Human settlements

Why did the Polynesians abandon their mystery islands?

from Jared M. Diamond

WHEN Europeans entered the Pacific Ocean in the 16th century, they found Polynesians or other peoples living on most islands except for some small isolated or ecologically impoverished ones. Archaeological evidence subsequently showed that at least 12 of these uninhabited islands had previously been occupied by Polynesians and then abandoned.

Why the inhabitants left these islands has been the subject of much speculation[1,2] — internecine warfare, similar to the killings that nearly wiped out the colony founded on Pitcairn Island by the mutineers from *HMS Bounty*, water shortage, illness, natural disasters, homesickness or lack of women are possible reasons. A recent paper by David Steadman and Storrs Olson[3] identifies another possible contributing factor: extermination of the populations of native birds used for food.

The 'mystery islands of Polynesia' include Pitcairn and Henderson, east of the Tuamotu Archipelago, Norfolk and Raoul, off the east coast of New Zealand, Nihoa and Necker, near Hawaii, Palmerston and Suwarrow in the Cook group and several of the Line Islands.

Steadman and Olson have studied Henderson Island, one of the world's most isolated scraps of land, lying over 100 miles east of Pitcairn Island and more than 3,000 miles from any continent. With an area of only 15 square miles, fissured coral terrain and little fresh water, Henderson is still uninhabited and is often considered to have been almost unaffected by man. It is home to 12 species of breeding seabirds and four endemic species of landbirds: a warbler, dove, parrot and flightless rail. The only other vertebrates are a few introduced species.

In 1971, Sinoto[4] discovered remains of a former Polynesian settlement with a radiocarbon date of about AD 1200–1500. The settlement evidently survived for some time, because the oldest of the three cultural strata included pearl-shell fishhooks and stone adzes, made of materials absent on Henderson Island and presumably brought by early settlers, whereas the youngest stratum contained shell tools made of inferior local materials after the imported material had been exhausted. The archaeological deposits contained bones of eight species of seabirds, six of them represented by juveniles that presumably had hatched on the island. At least one, and possibly three, of these species no longer breeds there and one of them, the storm petrel *Nesofregetta fuliginosa*, also disappeared from Mangaia in the Cook Islands after Polynesian settlement. There were also bones of two large pigeons of the genus *Ducula*, one of which would have weighed about 0.4 kg and is similar to *D. aurorae* or *D. pacifica*, species that survive on Tahiti and western Pacific islands, respectively; the other would have weighed about 0.8 kg and resembles *D. galeata*, found in the Marquesas. No bones of the usual Polynesian domesticated animals — pigs, dogs and chickens — were found.

Obtaining food on Henderson would have been difficult for these early Polynesian settlers, just as it is today. The steep coastline and lack of extensive reefs or lagoons limit the catching of fish and marine invertebrates. Domestic animals evidently did not arrive or survive, and growing the usual Polynesian crops such as taro, breadfruit and sweet potato may have been difficult on coral terrain with little soil. The settlers may instead have depended for food on the abundant breeding seabirds and on the large pigeons, which, because they had no previous experience of humans, were undoubtedly tame and easy to kill. When these birds were eventually exterminated, the settlers may have faced starvation or had to abandon their colony.

The evidence for extermination of birds on Henderson Island adds to the growing body of evidence from Hawaii, New Zealand, Fiji, New Caledonia, the Chatham Islands, the Cook group and the Marquesas. On all these Pacific islands the first arrival of humans, Polynesians or their ancestors, was followed by a wave of extinctions similar to the ones that Europeans caused when they first reached islands of the Atlantic and Indian Oceans, and that followed the Indonesian occupation of Madagascar[5]. The evidence from Henderson Island suggests that at least some of the other mystery 'islands' may have been abandoned as a result of overhunting the birds used as food; extinct birds are also known as fossils from Norfolk Island[6]. Imprudent hunting is evidently not just a modern problem. □

1. Bellwood, P. *Man's Conquest of the Pacific* (Oxford University Press, New York, 1979).
2. Kirch, P.V. *The Evolution of the Polynesian Chiefdoms* (Cambridge University Press, Cambridge, 1984).
3. Steadman, D.W. & Olson, S.L. *Proc. natn. Acad. Sci. U.S.A.* 3, 6191 (1985).
4. Sinoto, Y.S. *J. Soc. Oceanistes* **39**, 57 (1983).
5. Martin, P.S. & Klein, R.G. *Quaternary Extinctions* (University of Arizona Press, Tuscon, 1984).
6. Schodde, R. *et al. A Review of Norfolk Islands Birds: Past and Present* (Australian National Parks and Wildlife Service, Canberra, 1983).

Jared M. Diamond is Professor of Physiology at the University of California Medical School, Los Angeles, California 90024, USA.

Solid state physics

Phonon images in semiconductors

from W.A. Phillips

THE pattern shown in Fig. 1, which could be used as an illustration for a book on catastrophe theory, is an image of high-frequency (700 GHz) sound waves propagating in a single crystal of the semiconductor gallium arsenide. It comes from a recent paper by G. A. Northrop, S. E. Hebboul and J. P. Wolfe (*Phys. Rev. Lett.* **55**, 951; 1985). It is no accident that this pattern is similar to the caustics (bright lines) seen when light is reflected on the surface of a liquid in a cup. Both result from geometrical focusing. In semiconductors this focusing arises because the velocity of sound is not isotropic, which in turn is a result of the anisotropy of the crystalline structure and the interatomic forces. These pictures are therefore a sensitive test of our understanding of interatomic forces in solids.

The diagram is a result of an ingenious experiment. A pulse of laser light incident on one surface of the crystal excites electrons from the valence to the conduction band. On dropping back, the electrons emit phonons, quanta of vibrational energy, bearing the same relation to sound waves as photons bear to electromagnetic waves. This burst of phonons propagates ballistically through the crystal and is detected at a fixed point on its opposite face a fraction of a microsecond later. By scanning the laser across the surface of the crystal the phonon intensity can be measured as a function of propagation direction. Phonon intensity is converted to brightness on a video display to give a phonon image, so that caustics correspond to directions in which phonons are focused on the detector.

Sound propagation in crystals is much more complicated than in gases because of the effect of the regular structure. The dispersion relation, which describes the relation between angular frequency ω and wavevector $\boldsymbol{q}$ is more complex than for, say, sound waves in a gas, where the phase velocity $v_s = \omega/q$ is independent of ω. Experimentally, inelastic neutron scattering is the most powerful technique for studying dispersion relations — the change in neutron energy giving ω and the change in direction giving $\boldsymbol{q}$. Complementary theoretical studies in essence consider the solid as a collection of particles held together by springs that represent the