

square root of the number of noise notes. Thus, for constant d' , n varies as the square of the number of melody notes. On log–log plots we would expect the data values to fall on lines of slope 2.

Figure 1 shows that for three of the subjects this tentative prediction was quite well borne out. The fourth subject was a professional musician: she could tolerate more noise notes, her results were less variable, and they lay on a line of lower slope. This indicates that she had the greatest advantage when only a small number of melody notes were presented, possibly as a result of her well-developed sense of absolute pitch.

Our experiment represents a highly constrained situation because a correct answer can hardly imply recognition of the melody, particularly from only a few melody notes. But it does answer some elementary questions about the basis of musical recognition, and the technique can be developed to test whether it is absolute pitch, the occurrence of particular intervals, or other features of the melody that matter.

These experiments were prompted by results on the detection of biological motion³ and other visual tasks⁴. We believe that they point to another field where the effects of masking noise can help to elucidate the mechanisms of pattern recognition.

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Palaeontology

A refugium for relicts?

Luo¹ suggests that the vertebrate fauna from the Yixian Formation (Liaoning Province, China) shows that this region of eastern Asia was a refugium, in which several typically Late Jurassic lineages (compsognathid theropod dinosaurs, ‘rhamphorhynchoid’ pterosaurs, primitive mammals) survived into the Early Cretaceous¹ (Fig. 1). Data from slightly older sediments in the Japanese Early Cretaceous, however, suggest that the faunal composition of this region can only be partly explained by the concept of a refugium.

The Kuwajima Formation of Ishikawa Prefecture, central Japan, is yielding an important Early Cretaceous vertebrate fauna. This unit is a lateral equivalent of the

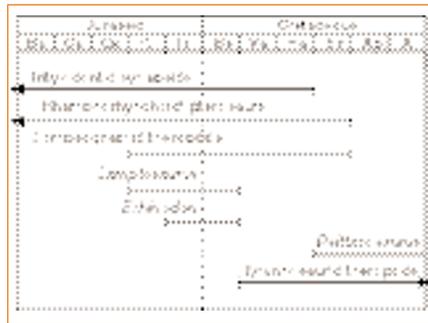


Figure 1 Stratigraphic ranges of clades that include taxa recovered from the Yixian Formation, China, and the Kuwajima and Itsuki Formations, Japan^{1,4,9}. Data on *Camptosaurus* and *Echinodon* are from ref. 13. Arrows, lineage extends beyond the time range shown here; solid bars, first and last occurrences. Al, Albian; Ap, Aptian; Ba, Bathonian; Be, Berriasian; Br, Barremian; Ca, Callovian; Ha, Hauterivian; Ki, Kimmeridgian; Ox, Oxfordian; Ti, Tithonian; Va, Valanginian.

Okurodani Formation that outcrops in neighbouring Gifu Prefecture². Stratigraphic, biostratigraphic and radiometric data show that the Okurodani Formation is basal Cretaceous (Valanginian or Hauterivian) in age³. The Kuwajima Formation has yielded more than one hundred isolated teeth of a new genus of tritylodontid synapsid⁴. Before these discoveries, tritylodontids were thought to have become extinct sometime in the Middle or early Late Jurassic, as the youngest-known tritylodontid (*Bienotheroides*) was recovered from late Middle Jurassic deposits. This discovery supports the concept of an East Asian refugium, but other evidence suggests that different factors may have had an equally strong influence on faunal composition.

A theropod dinosaur referable to the unnamed clade Oviraptorosauria + Therizinosaurioidea⁵ has also been found in the tritylodontid locality. This clade is best known from the Late Cretaceous of mainland Asia, although several taxa referable to this clade are known from the late Early Cretaceous of Liaoning (*Beipiaosaurus*⁶ and *Caudipteryx*⁷), and possibly from the Early Jurassic of Yunnan Province, China⁸. The Japanese material, consisting of a single manual ungual (Fig. 2) with a pronounced posterodorsal lip (a feature synapomorphic of this group of theropods⁵), is one of the earliest representatives of this group. The Itsuki Formation of Fukui Prefecture, a lateral equivalent of the Okurodani and Kuwajima Formations², has produced an isolated tyrannosaurid tooth, identifiable by its D-shaped cross-section — a synapomorphy of tyrannosaurids⁹.

These Japanese discoveries, combined with the presence of late Early Cretaceous taxa in the Yixian Formation (such as the ornithischian dinosaur *Psittacosaurus*¹⁰), suggest that several dinosaur clades (such as tyrannosaurids and psittacosaurids) may have originated and diversified in eastern



Figure 2 Manual ungual of a theropod dinosaur from the Kuwajima Formation (Valanginian or Hauterivian) of Shiramine, Ishikawa Prefecture, Japan. Note the prominent lip posterodorsal to the articular surface of the ungual, a synapomorphy of the clade Oviraptorosauria + Therizinosaurioidea⁵. Scale bar, 5 mm.

Asia while a number of other lineages (tritylodontid synapsids, compsognathid dinosaurs and ‘rhamphorhynchoid’ pterosaurs) persisted in this region. Moreover, the presence of hypsilophodontid and iguanodontid ornithopod dinosaurs in the Japanese Early Cretaceous¹¹ suggests faunal connections with western Asia and Europe. The historical biogeography of this region appears to be much more complex than was thought previously.

Alternatively, the so-called relict taxa in eastern Asia may indicate that faunal turnover at the Jurassic–Cretaceous boundary was not as marked as has been suggested¹². The presence of camptosaurid (*Camptosaurus*) and heterodontosaurid (*Echinodon*) ornithopods in European Early Cretaceous faunas¹³ indicates faunal similarities to the Late Jurassic Morrison Formation of North America. The presence of ‘Late Jurassic’ taxa in eastern Asia may simply represent another example of this more gradual Jurassic–Cretaceous faunal transition (Fig. 1), although more evidence is needed to distinguish between these alternatives.

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