P. KARUNAKARAN/HOLT STUDIOS

Figure 1 **Ancient roots — heaps of harvested manioc (*Manihot esculenta*) for sale at a market. Piperno and Holst[1] show that starch grains from manioc, and other Neotropical root crops, have survived on the surfaces of ancient stone tools.**

preparing food. It has been shown that the stone hunting weapons of prehistoric societies may carry traces of the victim's blood, and that the haemoglobin can be identified to species level[3]. It is possible that the rough surfaces of grinding tools could, similarly, carry a residue of informative starch grains.

This approach was used by Thomas Loy[4] in his research into prehistoric remains from the Solomon Islands. He examined stone tools, dating from 27,000 years ago, and found starch grains belonging to *Colocasia esculenta* (taro). This plant has a starch-rich corm (an underground, swollen stem base), and is now widely cultivated in the tropics. Loy's finding provided circumstantial evidence for use of this plant as food in the late Pleistocene and, possibly, even its early domestication. The work also confirmed the potential of starch-grain analysis as a means of tracing the history of early food plants.

Piperno and Holst[1] have now applied similar techniques to investigate manioc and arrowroot (*Maranta arundinacea*) in the humid tropical lowlands of Panama. They examined a number of archaeological sites from which milling stones were available, and extracted starch grains from the crevices in the rough surfaces of these stones using a binocular dissecting microscope and a needle. Not only did they find starch grains, but they also had considerable success in identifying these on the basis of an extensive type collection that they had established. The oldest site was a rock shelter where grinding cobbles dating from the pre-ceramic stage (8,000 to 5,000 years ago) were recovered from sediments in which phytoliths of bottle gourd, squash and maize had been found. Starch grains that compared well with those of manioc were found on the cobbles, confirming the early use of this plant in the lowland tropics. The authors also found starch grains of maize and arrowroot on these implements.

Much more work needs to be done on the taxonomy of starch grains, particularly those from potential crop species. But these preliminary results seem to establish that a variety of starch-producing plants, including manioc, were being exploited in central Panama about 7,000 years ago. Although we do not know whether these plants were gathered from the wild, or whether they were cultivated, palaeolimnological work in the area indicates some slash-and-burn clearance of the forest at that time. This strengthens the case for the development of agriculture as an explanation for the presence of these plants. The occurrence of other known crop species in association with the manioc and arrowroot gives weight to this argument.

Most important of all is the confirmation that recognizable starch grains can persist over many millennia in the Neotropics — this opens up new opportunities for determining, with precision, how these crop species with an invisible past were domesticated. □

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Daedalus

A magnetic speaker

The crudest component of a sound system is its loudspeaker. The most flawless recording, perfectly digitized, recovered and ultra-linearly amplified, must still be heard via a clumsy cone of plastic or paper flapping about in time with it. Daedalus now has a better idea. His new 'Paraspeaker' has no moving parts at all.

The Paraspeaker exploits the fact that the oxygen of the air is paramagnetic. So it is attracted into, and compressed by, a magnetic field. Vary that field at an audio frequency, and the pressure must vary in sympathy. This, says Daedalus, is why many transformers produce a steady hum, though they have no moving parts. The air around the transformer is alternately compressed and released by its stray magnetic field, and speaks up at its line frequency. Well — twice that frequency, actually. For, annoyingly, the induced pressure varies not with the field, but the square of the field. This gross nonlinearity doubles fundamental frequencies, and adds other frightful distortions as well.

Daedalus is undismayed. Electronic signal-processing is so fast and precise these days that this and other problems can be sorted out electronically in real time. The Paraspeaker will simply be a large coil of wire set in a hole in a baffle-board; but the electronics driving it will be subtle and complex. The audio signal will go through a square-rooter and programmable signal conditioner while it is still digital. After analog conversion, a dedicated amplifier will feed it to the Paraspeaker.

The Paraspeaker will be a ferociously inductive load; even the best analog amplifier may falter in driving it. The signal conditioner has the job of tweaking the digital signal so as to cancel the aberrations that it will meet downstream. Once programmed to counter the flaws of the following amplifier, it will ensure that a perfect signal reaches the Paraspeaker. So perfect sound will emerge. Its vacant central hole will be an open window on transparent, flawless sound.

The hi-fi community will be entranced. Yet the major benefactors will be the boom-box community, and its victims. For the boom box has but one advantage over a system using headphones: it avoids their discomfort and blanking out of ambient sound. But Paraspeaker earphones, being simply hollow coils, do not obstruct the ears. They can be worn 24 hours a day. The music addict will be able to enjoy his narcotic endlessly, without deafening the rest of us with his damnable loudspeakers.

David Jones