A study of the emission of social calls by *Pipistrellus* spp. within central Scotland; including a description of their typical social call structure

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Abstract

During the period 2001 to 2005 BaTML surveyors monitored the echolocation calls made by *Pipistrellus* spp. along the canal network that connects the east coast of Scotland with the west coast. During these activities the methods adopted allowed us to simultaneously look at social calls emitted and allocate these to species. When considering these results we found that although the highest emission rate is, as expected, during the month of September, high rates of emission also occur earlier in the bat season.

We have also taken this opportunity to describe the typical social call structure relating to the three species of pipistrelle bat thought to be present within Scotland, namely: *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus* and *Pipistrellus nathusii*.

Key words: BaTML, echolocation, bat, *pygmaeus*, *nathusii*

Introduction

Echolocating bats emit high frequency (ultrasonic) pulses, called echolocation, in order to assist with navigation and foraging (Altringham, 2003). In addition to echolocation, bats also use vocal communication (social calls) in a wide range of circumstances (Fenton, 2003) and these calls, in comparison with echolocation, are more complex and of a lower frequency in order that they can be heard over longer distances (Lawrence & Simmons, 1982). Although our knowledge regarding many of the social calls used by bats is limited, it is widely thought that bat social calls can occur for a variety of reasons, including: female/infant interaction; mate attraction ('songflight' and 'advertising' calls); territorial defence; aggression; distress (Pfalzer & Kusch, 2003).

Within Europe, five species of pipistrelle occur, of which the following three are considered to be present within Scotland: *Pipistrellus pipistrellus* (Bandit or Common pipistrelle), *P. pygmaeus* (Soprano pipistrelle) and *P. nathusii* (Nathusius' pipistrelle).

P. nathusii is regarded as rare in Scotland, with no breeding records discovered to date. It is however considered to be very likely breeding within Scotland, albeit rarely, and in time it is hoped that roosting records will materialise. A number of roosts and comparatively more records have been found in Northern Ireland and England (Russ & Montgomery, 2002; Russ *et al.*, 2001).

Within our study area, the canal corridors in the Central Belt of Scotland, by far the most commonly occurring *Pipistrellus* spp. appears to be *P. pygmaeus*. This species, which has been shown to have a close association with riparian habitat (Vaughan *et al.*, 1997; Russo & Jones, 2003; Davidson-Watts & Jones, 2006), is almost always encountered during our survey activities.

P. pipistrellus also occurs, however, with the exception of one location (Edinburgh City), it appears to be the less common, by far, of the two species. This species of bat has been shown to be more of a generalist in terms of its habitat selection, albeit it does include riparian type habitat within its portfolio (Vaughan *et al.*, 1997; Russo & Jones, 2003; Davidson-Watts & Jones, 2006).

As part of a separate study conducted by BaTML (Clear, 2005) we sought to establish if the predominant occurrence of *P. pygmaeus* within the canal corridors was as a result of habitat selection or alternatively, could it be resulting from a more general abundance of this species compared to *P. pipistrellus* within this part of Scotland anyway. In that study we found that it would appear that *P. pygmaeus* was the more common species of the two, irrespective of habitat type and that *P. pygmaeus* was also found in habitat types where water did not feature (e.g. woodland areas well away from riparian habitat). As such it would appear that *P. pygmaeus* may be much more of a generalist in its habitat selection locally than we would have anticipated.

Materials & Methods

During our pipistrelle surveys within the study area (Middleton *et al.*, 2005) we recorded the echolocation calls of commuting and foraging *Pipistrellus* spp. using a time expansion detector (Courtpan, EcoTranquility). This aspect of our work was carried out in order to establish their relative abundance and map their distribution. This study lasted 5 years (2000 to 2005) and involved 106 survey nights. Each survey commenced at 30 minutes after sunset and lasted for 90 minutes thereafter (Middleton *et al.*, 2005). The results relating to the echolocation data collected will be reported upon separately.

Due to the methods adopted in the fore-mentioned survey, it was also possible to simultaneously record, and allocate to species, the social calls emitted during each of the 106 survey evenings. Therefore, any recorded social calls were allocated to species based on previous studies (Barlow & Jones, 1997a & 1997b; Pfalzer & Kusch, 2003), as well as descriptions provided in published guides (Barataud, 1996; Tupinier, 1997; Russ, 1999).

It should be noted, that we have made no attempt in this study to separate non-mating social calls (e.g. 'agonistic calls' emitted during foraging and/or commuting) from 'advertisement' or 'songflight' calls (i.e. comprising of a longer sequence used by male bats whilst trying to attract a mate) (Sachteleben & von Helversen, 2006).

Description of Social Calls for *Pipistrellus* spp. occurring in UK

Prior to us discussing the results from this study we felt it useful to provide a brief overview of the typical social calls relating to the three recognised species of pipistrelle occurring within the UK.

The calls described within each of the following sub-sections are by no means the full repertoire for the species described. As previously discussed, bats make social calls for a variety of purposes. During our study we were recording bats whilst commuting and/or foraging (i.e. away from roosts). As such, what follows are the most commonly encountered call structures in these circumstances, albeit 'variations of a theme' can apply to each.

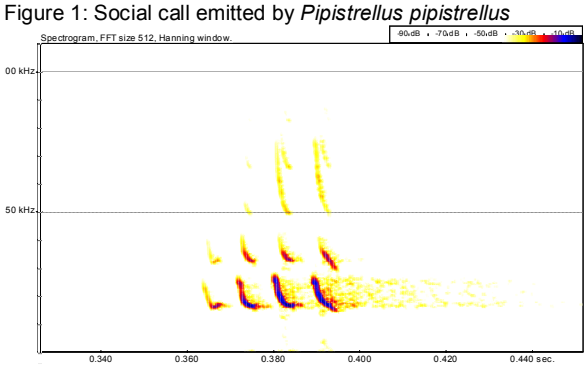
The following descriptions are accompanied by a figure providing a sonogram (Pettersson Elektronik AB, BatSound, V3.0) of a social call slowed down 10 times (i.e. as recorded using a time expansion detector). The methods used by BaTML in recording and analysing such data are described in Middleton, *et al.*, (2005).

Pipistrellus pipistrellus

Generally speaking the frequencies used by this species during 'songflight' (i.e. 'advertisement') are lower and of longer duration than that of *P. pygmaeus* (Barlow & Jones, 1997a). Usually there are four components to the call (as shown in Figure 1), however occasionally, calls with three or five components do occur. In the study referenced (Barlow & Jones, 1997) it was found, that on average, the frequency of maximum energy of all components to the call, measured 17.9 kHz (+/- 0.9 S.D.). This was calculated from the frequency of maximum energy occurring for each individual component. Further, Barlow & Jones (1997a) also found that these calls were emitted, on average, at a rate of 1.42 calls per second.

'Agonistic' calls of this species are very similar to their 'songflight' calls, only they are produced randomly, often in isolation, and not as part of a longer, concentrated series of calls. On average it has been found that these calls occur at higher frequencies relative to their songflight calls. For example, when frequency of maximum energy is measured, as described above, a slightly higher result (19.8 kHz +/- 2.53 S.D.) would be expected (Barlow & Jones, 1997a).

Figure 1: Social call emitted by *Pipistrellus pipistrellus*

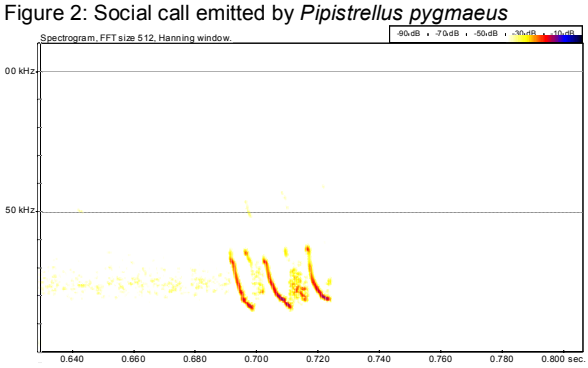


Pipistrellus pygmaeus

Generally speaking the frequencies used by this species during 'songflight' (i.e. 'advertisement') are higher and of shorter duration than that of *P. pipistrellus* (Barlow & Jones, 1997a). Usually there are three components to the call (as shown in Figure 2) however, occasionally calls with two or four components occur. In comparison with *P. pipistrellus*, usually the final component of a call produced by *P. pygmaeus* is higher than its preceding components (Russ, 1999). In the study by Barlow & Jones (1997a), it was found that, on average, the frequency of maximum energy of all components to the call, measured 20.8 kHz (+/- 1.4 S.D.). This was calculated from the frequency of maximum energy occurring for each individual component. Further, this study also found that these calls were emitted, on average, at a rate of 1.73 calls per second.

'Agonistic' calls of this species are very similar to their 'songflight' calls, only they are produced more randomly, often in isolation, and not as part of a longer, concentrated series of calls. Barlow & Jones (1997a) found that there was no significant difference in any of the parameters they measured between the 'songflight' and 'agonistic' call structure for *P. pygmaeus*.

Figure 2: Social call emitted by *Pipistrellus pygmaeus*

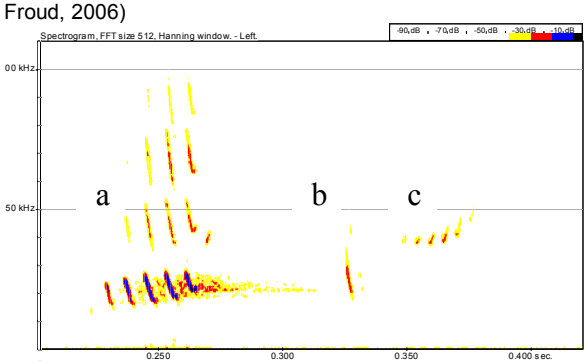


Pipistrellus nathusii

Typically the social calls of *P. nathusii* are quite easy to differentiate from the other two *Pipistrellus* spp. occurring within the UK. In addition, these calls are also very different to that of *P. kuhlii* which occurs on mainland Europe and typically produces calls of 2 components (Barataud, 1996).

P. nathusii social calls usually end with a 'trill' effect (e.g. 'c' within Figure 3). Between the opening sequence (e.g. 'a' within Figure 3) and this 'trill' there is usually a single component, frequency modulated call (e.g. 'b' within Figure 3) (Russ, 1999). Even whilst listening to these social calls using a heterodyne bat detector, it is possible, at times, to hear the double note effect produced by the two longer sequences of this bats typical call (French & Froud, 2006). These social calls (whether 'agonistic' or 'advertisement') are considered to be 100% reliable when separating this species of pipistrelle from all others within the UK and indeed throughout Western Europe (Barataud, 1996; Tupinier, 1997).

Figure 3: Social call emitted by *Pipistrellus nathusii* (French & Froud, 2006)



Results

During our five year study period, 946 social call emissions were recorded from a total of 106 survey evenings (159 survey hours). As a whole this represents, on average, 5.95 social calls recorded per hour and 8.92 social calls per survey (90mins). A summary of our data is provided within Appendix I.

As anticipated, by far the bulk (89%) of social calls encountered during this study clearly belonged to *P. pygmaeus* (Figure 4). As previously discussed this species shows a preference for riparian habitat (Vaughan *et al.*, 1997) and also appears to be far more common locally, irrespective of habitat type (Clear, 2005).

P. pipistrellus accounted for 7.40% of our recordings, whilst 3.60% could not be allocated to species as they were unclear with regard to their structure. Even if all of these unidentified calls belonged to *P. pipistrellus*, we would still have a considerable bias towards *P. pygmaeus* in our encounters. At no time during these studies did we come across social calls resembling those of *P. nathusii*.

Figure 4: Percentage split of social calls emitted, allocated to species

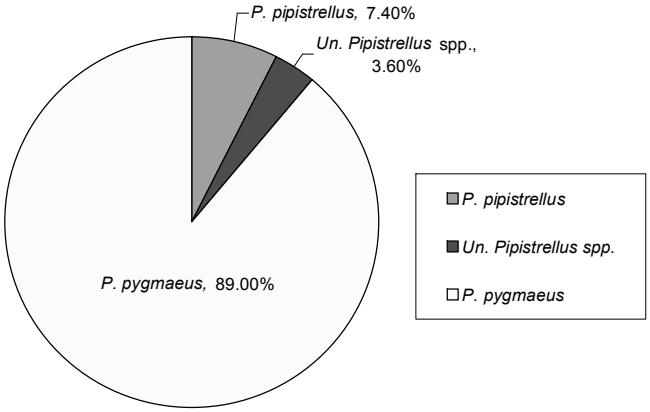


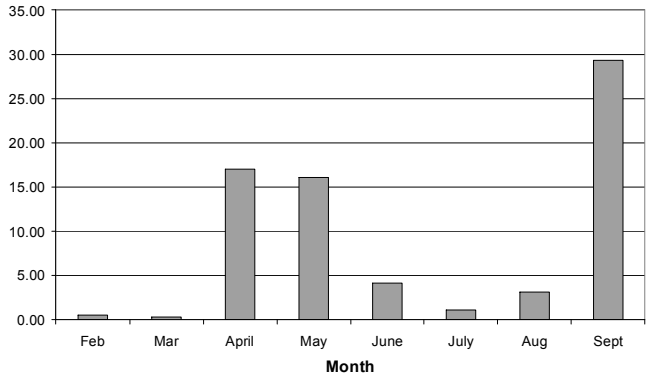
Figure 5, below, describes the total number of social calls emitted on a monthly basis during the period 2001 to 2005 (five years). No surveys were undertaken during the months of October to January annually. In February and March we encountered a total of three calls in five years, giving us an average social call emission rate per survey of 0.5 and 0.33 respectively. Generally speaking bat activity is very low at this time of year anyway and the low incidence of social calls is probably directly related to the low occurrence of active bats. In addition it should also be highlighted that our survey effort at this time of year has been substantially less than during the warmer months.

From April onwards bats become considerably more active (Gourlay, 2004). Our social call rate during these months increased considerably to an average of 17.00 and 16.07 calls per survey respectively.

The months of June, July and August registered far less social call activity during our surveys. The average call rate per survey during this period reduced to 4.18, 1.13 and 3.12 respectively.

Finally, in September our social call emission rate increased to an average of 29.30 per survey. This level was by far the highest rate of social call activity encountered during our study.

Figure 8: Monthly distribution of *Pipistrellus* spp. social calls



Discussion

In a recent study in Germany (Sachteleben & von Helversen, 2006) it was observed that 'songflight' activity (i.e. 'advertisement' calls) in *P. pipistrellus* was at its greatest during the month of September. This study also found that 'songflight' activity usually occurred later in the evening, with no such calls occurring during the first hour of activity prior to mid August. However as the mating season (autumn) progressed the call rate did increase and also occurred earlier in the evening.

In an earlier study, carried out in Sweden, relating to bats we now know were *P. pygmaeus* (Gerell & Lundberg, 1985) there is nothing to suggest that the behaviour of this species differs from *P. pipistrellus* with regard to its increased 'advertising' call activity in autumn.

In our study we made no attempt to differentiate calls beyond a generic social call category. However, having considered our observations, it would be reasonable to assume that the increase in our activity during the month of September was influenced by the presence of 'songflight' and 'advertisement' calls.

In comparison, the low emission rate during June, July and August is not surprising, as any 'advertising' that could be generated from males, may be more likely to occur later in the evening and after our survey activities had concluded.

One aspect of our study that we are currently unable to explain is why the April/May social call emission rate should be notably different to the June/August period. If anything we would have expected generic social call activity to possibly be higher during late summer as female bats communicated with their offspring during initial foraging bouts. The author would welcome any correspondence relating to potential explanations for these results.

This study was very much a by-product of a far wider look at the echolocation calls of *Pipistrellus* spp. locally. As such, our methods were not specifically designed to study social call activities. Bearing in mind this shortcoming in our collection of data, there are certainly a number of opportunities for a more substantial and focussed study of pipistrelle social calls locally, for example:

- A study incorporating the period beyond September annually.
- Studies resulting from the isolation of social calls between 'non-mating' and 'advertisement' calls.
- A more thorough look at social call emission rates and structure during springtime bat activity.

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Appendix I: Summary of results

Table 1: A summary of the results relating to the emission of social calls from *Pipistrellus* spp. during the period 2001 to 2005

Month	Surveys Completed	*P. pipistrellus*	Unidentified *Pipistrellus spp.*	*P. pygmaeus*	Monthly Total	Average Per Survey
Feb	2		1		1	0.50
Mar	6			2	2	0.33
April	15	53	18	184	255	17.00
May	14	6	2	217	225	16.07
June	17	5	3	63	71	4.18
July	16		2	16	18	1.13
Aug	26	6	8	67	81	3.12
Sept	10			293	293	29.30
Totals	**106**	**70**	**34**	**842**	**946**	
%age		**7.40%**	**3.60%**	**89.00%**	**100.00%**	
Average		**0.66**	**0.32**	**7.94**		**8.92**