
4.4.2. Time Budgets

The time spent on activities such as feeding and vigilance in spring by the two sexes in three commonly observed group types did not differ significantly. However, one of the most important findings in this study was that males in male/female pairs spent significantly more time feeding than single males, and the females in pairs also fed more than single females but not significantly so. In addition, the look up rates of males and females in pairs showed a significant positive correlation. Thus, the behaviour of male and female in a pair appear to be similar, and not different as would be expected if males were acting as sentinels for detection of intruding males or predators.

A possible explanation of the rather different behaviour of kalij in this context lies probably in its habitat preference. As has been demonstrated in Chapter 5, kalij prefer to feed in open areas very close (5m) to cover. The majority of the time budgets of birds were recorded either on terracings less than 5m from scrub or in terracings with dense crops about 50-80cm high. It seems preference for such habitat accrues substantial benefit to kalij in terms of protecting them from aerial predators, which are a potential source of danger for birds feeding out in the open. Its other benefit to the birds, and particularly the males, is in increasing the overall rate of food intake by not having to stand guard for large proportions of time. This, however, does not mean that kalij males do not guard their mates, as some
evidence to the contrary was found in the time budgets of females: they fed more in pairs but not significantly so, than they did when by themselves, thereby indicating that they benefit from the presence of males. The significant positive correlation between the look up rates of males and females in pairs suggests that they both watch for intruding males and/or ground predators, but this does not seem to affect the food intake of females significantly.

Males in some species of monogamous birds spend most of their time guarding their mates during their fertile periods (Birkhead 1979, 1982; Lumpkin et al. 1982). Mate-guarding is known to occur for longer periods in some monogamous game birds such as the grey partridge (Jenkins 1961) and cheer pheasant (Kaul 1989) as well as in some polygynous species such as the ring-necked pheasant (Ridley & Hill 1987) and the red jungle fowl (McBride 1969 in Ridley & Hill 1987). The explanation of this behaviour by males lies in the fact that in all of these species there are a number of non-territorial or unpaired males which seek to mate with the females by force (Avery & Ridley 1988). The males thus mantain a constant vigil, and stay close to their females.

4.4.3. Conflict

Male and sometimes female kalij were observed to behave aggressively towards other males and females. There is little information in literature regarding the aggressive behaviour shown by different races of kalij or
by other species of *Lophura* (e.g. Ali & Ripley 1983, Johnsgard 1986). However, most of the types of aggressive behaviour observed resembled those of the ring-necked pheasant (Ridley 1983, Hill & Robertson 1988).

The male kalij threatened the intruders with aggressive displays first, as was observed when intruders were made to leave the area without any fighting. It is not clear how fights start, but on a number of occasions they were preceded by bouts of calling, sometimes involving two birds. It is probable that fights result only if an intruder persists in the area. The ring-necked pheasants avoid the risk of injury by using an escalating series of aggressive displays leading to a fight only if the intruder stays in the area (Ridley 1983).

The majority of fights between male kalij were seen in the fortnight before the presumed onset of incubation, and in the following fortnight when about half of the females had probably not yet started incubation. In contrast, Ridley (1983) observed most fights in ring-necked pheasants early in the season when territories were being established, and not at the peak of fertile matings. For Cheer, Kaul (1989) recorded the only fight, and the peak of territory defence behaviours, in early March. These findings again contrast with those on kalij and suggest that aggressive displays as well as fights have a more important function of deterring males from stealing copulations than in territory defence.
4.4.4. Courtship

Kalij were seen performing courtship behaviour in the fortights just before and after the onset of incubation. The most frequently seen behaviour was tidbitting, in which a male called a female to a morsel of food. This behaviour has been observed in most species of the genus *Lophura* (Johnsgard 1986), as well as in some other pheasant species such as the ring-necked pheasant (Ridley 1983), and the cheer pheasant (Kaul 1989). Tidbitting display was performed by territorial male ring-necked pheasants to the regular harem members in the later part of the mating season (Ridley 1983). The cheer pheasants perform this behaviour throughout the spring, but show an increasing tendency to do so up to the onset of incubation, after which it ceases completely (Kaul 1989). Tidbitting seems to be performed when the females are in their most fertile period and Ridley (1983) regarded it a means of enhancing the pair bond between the harem members and the male in the ring-necked pheasant.

The other type of display performed by male kalij was the lateral display, an element of courtship in many pheasant species (Johnsgard 1986). Ridley (1983) observed it to be commonest early in the season during harem formation, and speculated that it was used to recruit harem members. Later in the season, he observed this display being made to strange females perhaps to accept mounting.
In this study two out of three such displays were made to females with whom the males had just mated, and were perhaps made to solicit further copulation. There was no indication of males using force as female did not make attempts to escape (as observed by Ridley). On one occasion, however, a female responded to the display by walking away, although she stayed near the male for considerable period of time after that.

4.4.5. Conclusion

Kalij have a complex system of communication consisting of a diverse repertoire of calls, and a multitude of aggressive and courtship displays. This study has demonstrated that calling and wing whirring in kalij are associated with breeding, and probably with home range defence, mainly at times of intrusion by rival males. The rivals are persuaded to leave the area by means of a series of threatening displays, which if not heeded, lead to fights.

Members of pairs, on the other hand, benefit from each others presence whilst feeding in the open through increased feeding rates as a result of high levels of combined (corporate) vigilance. They warn each other of potential danger by means of a high intensity call, and whilst in cover, perhaps call to each other when separated.

This account is not a complete picture of the social repertoire of kalij. The fact that almost all of the calling took place in cover, made it difficult to
understand the context in which different call types were given. Such understanding would have been aided by playback experiments, but these could not be carried out in a systematic manner because of some difficulties faced in the field, including the susceptibility of the equipment to defects. A third important obstacle which prevented a full understanding of the contexts of different aggressive and courtship behaviours was the lack of identity marks on birds.

A future study on the behaviour of kalij must involve marking the birds individually, and should include as its objective an extensive series of experiments using call play-back. The experimental design must include recording the calls of birds (males and females) from neighbouring ranges both calling spontaneously and at times of intrusion, to study their structure for possible individual variations i.e. the sequence and relative frequency of different elements, pitch (KHz) and intensity or amplitude (dB). The playback of the calls of strangers, of neighbours, and of mates, and analysis of the response of birds to these, will provide insight into perhaps one of the most sophisticated system of communication of any of the gamebird studied so far.