Island population biology

Possible effects of unrestricted pesticide use on tropical birds

from Jared M. Diamond

As the list of endangered species grows inexorably longer, announcements of yet another plant or animal being close to extinction have lost their shock value. It may still occasion surprise, however, when an entire fauna is found to be disappearing. Thus, J. Mark Jenkins' report (*The Native Forest Birds of Guam*, Am. Ornithologists' Union, Orn. Monogr. no. 31, Washington; 1983) on the decline of all native forest bird species on the island of Guam deserves mention — especially as it may portend similar catastrophes in other areas exposed to unrestricted use of insecticides.

Guam is a humid forested tropical Pacific Island of 209 square mile area, belonging to the Marianas group and administered as a US territory. It formerly harboured 13 native forest bird species, all but two of them endemic at the species or subspecies level to Guam or to the Marianas. Most of the species were common or abundant until the early 1960s. Their fates thereafter have been documented by roadside censuses carried out by government biologists, and by counts that Jenkins carried out in 1978 and 1979. In the late 1960s and early 1970s all native forest bird species went into decline, and four are now near extinction. The worst affected area is southern Guam, where nine species have disappeared completely and only one remains common. The surviving populations of most native species are now confined mainly or entirely to the northernmost one-tenth of the island, the rest of Guam having become virtually an ornithological desert for native species.

What happened? The usual explanations invoked to explain island bird extinctions — habitat destruction, introduced predators, storms and disease — do not work well for Guam. The island still has extensive areas of native forest, in which Japanese soldiers who refused to surrender in 1945 remained hidden until the last of them was captured nearly 30 years later. Forests sufficiently large and productive to support humans could surely support fly-catchers and honey-eaters if there were no other problems. Furthermore, although habitats have been damaged by development, this has mainly affected the northern area where native birds are nevertheless doing best; with one exception the introduced predatory mammals, lizards and snakes have been present at least since 1890; and while Guam experiences periodic typhoons with windspeeds of up to 200 m.p.h., the native birds must have been exposed to such typhoons throughout their evolutionary history. Introduced diseases are always a possible explanation, but there is no specific evidence for their role on Guam.

Several pieces of evidence implicate pesticides. The US military sprayed, dusted and fogged DDT weekly onto Guam (especially southern Guam) during and after World War II, and farmers in southern Guam carelessly applied large amounts of DDT in the 1960s. Bodies of the insectivorous swift *Collocalia vanikorensis bartschi* yielded DDE residues averaging 0.27 parts per 10^9 (p.p.m.) in 1975, while guano collected under swift nests yielded DDE residues increasing from 0 p.p.m. in the oldest layers to 0.1 p.p.m. in the most recent layers. Farmers, developers and the US military are still applying insecticides and herbicides today for pest and weed control. The insecticide hypothesis would explain why Guam's insectivorous birds have suffered steeper population crashes and more severe range contractions than have its omnivores and frugivores.

While many North Americans and Europeans feel that use of pesticides is subject to too few controls in their own countries, these agents are misused even more in some tropical countries without vocal environmental movements. If the insecticide theory for population crashes of Guam birds proves substantially correct, the recent fate of Guam's avifauna may find parallels elsewhere. □

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Semiconductor processing technology

New prospects offered by photolytic deposition

from S.J.C. Irvine

A Rank Prize Funds mini-symposium was recently held in Malvern on the topic of photolytic deposition*. Participants were brought up to date with the most recent advances in the use of lasers for a wide range of semiconductor device processing technologies, from laser writing of metal contacts less than 1 μm wide to laser-enhanced etching of gratings on GaAs.

A major innovation in the field has been metalization of semiconductors for micro-electronics, such that metal films are accurately deposited from a volatile metal-organic source in a region of the substrate illuminated by a laser. This can be achieved by various mechanisms, including direct local heating of the semiconductor surface for pyrolytic decomposition of the metal-organic source and photolytic decomposition using UV lasers. R. M. Osgood (Columbia University) pointed out that while in photolytic processes, bond-breaking is more specific and sub-micrometre features can be written, pyrolytic deposition offers greater surface sensitivity and higher deposition rates. D. Bäuerle (Johannes Kepler University, Linz) uses an argon ion laser for writing nickel strips at scan rates in excess of 100 μm s^{-1}. High deposition rates allow fast scan rates and therefore short processing times for writing metalization structures. Deposition of the highest-resolution structures have been achieved, however, by photolytic decomposition of metal-organic adlayers.

D.J. Ehrlich (MIT Lincoln Laboratory) described how aluminium stripes, considerably narrower than the laser spot width, can be deposited by exploiting nonlinear effects in photodeposition. Aluminium lines are nucleated onto quartz using a UV laser and subsequently thickened by selective heating of the aluminium with a CO_2 laser. The thickening process occurs by the more rapid pyrolytic decomposition of tri-isobutyl aluminium. One interesting use of nonlinear processes is a photodesorption or photoactivation for patterning of a surface before deposition.

Two exciting developments reported at the symposium were the deposition of copper and platinum. Until now, it has been difficult to find suitable volatile precursors for photodeposition. Copper deposition was reported by S. Rolt of STL and by F.A. Houle of IBM, using acetylacetonate chelate compounds and illuminating the substrates with UV eximer lasers to photodissociate these precursors. Platinum photodeposition can be achieved through KrF eximer laser excitation of $Pt(PF_3)_4$ (I. Gianinoni, Max-Planck Institut für Quantenoptik, Garching). Clearly, future developments in the range of metals deposited by photolytic excitation will strengthen the applications of this technology.

Another new area of development, vital for the progress of photolytic processing, is the growth of epitaxial semiconductor films, where single crystal layers are photo-deposited onto lattice-matched substrates. The conditions for deposition are more

*'Photolytic deposition on metals, semiconductors and dielectrics', 24-27 April, organized by K. Ibbs and S.J.C. Irvine.