News & views

NATABA/GETTY

Figure 1 | A singing blue tit (*Cyanistes caeruleus*).

Evolution

Absence of female partners explains dawn chorus

Diego Gil

Why birds sing intensely in a dawn chorus during the early morning has long been debated. Evidence gathered from observing birds in the wild offers a fresh perspective on what might drive this phenomenon.

Although it is widely recognized that solitude can boost artistic production, few people would have guessed that this might apply to animals, too. Writing in *Proceedings of the Royal Society B*, Schlicht *et al.*[1] support this idea by showing that the intense dawn chorus of male birds can be explained by the absence of female partners.

The dawn chorus refers to a period in the morning, well known to early risers, when birds seem to engage in a frenzy of singing. Some time before sunrise, particularly in spring, many species sing loudly simultaneously, and the result is an intense chorus that wanes when the Sun rises. A similar, but less intense, peak of singing, known as the dusk chorus, occurs before the Sun sets.

As common as it is, the dawn chorus of birds has puzzled people for centuries, and there is still no consensus regarding its cause. Ornithologists have proposed at least nine hypotheses, none of which seems to accommodate all the existing data[2,3]. The hypotheses with greatest support so far are those that propose that male birds sing at dawn to warn off competitors or to guard their mates at the peak of their fertility[4], or that birds sing to re-establish territorial boundaries after the night[5].

Other hypotheses provide more mechanistic explanations — for example, that dawn singing enables birds to use up the energy surplus that was stored for their needs at night[6] or that birds take the opportunity to sing at a time when predation levels are lower than usual[3]. Although some of these hypotheses do a good job of explaining particular patterns for various species, none of them seems to be applicable to all dawn-chorus phenomena[2].

Schlicht *et al.* propose a hypothesis that aims to explain dawn and dusk choruses in all bird species. According to their female-absence hypothesis, an intense chorus will happen whenever two conditions are met. First, that females and males separate briefly at dawn and dusk (if females leave their roost later than males in the morning and go to roost earlier than males in the evening); and second, that the males are likely to sing more when their mate is absent.

To test this hypothesis, the authors recorded the song rates of male blue tits

(*Cyanistes caeruleus*; Fig. 1) in southern Germany, and related these to the presence or absence of their female partners. Schlicht and colleagues first tagged the birds with radio-frequency-identification (RFID) tags to enable the location of the animals to be determined. They then placed an automatic RFID recorder near the nest box, and used this system to determine whether the female was inside or outside the nest box.

After filtering the recordings to make sure that the bird of interest was the one singing in the recordings, Schlicht *et al.* found that the males sang at high rates while their female partners were still roosting in the nest box at dawn, and stopped singing as soon as the females left the nest box to join them. Similarly, males were more likely to sing when the females went to roost in the evening, and song rates also increased whenever the females entered the nest box during the day.

Interestingly, male song rates increased in a linear manner as separation time from the female increased during the day. However, this linear relationship predicts an impossibly high dawn song rate after overnight separation, which was not observed.

To check for any extra support for the generality of their hypothesis, the authors searched published work and found some circumstantial evidence that males and females of most species show a mismatch in their daily activity, leading to separation periods at dawn and dusk. Furthermore, several studies (but not all) indicate that male singing activity increases when a female partner is separated from the male in the context of experimental manipulations.

The patterns found for blue tits are exciting for this field, and do convincingly fit this female-absence hypothesis. They also provide support to observations that show similar patterns in other species. However, further work will be necessary to determine whether Schlicht and colleagues' hypothesis describes a universally applicable mechanism for the dawn chorus. Birdsong in males has a dual function. It is used to defend territories against other males and to attract females, and which of these two roles is dominant varies between species and can depend on the breeding stage for a given species[7].

Schlicht *et al.* conducted their study during the ten days around egg laying. This is the fertile period of the blue tit, one of the species in which male dawn singing reaches a maximum at this precise stage of the breeding season when the female is inside the nest. Thus, the change in male singing activity in relation to the presence of a fertile female about to mate makes sense from a mate-guarding perspective. The male cannot guard the female from copulation attempts by other males when she leaves the nest if he sings when she is outside the nest[2,8].

However, not all bird species sing during the female's fertile period: some even become completely silent at this time[9]. In addition, dawn choruses can happen throughout the breeding season, by males engaging in feeding chicks and even by unpaired males. It remains to be determined whether, in situations such as those and when females are no longer fertile, the singing patterns found in this study also occur.

The female-absence hypothesis offers a mechanistic explanation for the dawn chorus, but the authors do not propose an evolutionary function. Rather, Schlicht and colleagues speculate that, possibly after an origin not related to evolutionary processes of natural selection or mate choice by sexual selection, a full range of functions mediated by this singing might have been acquired over time, such as strengthening the pair bond, manipulating female behaviour or displaying male quality.

This phenomenon nevertheless begs for a functional explanation. Although the first of the two conditions of the hypothesis (separation between males and females at dawn or dusk) could be explained by an origin due to inherent sex-specific differences under natural selection, the second condition (less singing when the female is present) strongly suggests that this pattern of singing has a function. And even if the patterns predicted by the female-absence hypothesis can be applied to other species, we need to address the following key question. Why do males sing more when females are absent or less when females are present?

Diego Gil is in the Department of Evolutionary Ecology, National Museum of Natural Sciences, 28006 Madrid, Spain.
e-mail: diego.gil@csic.es

1. Schlicht, L., Schlicht, E., Santema, P. & Kempenaers, B. *Proc. R. Soc. B* **290**, 20232266 (2023).
2. Gil, D. & Llusia, D. in *Coding Strategies in Vertebrate Acoustic Communication* (eds Aubin, T. & Mathevon, N.) 45–90 (Springer, 2020).
3. Staicer, C. E., Spector, D. A. & Horn, A. G. in *Ecology and Evolution of Acoustic Communication in Birds* (eds Kroodsma, D. E. & Miller, E. H.) 426–453 (Cornell Univ. Press, 1996).
4. Mace, R. *Nature* **330**, 745–746 (1987).
5. Kacelnik, A. & Krebs, J. R. *Behaviour* **83**, 287–308 (1983).
6. McNamara, J. M., Mace, R. H. & Houston, A. I. *Behav. Ecol. Sociobiol.* **20**, 399–405 (1987).
7. Catchpole, C. K. & Slater, P. J. B. *Bird Song: Biological Themes and Variations* 2nd edn (Cambridge Univ. Press, 2008).
8. Birkhead, T. R. & Møller, A. P. *Sperm Competition and Sexual Selection* (Academic, 1998).
9. Liu, W.-C. & Kroodsma, D. E. *Auk* **124**, 44–52 (2007).

The author declares no competing interests.
This article was published online on 6 February 2024.

Condensed-matter physics

New type of magnetism splits from convention

Carmine Autieri

Magnetic materials with zero net magnetization fall into two classes: conventional antiferromagnets and altermagnets. Physicists have identified a property in altermagnets that widens the divide between the two groups. **See p.517 & p.523**

The energies of electrons in a material are confined to specific levels. These levels can split into bands that correspond to possible configurations of the electrons' intrinsic angular momentum — their 'spin'. Such spin splitting underlies the existence of ferromagnetism: the type of magnetism found in iron. But it has also been predicted to arise in materials showing a newly discovered type of magnetism, known as altermagnetism, and such systems could prove more useful than ferromagnets for some technological applications. In two papers in *Nature*, Krempaský *et al.*[1] (page 517) and Zhu *et al.*[2] (page 523) report experimental evidence of spin splitting in materials classed as altermagnets.

Energy levels are said to be degenerate if they correspond to two or more quantum states. In 1930, the Dutch physicist Hans Kramers found that a particular type of degeneracy — now known as Kramers degeneracy — exists in non-magnetic systems that show time-reversal symmetry (those that adhere to the same laws of physics whether time runs forwards or backwards)[3]. Kramers degeneracy was subsequently found to exist in all non-magnetic systems.

But what about magnetic systems? Kramers degeneracy is thought to extend to antiferromagnetic systems, the name of which refers to their relationship with ferromagnetism. The spins in ferromagnetic materials all point the same way, but in antiferromagnets, adjacent spins are oriented in opposite directions, so the net magnetization of the material is zero. However, Kramers degeneracy has never been