Fossil cricket: Jurassic love song reconstructed

February 6 2012

A present-day katydid

Some 165 million years ago, the world was host to a diversity of sounds. Primitive bushcrickets and croaking amphibians were among the first animals to produce loud sounds by stridulation (rubbing certain body parts together). Modern-day bushcrickets – also known as katydids – produce mating calls by rubbing a row of teeth on one wing against a plectrum on the other wing but how their primitive ancestors produced sound and what their songs actually sounded like was unknown – until now.

On discovering several insect fossils, a group of Chinese palaeontologists, including Jun-Jie Gu and Professor Dong Ren from the Capital Normal University in Beijing, contacted Dr Fernando Montealegre-Zapata and Professor Daniel Robert, both experts in the biomechanics of singing and hearing in insects, in Bristol's School of Biological Sciences. The group also teamed up with Dr Michael Engel of the University of Kansas, USA, a leading expert on insect evolution.

The Chinese researchers provided an exceptionally detailed bushcricket fossil from the Mid Jurassic period. The specimen had such well-preserved wing features that the details of its stridulating organs were clearly visible under an optical microscope. Such information has never been obtained before from insect fossils. It was identified as a new fossil species and named *Archaboilus musicus* by the Beijing-Kansas team.

Dr Montealegre-Z and Professor Robert examined the anatomical construction of the fossil's song apparatus, and compared it to 59 living bushcricket species. They concluded that this animal must have produced musical songs, broadcasting pure, single frequencies.

Professor Robert said: "This discovery indicates that pure tone communication was already exploited by animals in the middle Jurassic, some 165 million years ago. For *Archaboilus*, as for living bushcricket species, singing constitutes a key component of mate attraction. Singing loud and clear advertises the presence, location and quality of the singer, a message that females choose to respond to – or not. Using a single tone, the male's call carries further and better, and therefore is likely to serenade more females. However, it also makes the male more conspicuous to predators if they have also evolved ears to eavesdrop on these mating calls."

The research, published today in *PNAS*, implies that the acoustic environment was already quite busy 165 million years ago with many animals (such as amphibians and other arthropods) singing at the same time, possibly chorusing, within the additional background noise produced by waterfalls, streams and wind.

Amazingly, based on the detailed morphology of *Archaboilus*' wings, Dr Fernando Montealegre-Z could reconstruct the songs emitted by these ancient insects.

Following biomechanical principles that he discovered some years ago, Dr Montealegre-Z established that A. musicus sang a tone pitched at 6.4kHz and that every bout of singing lasted 16 milliseconds. This turned out to be enough information to acoustically reconstruct the song itself, possibly the most ancient known musical song documented to date.

This paleobioacoustical analysis also provides a unique insight into the ecology of an extinct insect.

Dr Montealegre-Z said: "Using a low-pitched song, A. musicus was acoustically adapted to long-distance communication in a lightly cluttered environment, such as a Jurassic forest. Today, all species of katydids that use musical calls are nocturnal so musical calls in the Jurassic were also most likely an adaptation to nocturnal life. Being nocturnal, *Archaboilus musicus* probably escaped from diurnal predators like *Archaeopterix*, but it cannot be ruled out that Jurassic insectivorous mammals like *Morganucodon* and *Dryolestes* also listened to the calls of *Archaboilus* and preyed on them.

"This Jurassic bushcricket thus sheds light on the potential auditory capacity of other animals, and helps us learn a little more about the ambiance of a world long gone. It also suggests the evolutionary mechanisms that drove modern bushcrickets to develop ultrasonic signals for sexual pairing and for avoiding an increasingly relevant echolocating predator, but that only happened 100 million years later, possibly with the appearance of bats.

More information: 'Wing stridulation in a jurassic katydid (insecta, orthoptera) produced low-pitched musical calls to attract females' by Gu, J. J., Montealegre-Z, F., Robert, D., Engel, M. S., Qiao, G. X. and Ren, D. in Proc. Natl. Acad. Sci. USA DOI:10.1073/pnas.111837210

Provided by University of Bristol