should reveal Δm^2 and, combined with the information on P, the mixing angle λ.

Among other interesting effects discussed by Krauss and Wilczek[2] (such as the modification of vacuum oscillations by matter effects) there are two concerning the nearly monoenergetic ^{7}Be neutrinos. The first occurs because the distance L between the Sun and Earth varies by 3.4 per cent in the course of the year due to the eccentricity of the Earth's orbit. Trivially, this leads to a $1/L^2$ variation of the total solar-neutrino flux at the Earth. Because the equation for P depends on L, this variation also causes a periodic horizontal displacement of the P-curves in Fig. 1*b*, with an amplitude indicated in Fig. 1 by ΔL. Thus, the ^{7}Be recoil electron rate is expected to vary in time with a period and an amplitude depending on both Δm^2 and λ, an effect observable for $\Delta m^2 > 10^{-10}$ eV^2 and values of λ that are not too small.

The second effect is not related to neutrino oscillations. Since the electrons captured by ^{7}Be nuclei in the solar core have a maxwellian velocity distribution depending on the local temperature T, the ν_e emitted in this capture reaction have a spread in energy (~ 1 keV). Hence, the ^{7}Be recoil electron spectrum in Fig. 1 does not have a sharp cutoff at its endpoint energy. A measurement of the exact shape of this spectrum near the endpoint energy thus allows determination of T (requiring, of course, an energy resolution better than 10 keV.

Clearly, although the solar-neutrino detection suggested by Cabrera *et al.* and other detectors with similar capabilities in neutrino-energy spectroscopy are still far from being built, it would be well worthwhile investing in their development. □

1. Cabrera, B., Krauss, L.M. & Wilczek, F. *Phys. Rev. Lett.* **55**, 25 (1985).
2. Krauss, L. & Wilczek, F. *Phys. Rev. Lett.* **55**, 122 (1985).
3. Rowley, J.K., Cleveland, B.T. & Davis, R. Jr *AIP Conf Proc.* **126**, 1 (1985).
4. Hampel, W. *AIP Conf. Proc.* **126**, 162 (1985).
5. Hampel, W. *Proc. Neutrino 84*, 530 (World Scientific Publishing, Singapore, 1984).
6. Bakich, A.M. & Peak, L.S. *AIP Conf. Proc.* **126**, 238 (1985).
7. Chen, H.H. *AIP Conf. Proc.* **126**, 249 (1985).
8. Drukier, A. & Stodolsky, L. *Phys. Rev.* D**30**, 2295 (1984).

W. Hampel is at the Max-Planck-Institut für Kernphysik, 69 Heidelberg 1, FRG.

Vertebrate palaeontology

First marsupial fossil from Asia

from Michael J. Benton

MARSUPIALS, pouched mammals like kangaroos and opossums, are today restricted to Australia and the Americas (Fig. 1). How this split distribution came about has been much debated by biogeographers. A northern dispersal route was favoured at first, with the early marsupials travelling from the Americas across Asia to Australia, but no evidence of marsupials had been found at that time in Asia. The acceptance of continental drift led most people to prefer a southern dispersal route from South America to Australia via Antarctica (Fig. 2). Now that evidence of a fossil marsupial has been reported from central asiatic USSR, the question is again open.

The specimen is a single tooth, identified as a first or second upper molar from the right side of the jaw. It is very small (1.7 mm long by 1.6 mm across) and its closest affinities seem to be with the opossums (family Didelphidae, subfamily Didelphinae). It is most like a tooth of the European fossil opossums *Amphiperatherium* and *Peratherium*, and the North American *Herpetotherium*. The new Russian find comes from the middle of the Aksyir Formation, which is lowermost Oligocene (almost 37 Myr ago), in the Zaysan territory in eastern Kazakhstan, central Asia.

The fossil record of marsupials was fairly simple until a few years ago. The oldest forms came from the late Cretaceous (84–65 Myr) deposits in North America, in which fossils are quite common. Up to 30 species of early marsupials have been identified in Alberta, Montana and Wyoming; these are divided into three families, two of which died out with the dinosaurs at the end of the Cretaceous period and the Didelphidae (opossums), which has survived to the present day. A few late Cretaceous marsupials have also been reported from Peru and Bolivia in South America.

In the subsequent Tertiary period, the didelphid marsupials spread to Europe, where they survived until the Miocene (about 20 Myr). In North America, the didelphids also become extinct in the Miocene but then reinvaded from South America about three million years ago. During the Tertiary, many new groups of marsupials arose in South America, including equivalents of sabre-toothed cats and some dog-like forms, but only three families still survive.

There are now 13 families of marsupials in Australia. The fossil record is sparse, with only a few odd teeth and jaws known from the late Oligocene, but there are more abundant and diverse remains from the Miocene onwards.

Three years ago, a South American marsupial (a polydolopid) was found in the Eocene deposits (about 40 Myr) of Antarctica[2], a find that seemed to support the theory of a southern dispersal route, with an ice-free Antarctica as the bridge between the southern tip of South America and Australia. Then, two years ago, marsupial remains in Africa were reported by two independent teams[3,4]—but these are probably the remains of animals that wandered into Africa from Europe and thus do not help to disentangle the palaeobiogeography of early marsupial dispersal.

Although the Asian tooth may seem to provide support for the northern dispersal theory, it is approximately equivalent in age to the oldest known Australian marsupials, and so occurs too late to fit with the theory. It is also a didelphid, a European–American form, with no particular Australian affinities. Most probably the didelphids were at one time distributed more widely than has been thought and then died out without leaving any descendants in Europe, Africa and Asia. □

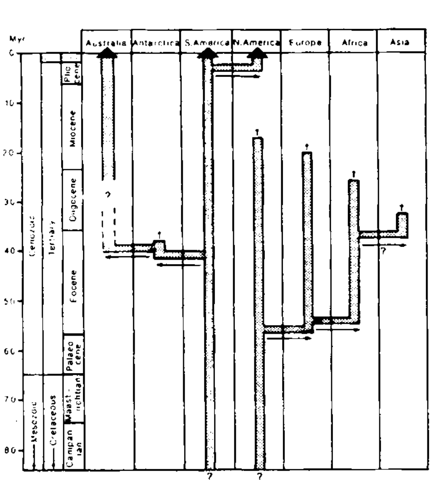

Fig. 1 Probable relationships between marsupial groups in different continents.

Fig. 2 The two possible dispersal routes with the positions of the continents as they were 80 Myr ago (modified from ref. 5).

1. Gabunia, L.K. & Shevyreva, N.S. *Doklady Akad. Nauk. S.S.S.R.* **281**, 684 (1985) (translated by J. Wilson, Ulster Museum, Belfast).
2. Woodbourne, M.O. & Zinmeister, W.J. *Science* **218**, 284 (1982).
3. Mahboubi, M., Ameur, R., Crochet, J.-Y. & Jaeger, J.-J. *C. r. Acad. Sci., Paris* **297** (III), 415; *ibid.* 691 (1983).
4. Bown, T.M. & Simons, E.L. *Nature* **308**, 447 (1984).
5. Marshall, L.L. in *Aspects of Vertebrate History* (ed. Jacob, L.L.) 345 (Museum of Northern Arizona, Flagstaff, 1980).

Michael J. Benton in in the Department of Geology, The Queen's University of Belfast, Belfast BT7 1NN, Northern Ireland.