In conclusion we have confirmed the weak oestrogenic activity of both podocarpic acid and its reductive derivative podocarpinol. Assay of other candidate phyto-chemicals (including gibberellins) revealed no oestrogenic activity. As there is evidence for a link between the cycles of Kakapo reproduction and the fruiting cycles of the natural food trees (Powlesland et al. 1992), we consider that more work on this area is merited. Oestrogenic activity was detected at very low levels in one of the commercial chick-raising foods. This result was not surprising as soya beans, which are known to contain oestrogenic isoflavones (Wang and Murphy 1994), form a portion of the chick-raising food formulation. In this context it is perhaps worthy of note that the levels of isoflavones vary between different soy bean cultivars and also in response to different growth conditions (e.g. fungal infection, water stress and light intensity). Consequently some inter-batch variations in isoflavone levels in chick-raising foods containing soya would be expected. On the evidence we have obtained to date the levels of oestrogenic activity in the chick-raising foods are not thought to be of physiological significance. Nevertheless, as isoflavone levels may vary between different soy bean lots, it is perhaps prudent to be cognisant of the possible presence of oestrogenic phytohormones in some chick-raising foods.

Our thanks go to Adrian Hobden (Glaxo-Wellcome, USA) and John Sumpter (Brunel University, UK) for generously supplying the recombinant yeast strain used for this bioassay, and to Nicola Beresford (Brunel University, UK) for helpful advice on the bioassay procedure. Thanks to Reg Keogh (AgResearch, New Zealand) for supplying oestrogenic clover seeds.


Captive breeding of Houbara bustards in Saudi Arabia: 11 successful years

S. HÉMON, P. PAILLAT, Y. VAN HEEZIK AND J. JUDAS

National Wildlife Research Center, PO Box 1086, Taif, Saudi Arabia

The Houbara bustard (Chlamydotis [undulata] macqueenii) inhabits deserts, semi-deserts and arid shrublands, and is distributed across the Middle East to Mongolia. During the last half of the 20th century Houbara bustard populations declined drastically throughout much of the range, and the species is now considered endangered in many countries. Its role as the favoured quarry of Arab falconers, along with severe habitat destruction due to overgrazing and human encroachment into once remote desert areas, are the main reasons for the decline of Houbara populations. The threat of extinction of local populations led the National Commission for Wildlife Conservation and Development to undertake a number of conservation measures, including captive breeding of Houbara for reintroductions. HRH Prince Saud Al Faisal initiated a breeding programme in 1986, with the aim of establishing a self-sustaining captive population that would produce an annual surplus for releases into protected areas throughout the Kingdom. The aim of the reintroduction programme is the restoration of viable resident breeding populations of Houbara within a network of protected areas in Saudi Arabia. Egg collecting expeditions took place in Pakistan in 1986, to obtain a flock of founder birds. Eggs brought back to the National Wildlife Research Center (NWRC) at Taif, Saudi Arabia, were artificially incubated and the chicks were reared by hand.

Breeding Houbara in captivity was initially a difficult task given the paucity of knowledge about the biology and ecology of this species. Birds were reared by hand to encourage tameness, in order to reduce the stress of manipulations for procedures such as artificial insemination and the collection of semen. The first captive-bred chicks hatched in 1989. A study conducted in 1992 showed that optimal results are obtained when inseminations of at least 10 million spermatozoa are performed every 4–6 d. By using techniques such as egg pulling, artificial insemination and artificial incubation, chick production has steadily increased, with 313 chicks hatching in 1999, of which more than 130 will be released as sub-adults into the wild in Saudi Arabia. The level of fertility...
of captive Houbara has also increased, from 66% in 1992 to 93% in 1999. In 11 years of captive chick production, more than 1300 chicks have hatched at the NWRC, and of these more than 310 have been released into the Mahazat as-Sayd protected area. Ten years after the production of the first chicks, the NWRC breeding unit is now able to produce relatively large numbers of Houbara, both for restocking the breeding flock and for releases into the wild.

Reintroduction of Houbara bustard in central Saudi Arabia

J. D. AS
National Wildlife Research Center, PO Box 1086, Taif, Saudi Arabia

Captive-reared Houbara bustards (Chlamydotis undulata (macqueenii)) were reintroduced in the wild for the first time in 1991 in Mahazat as-Sa’d, a 2200 km² fenced protected area of central Saudi Arabia. Different techniques of release are tested each year to determine factors affecting survival. Predation has been identified as the main cause of mortality. From 1993 to 1997, the mean survival rate after 3 months was 47.5%, whereas it was as high as 85.9% for the release of January 1999. Several factors could explain this higher survival, such as older age at release, enhanced captivity conditions before release, enhanced body conditions with better food availability and lower or delayed predation risks. Since 1991, 360 birds have been released, resulting in an established breeding population close to 110 individuals. All of them were equipped with radio transmitters, allowing accurate assessment of breeding parameters and population trends, and to enable studies on the still poorly known ecology of this species.

Estimation of age in wild birds

H. KLANDORF, M. IQBAL AND J. BONNER 1

al and Vet Science, PC Box 6108, We Virginia University Morgantown, WV 26506 108 and National Avian, Pi urgh, PA 16221, US

Small population management (most zoo programs) attempts to pair not just the most genetically compatible, but the most completely compatible animals. This often requires sending animals across the country to be paired or re-paired. If this technique could be applied to living birds, it could play a critical role in Species Survival Plans and the pairing of endangered species. Many observations can be made regarding the age of an individual of any species, from the amount of skin wrinkling in humans to the amount of graying or whitening of the muzzle in many other mammalian species. Yet, with birds, there are few such reliable indicators. We are using a biomarker of ageing, pentosidine (Ps), a product of non-enzymatic glycation (the attachment of glucose to proteins without the aid of enzymes), validated in numerous mammalian studies, (Brownlee et al., 1986) and in domestic poultry (Iqbal et al., 1997), and which accumulates over the lifespan of an animal. The intent of this study was to determine if a comparable change in Ps concentrations could be established in wild birds. We obtained skin samples from previously frozen birds of both known and unknown ages. The samples were analyzed for Ps concentration. The preparation of the skin digest for Ps was described by Iqbal et al. (1997). Briefly, this involves removal of the epidermal and adipose layers from skin samples, homogenization in phosphate-buffered saline (PBS), pH 7.5, and extraction with chloroform–methanol. Further preparation of the digest for the Ps assay involves digestion 6N HCl, purging with N₂, heating for 18 h, evaporating the acid in a centrifuge-type vacuum drier, reconstituting in water and final filtering. The estimation of Ps was carried out by the HPLC method described by Sell et al. (1992). In brief, this involved adding enough ddH₂O to a specific amount of acid-hydrolysed digest in order to give a pre-selected concentration of collagen. Separations were achieved by the application of a linear gradient of 12–42% acetonitrile from 0 to 20 min in water and 0.01 M HFBA. Final quantitation of Ps is made by comparing peak areas with the Ps standard curve injected under similar conditions. In agreement with results from mammalian studies, we have established that Ps is present in the skin of various species of wild birds and that the concentrations increase linearly with age (P<0.001). In addition, given the strong correlation between Ps accumulation and bird age, we have been able to estimate the ages of unknown birds (Table). The results of this study demonstrate that not only is Ps present in the skin of avians, but it can also be used as a reliable determinant of age. Knowledge regarding the longevity of birds could provide insight not only into the dynamics of a specific sample of