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Comparison of the onset of dawn chorus of bulbuls and house sparrows in two different geographical locations: effect of climate, noise and light pollution

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Abstract

The onset of dawn chorus was studied for a period of fourteen months for bulbuls (*Pycnonotidae*) and house sparrows **(***Passer domesticus)* in two different geographical locations. One is very quiet and semi lit place in the suburbs of the small Mediterranean city of Tulkarem/Palestinian Authority. The other location is comparatively noisy and very well lit place in the Ar-Rayyan urban district of the city of Riyadh/ Saudi Arabia where desert climate prevails. This study is the first of its kind and clearly shows that the timing of dawn chorus is similar for autumn and winter seasons in both locations but major differences were observed from February until September between the two locations. It can be concluded that very early timing of dawn chorus during spring / summer for the Riyadh location cannot only be attributed to breeding season and is temperature dependent (strong positive correlation, r>0.6). The similarities for autumn and early winter between the two locations is very interesting in that it is not in agreement with the notion that big cities (urbanization) influence the timing of dawn chorus due to noise and light pollution. This emphasizes that dawn chorus is a complex process and that change in the onset and pattern of dawn chorus can not merely be attributed to one variable such as noise or light pollution alone.

Key words: Bulbuls, House Sparrows, Dawn Chorus, Climate, Temperature, Noise, Light, Pollution

Introduction

Photoperiod is widely believed to be the major factor that determines the onset of dawn and dusk chorus in passerine birds. Climate, light and noise pollution can influence avian behavior in many ways including the onset of dawn chorus.

Environmental factors such as climate (Westcott, 2001; Botero et al., 2009), noise (Fuller et al., 2007; Slabbekoorn and Peet, 2003) and light pollution (Rodriguez, 2009) all influence bird behavior in many ways including timing of bird song and singing patterns. Therefore, it is widely accepted that climate change, noise and light pollution will induce changes in the timing and pattern of daily dawn chorus, i.e. artificial light causes birds to sing earlier (Miller, 2006) and to sing at a higher bitch in noisy areas (Fuller et al., 2007). Individual temperate songbird species begin singing at characteristic times each morning (Allen, 1913). Animals in their natural habitat rely on the cycling of the sun (photoperiod) and the seasons to adjust their biological clocks and metabolism (Thrush, 1999). Beginning of singing in the morning, the dawn chorus, is triggered by a combination of the birds internal clock and the very first rays of light. It was shown that relatively larger eyed passerine birds start singing earlier (Berg et al., 2006). There are many theories and models that explain/predict the timing of dawn chorus. The energy storage stochasticity hypothesis predicts that the participants in the dawn chorus follow state-dependent decision rules based on their energy reserves at these times of day (Hutchinson, 2002). It was also predicted in the same study that from day to day cloud cover determines when a dawn chorus starts and that overnight temperature and wind strength have more effect on chorus intensity and duration.

While the inefficient foraging hypothesis states that the timing of dawn song is related to light availability so that birds become active at twilight when light levels are insufficient for foraging, yet adequate for social communication as well as predator avoidance (Kacelnick, 1979).

Photoperiodic responses such as sexual maturation and moulting are affected by changes in ambient temperature (Dawson and Visser, 2010). It is now clear that phenological change can and does differ between species, between locations and between trophic levels. This makes predictions for the future much more

complex than was imagined (Sparks, 1999 and Sparks et al., 2005).

Bulbuls (*Pycnonotidae*) are diurnal birds that do sing during day time but do not usually sing at night. They have almost a regular start for dawn chorus which is around 20 minutes before sunrise and stop singing soon after sunset (Hasan, 2010). Some birds start singing as early as one hour before sunrise such as robins (*Erithacus rubecula*) (Thomas, et al., 2003) while northern mockingbirds (*Mimus polyglottos*) start singing 0.5 to 1 hour before sunrise and continue singing throughout the day (Hill et al., 2005). It is also reported that the activity of birds can also be influenced by the intensity of moonlight (Wilson and Watts, 2006). Some models used to predict timing of dawn chorus even suggested that from day to day cloud cover, overnight temperature and wind strength determines when a dawn chorus starts (Hutchinson, 2002). Birds living in constant light (like Neiden/Finland) react to the closest approximation of their light intensity cycle to that at dawn further south and it is also controlled by internal factors. It is suggested that the start of nest-visit cycle is controlled by light intensity, but modified by temperature effects. The possibility that the environment affects the bird indirectly, via its brood or food, can be ruled out (Brown, 2008)

This is the first study that investigates the onset of dawn singing in two bird species (bulbuls and sparrows) in two climatically different geographical locations that also have a considerable difference in light and noise pollution. It clearly shows that onset of dawn chorus is temperature dependent and is a complex process.

Methods

The start of dawn singing was recorded for the twelve months of the year in 2009 and 2010 in a very quite residential suburb of Tulkarem / Palestine, 32°18′41.50″N 35°01′37.34″E (Mediterranean climate) and the 14 months of 2010 and 2011 in the comparatively noisy and well lit Ar-Rayyan residential district in Riyadh / Saudi Arabia, 24°38′N 46°43′E (desert climate). The common black-head bulbul (*Pycnonotus barbatus* and the white spectacled *Pycnonotus xanthopygos*) are the two bulbul species that are observed in Tulkarem as well as the whole of Palestinian Authority Territory. The bulbul species (*Pycnonotus barbatus*) and the white-cheeked bulbul species (*Pycnonotus leucogenys*) are seen in the studied area in Riyadh. The weather in Tulkarem area is Mediterranean; moderate, can be cloudy and rainy while complete desert conditions prevail in Riyadh. Bulbuls and sparrows (*Passer domesticus*) at Tulkarem and Riyadh sites started singing before dawn, continued through out the day and stopped soon after sunset in an identical fashion.

The noise levels in Tulkarem site are not expected to exceed 10 dB (A) (Abdelraziq et al., 2003) while in Riyadh they exceed 90 dB (A) (Al-Mutairi et al., 2009, Koushki et al., 1993). There are no records for light pollution for the two sites but it is easily concluded that light levels in Tulkarem are very much less than those in Riyadh.

Start of dawn singing was recorded on a calendar that shows times for dawn, sunrise and sunset. The difference in time between start of singing and sunrise is calculated. The design and location for the first location is described by Hasan, 2010. Same study design was used to investigate dawn singing at Ar-Rayyan district in Riyadh.

The exact number of singing birds was not determined since the study was concerned only with the start of singing. One or two incidents of short burst in singing were not counted so as to rule out unforeseen causes such as human or other disturbances. Therefore, at least two or more incidents of continued singing are assumed to be valid as a true starting of dawn chorus. Actual observed day maximum and night minimum temperatures were recorded from the following web site (www.weather.com/outlook/travel/businesstraveler/monthly and www.wunderground.com.pa)

Statistical Analysis

Microsoft excel program was used to plot relevant graphs. Correlation (r value) between start of dawn chorus and both maximum day and minimum night temperatures was also calculated by the same program.

Results

Start of singing for bulbuls compared to sunrise in both locations for the month of January and February 2009 in Tulkarem and January and February 2010 in Riyadh is shown in table 1. These results show that there is a regular pattern for the timing of dawn chorus compared to sunrise and also show that no major differences are found between the two species in Tulkarem and Riyadh for the month of January. This is a very interesting finding when looking at the difference in climate and ambient noise and light between the two locations. In contrast, data for the month of February at the two locations were similar in the beginning but started to vary considerably later on. This variation coincided with increasing temperature in Riyadh. The table also shows that bulbuls in Riyadh sang surprisingly too early at dawn compared to January and compared to Tulkarem location. Figure 1 shows graphs comparing the onset of dawn chorus for bulbuls and sparrows in Tulkarem and Riyadh for a 12 month period. It clearly shows great similarities in autumn and early winter (October to January) and big differences in spring and summer months (February to

Table 1: The onset of dawn chorus for bulbuls before sunrise (minutes) for the month of January and February in Tulkarem and Riyadh

Date	Tulkarem Jan-09	Riyadh Jan -10	Tulkarem Feb-09	Riyadh Feb-10
1	19	22	19	23
2	20	18	20	24
3	21	19	18	39
4	18	20	19	79
5	19	19	12	28
6	18	18	10	38
7	17	19	10	24
8	20	20	15	17
9	16	21	13	23
10	18	22	11	23
11	24	20	18	35
12	19	20	11	39
13	18	19	13	42
14	17	19	19	80
15	20	16	24	82
16	17	18	17	82
17	13	16	18	80
18	13	19	16	85
19	18	16	15	88
20	15	17	16	80
21	17	22	14	92
22	18	18	12	112
23	19	20	13	119
24	21	18	17	128
25	19	22	19	129
26	19	20	17	125
27	16	18	16	109
28	17	17	18	120
29	13	14		
30	18	21		
31	19	24		
Average (min)	17.935	19.097	15.714	69.46

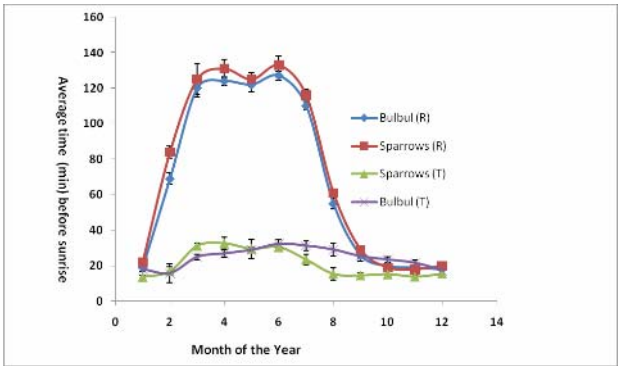

Fig. 1: Onset of dawn singing for the two bird species in (R): Riyadh and (T): Tulkarem for 12 month period ± SD

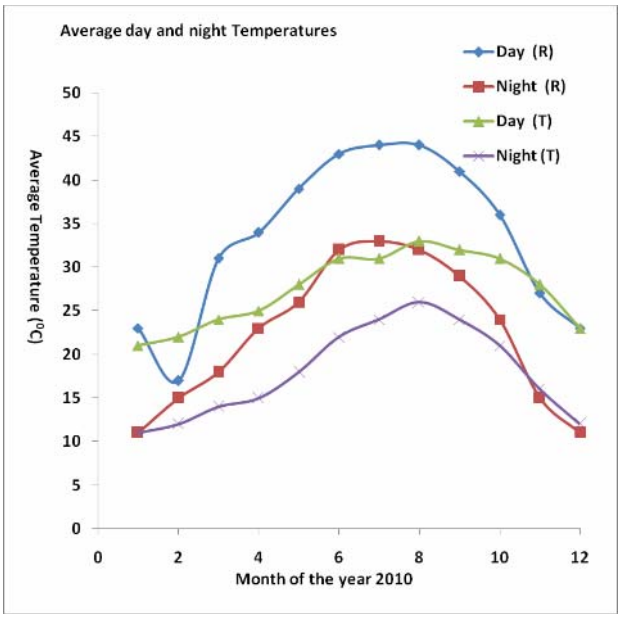

Fig. 2: Comparison of average day and night temperatures in Riyadh ® and Tulkarem (T)

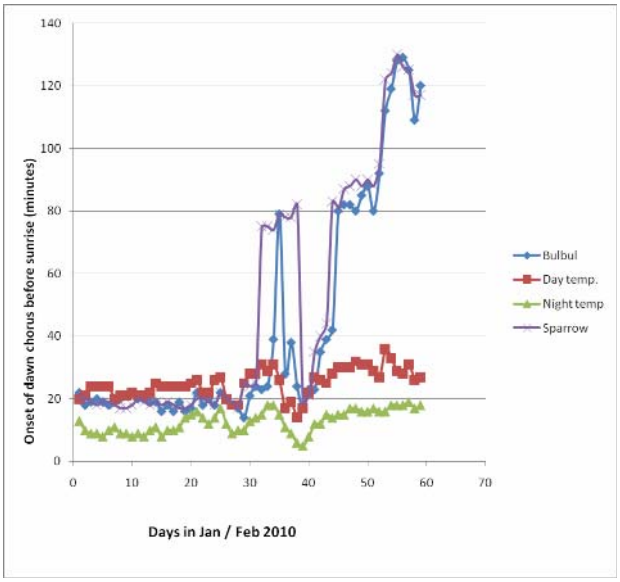

Fig. 3: Effect of day /night temperatures on timing of dawn chorus.
Correlation (r) =0.64 for maximum temperature and 0.71 for minimum temperature for bulbuls and similar r values for sparrows

September). The same figure also shows that birds in Tulkarem started singing a bit earlier in spring/summer which can be explained by the start of breeding season but a big difference is seen between the two locations. This can only be explained by differences in ambient

temperatures between the two locations. Figure 2 compares average day and night temperatures for the two locations and shows similarities between the two locations in autumn/winter and big differences in spring/summer. So a correlation is seen between figure 1 and 2 (when weather is similar the onset of singing is similar but when weather is different the onset of dawn chorus is different).

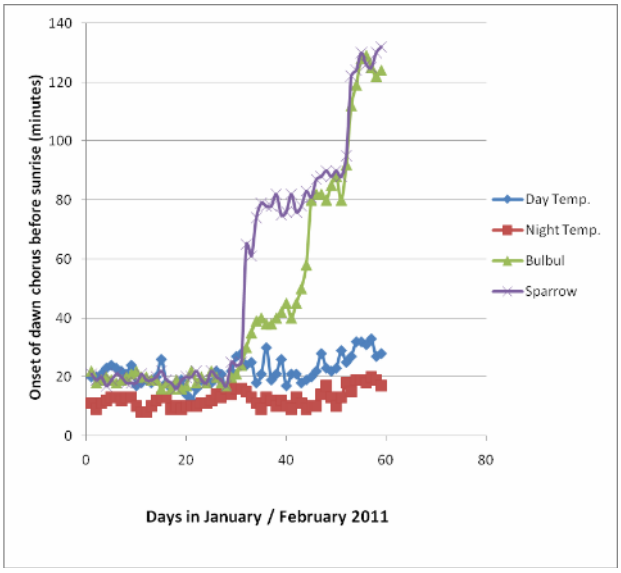

Fig. 4: Effect of day/night temperatures on timing of dawn chorus

Correlation (r) =0.68 for maximum temperature and 0.61 for minimum temperature for bulbuls and similar r values for sparrows.

Figure 3 shows a plot of daily (maximum) and night (minimum) temperatures for both January and February 2010 in Riyadh compared to the timing of daily start of singing for bulbuls. A big change in timing of dawn chorus is noticed at the end of January and beginning of February (1st peak) and a second peak is shown after the 10th of February. The rise and fall of timing in dawn singing seems to be dependent on day (maximum) /night (minimum) temperatures. At the end of January and beginning of February temperatures fluctuated considerably ranging from max 30/15^{0}C (day/night) to 15/6^{0}C. Statistical analysis shows a strong positive correlation (r>0.6) between temperature and start of dawn chorus. There was no such variation in timing of dawn chorus for Tulkarem location. No correlation (r=≤0.1) between timing of dawn chorus and recorded temperatures for Jan / Feb 2009 in Tulkarem. It can be presumed by looking at figure 3 that day/night temperature of 30±5^{0}C/15±5 is the threshold for very early singing and that day/night temperatures of 14±2/5±2 is the threshold for late singing in Riyadh. Figure 4 shows the onset of dawn chorus for Jan / Feb 2011. It shows similarity to figure 3 except that temperatures in February 2011 did not fluctuate as in February 2010. The difference between the two figures (the high/low peak early February) can be explained by the fact that night temperature did not go below 9 degrees in Feb 2011 while they went down to 5 degrees in Feb 2010.

Discussion

Although photoperiod is believed to be the main factor that determines the onset of dawn chorus, there are many independent variables including ambient temperature, environment and environmental pollution that decide the timing and pattern of dawn chorus. There is an increasing interest in research regarding the effect of environment, climate change and pollution (especially light and noise) on avian life. Light pollution can be catastrophic to avian life in a way that affects behavior and orientation and constitutes a new focus of research in ecology (Longcore and Rich, 2004). Noise pollution is also known to affect the singing behavior and dawn chorus in birds (Fuller, 2007, Molenaar et al., 2006). A recent report has shown that climate conditions have a great effect on timing and pattern of bird song (Botero, 2009).

It was shown in a previous study (Hasan, 2010) that bulbuls and blackbirds have a regular start of dawn chorus compared to sunrise and that street and moon lighting had no effect on the onset of dawn chorus in Tulkarem area and that weather conditions such as wind and heavy rain were the only factors that caused a considerable and immediate delay in the timing of bulbuls and blackbirds dawn chorus.

It can be clearly seen in both locations investigated that there are two patterns for the onset of dawn chorus (figure 1). An early start in early spring and summer (Feb-Oct), were big differences are seen between the two locations and a late start in autumn and early winter (Oct-Jan) where we see similarity between the two locations. At first, the early start can be attributed to the start of the breeding season but when comparing the two locations together we see no major difference in autumn and early winter between the two locations and a big difference in spring/summer. This difference in spring/ summer can only be explained mainly by the increasing ambient temperatures in Riyadh.

The weather conditions during autumn and winter (Oct-Jan) in Riyadh are mainly very moderate and not very different from Tulkarem except in the lack of rain and cloud cover. Temperatures start to rise significantly in February in Riyadh compared to Tulkarem.

So why are the similarities and the differences? Could ambient temperature have a direct effect on bird behavior particularly the onset of dawn chorus? And why are birds singing too early before sunrise in Riyadh? It is difficult to attribute the differences to

noise or light pollution in Riyadh which is in agreement with our previous study (Hasan, 2010) where it was shown that street lighting did not affect the onset of dawn chorus. It was also found in one of the previous studies (Hill et al., 2005) that ambient light had no effect on the output of birdsong.

Looking at February data we see a great difference in timing of dawn chorus between the two locations and within the Riyadh location itself. The question is why do birds in Riyadh have to start singing so early. The exact reason for this difference can be partly explained by ambient temperature but a combination of seasonal change (ambient temperature), light and noise pollution and internal factors is more plausible explanation. January / February in Tulkarem are usually considered as the main winter months of the year while January in Riyadh is usually mild but mostly without any rain (desert like weather). February was different in that temperatures can fluctuate considerably and start to rise considerably. It is not reported previously that birds started singing as much as two hours before sunrise; one hour is the earliest reported time (Thomas et al., 2003; Hill et al., 2005).

These results are not in agreement with the general hypothesis that cities will change the song of birds as a result of light and noise pollution (Slabbekoorn and den Boer-Visser, 2006; Nemeth and Brumm, 2009). More research is still needed to decide the real factors behind the observed variations in timing and pattern of dawn chorus.

Therefore, it is believed that, at least in this case, changing of timing of dawn chorus is primarily temperature dependent. The influence of the sum of all environmental variables alongside internal factors on the timing of dawn chorus needs to be considered to make a real judgment (Brown, 2009).

Conclusion

Timing of dawn chorus for birds is a complex process and it is determined by many independent variables. No one factor can be claimed to be the only determinant in causing changes in timing of dawn chorus or animal behavior in general. Therefore it is not claimed here that temperature is the sole factor that is controlling timing of dawn chorus. Although it seems to be true for the Riyadh site at this time of the year and these prevailing conditions. Continuous monitoring is needed for more than one bird species and at different locations.

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