

Good behaviour in conservation

THE difficulties of reintroducing captive-bred species into the wild are epitomized by attempts to conserve the waldrapp (or bald) ibis, *Geronticus eremita*, shown here. There are now fewer than 300 birds left in the wild, almost all living in a single reserve in Morocco, whereas in the sixteenth and seventeenth centuries the species was found in the Middle East and North Africa, and as far north as Switzerland, Austria and Germany. The last wild Turkish population became extinct in 1989 as a result of pesticide pollution and habitat disturbance.

Ironically, although numbers have plummeted in the wild, the bird flourishes in captivity and about 800 captive individuals exist. The waldrapp ibis is in many ways a prime candidate for reintroduction. It appears to be a prolific breeder in the right conditions, and it seems to have disappeared from Europe largely as a result of human persecution: the eggs and chicks were considered a great delicacy.

There have been two attempts at reintroducing waldrapps, one in Turkey in 1981, and another in Israel two years later. Both seem to have failed. Two hundred birds were released, but immediately dispersed and none has survived.

The failures were thought to be due to a breakdown in the normal social behaviour of the ibises. Waldrapp ibises are social birds with extended parental care, and it seems that much of this behaviour must be learnt, but is not in captivity. Can it be taught to captive-bred individuals? It appears that it can, as K. Pegoraro and colleagues from the University of Innsbruck told an ethological conference this

autumn*. Young waldrapp ibises were hand-reared in Austria by human foster parents who taught them to find their way to nearby fields to forage. They also had to be taught to recognize predators, human and otherwise, and other dangers such as cars. Waldrapp ibises have no alarm call and so were taught to recognize that of a chough raised with them, which was easily mimicked by their human guardians when danger threatened. Even mutual preening had to be taught.

Eventually their behaviour was very simi-

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lar to that observed in the wild population in Morocco, although it is not known how successfully these captive-bred birds will breed. There are no plans to establish a permanent colony in Austria. But birds hand-reared according to similar principles may be released in the National Park Cabo de Gata-Nijar in Spain, where the climate, topography and availability of prey are very similar to conditions at the reserve in Morocco.

W. J. Sutherland

William J. Sutherland is in the School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, UK.

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mantle structure beneath the western Transverse Ranges does not match the crustal structure⁸, so it looks as if the fault is diverted in the ductile layer between brittle crust and mantle. Low-angle thrust focal-mechanism solutions are found at mid-crustal depths, just where the décollement should occur⁹. A geological precedent may be found in the crystalline thrust sheets or tectonic 'flakes' in the eastern Alps¹⁰ and the San Gabriel Mountains of southern California¹¹. These thrusts, now at the surface, formed at depths and temperatures assumed to be near the base of brittle crust.

The shortening rates based on the décollement model are at the high end of those rates possible based on known slip rates on other faults in southern California¹². The discrepancy with the rates based on tectonic geodesy can be resolved if, first, the reverse faults do not flatten to décollements but continue downward into the lower crust as ductile shear zones¹³, and second, the age estimate of the top of the Saugus formation, on which the geological rates are based, is too young.

If the faults do not flatten to zero dip at

a décollement, the horizontal convergence rate would be the fault slip rate times the cosine of the fault dip angle in the lower crust (see figure). This would reduce the convergence rates to between 70 and 40 per cent of their values based on the décollement model. The age of the top of the Saugus is 200 kyr, if we calculate it from estimates of the racemization rate of amino-acids¹⁴. Because of uncertainties in the kinematics of amino-acid racemization and the effects of other factors, notably temperature, these estimates could be wrong. The geodetic results support an older age; let us take 500 kyr, based on a magnetostratigraphic section in the east Ventura basin¹⁵ as representative for the Ventura basin as a whole. With this revised age of the top of the Saugus formation and the assumption that reverse faults continue into the lower crust, the convergence rates based on geology are 7–9 mm yr⁻¹, in agreement with the geodetic results. These rates are about the same as those for the preceding 500 kyr, whereas the younger age of the Saugus required an abrupt increase in convergence rate since the Saugus was deposited.

Results from the Global Positioning

System suggest that the southern part of the survey area is rotating, and this points to a weakness in the balanced cross-section method on which the geological estimates of convergence rates are based. Balanced cross-sections of deformed regions are constructed so that they can be restored to their undeformed state without loss of cross-sectional area. This is based on the assumption that deformation

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