South American studies of the peregrine, an indicator species for persistent pollutants

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During the past 25 years a novel extinction process has affected a number of northern hemisphere bird species. All are predatory, preying upon other birds, mammals, or fish. The predominant symptom of this process has been the failure of a large proportion of the individual pairs in a given region to produce a sufficient number of young to maintain the local populations. Thin-shelled eggs, resulting from a decrease in calcium carbonate deposition, have been associated with the reproductive failure of each species (Ratcliffe, 1967; Hickey and Anderson, 1968; Hickey, 1969). Among the first to show such a decline was the peregrine falcon (*Falco peregrinus*), whose population in eastern North America had disappeared by 1964 (Berger *et al.*, 1969). Populations in the Arctic have more recently shown evidence of regional declines associated with a degree of shell thinning (Cade *et al.*, 1971). In Britain, the peregrine declined very rapidly during the 1950s, but recently the trend has apparently reversed in some inland but not coastal localities (Ratcliffe, 1972).

Peregrines also occur throughout Eurasia, Africa, India, and Australia, and the subspecies *F. peregrinus cassini* is found in southern Chile and Argentina. The bulk of the Chilean population appears to occur south of the Strait of Magellan, but pairs have recently been found to breed in central Chile by W. R. Millie as described in Jonhson (1965).

Chlorinated hydrocarbons

Studies have indicated that chlorinated hydrocarbon pollutants, particularly the DDT derivative, p,p'-DDE, are associated with the observed reproductive failures. Preliminary studies of the distribution of these compounds in the southern hemisphere have indicated that local concentrations appear to be substantially lower than in corresponding latitudes of the northern hemisphere (Risebrough and Carmignani, 1972). Peregrines in southern South America therefore might not show the symptoms of the extinction process observed elsewhere and could serve as a control population for continuing studies of the phenomenon. Our studies in Chile and Argentina in late 1972 were made to explore the feasibility of such a project; they complement our earlier studies in Antarctica and elsewhere.

From Santiago and Viña del Mar, with the assistance of Jurgen Rottmann, Departamento Forestal del Ministerio de Agricultura, A. W. Johnson, and W. R. Millie, one of us (WW) checked known and likely peregrine sites in central Chile, both inland and coastal. We found none of these known sites occupied, but were able to locate a single breeding pair in a coastal situation. This pair when found had three young approximately 12 days old. Both adults at this eyrie were trapped and biopsied for subcutaneous fat by the techniques described by Enderson and Berger (1968). The adults were then released unharmed and subsequently raised all three young to fledging age.

Hero Cruise 72-4

The fjord country of southern Chile contains many potential breeding sites for peregrines, but

to date they have apparently not been recorded from this region. Cruise 72-4 of the research ship *Hero* was devoted to biological studies of the fjord region by personnel of the Universidad de Concepcion, under the direction of Drs. Lisandro Chuecas and Hugo Saelzer R. One of us (RWR) was able to participate in the second portion of this cruise, which departed Punta Arenas on September 28, 1972. Despite the assistance of Captain Pieter Lenie and his crew, no peregrines were seen, perhaps due to the relative paucity of suitable prey species in the interior fjords. However, while *Hero* lay at anchor among the outer islands, hundreds of diving petrels (*Pelecanoides magellani*) came aboard one night. Here, at least, there appeared to be sufficient prey for peregrines, as perhaps additional searches may show.

In Punta Arenas, the Instituto de la Patagonia is building up a collection of local fauna and flora under the direction of Dr. Mateo Martinic. This collection presently contains five peregrines, which we were able to examine. Tissue samples of birds of prey are being saved for pollutant analysis by William A. Texera, Peace Corps volunteer.

From Punta Arenas, we (WW and JTM) traveled to the more mountainous country near Lago Torres, Chile. This area seemed suitable for peregrines, although we saw none in a considerable area covered afoot and by horses provided by Eduardo Scott W. of Estancia Paine. In this area there were numerous other raptors, including condors (*Vultur gryphus*), aguilas (*Geranoaetus melanoleucus*), caranchos (*Polyborus plancus*), chimangos (*Milvago chimango*), and great horned owls (*Bubo virginianus*).

Tierra del Fuego

We then traveled to the Argentine portion of Isla Grande, Tierra del Fuego, where the remaining field studies were carried out. Here, through the assistance and advice of members of the Goodall and Bridges families of the Estancias Harberton and Viamonte, we attempted to locate breeding peregrine falcons. We observed 100 kilometers (measured straight line) of the eastern coast of Isla Grande afoot, and although sufficient numbers of suitable prey were seen no peregrines were found. The cliffs of this coast are sandstone and may be exposed to some severe winds, although the prevailing wind is from the west. Other species of raptors, however, including the aguila and caranchо, were commonly observed to use these cliffs for nesting.

The Beagle Channel near Ushuaia was likewise without peregrines, although other raptors were encountered. In addition to these raptors, nesting colonies of skuas (*Catharacta skua*) were observed, perhaps a competitor of the peregrine. Upon turning our attention inland, we did discover peregrines and observed one adult pair and a subadult male in a single location. No evidence of breeding was found during the 15-day period they were under observation, although behavior associated with breeding was observed. Prey remains were subsequently identified at the Museo Argentino de Ciencias Naturales, Buenos Aires, with the help of Dr. Mauricio A. E. Rumboll. These peregrines were found to be eating parrots (*Cyanoliseus patagonus*) and whale-birds (*Pachyptila* sp.). The whale-birds as prey are especially interesting, as the site is over 100 kilometers from the nearest coast, and Millie also identified these birds as peregrine prey from central Chile.

While the guests of Senora Cullare and Sr. Luis Cullare at the Estancia Pirinaico, we obtained specimens from freshly shot caranchos, a red-backed hawk (*Buteo polyosoma*), and the local robin (*Turdus falcklandii*). Tissues were preserved for chlorinated hydrocarbon analysis.

While on Isla Grande, we hoped to gather some additional observations on the little known Kleinschmidt's falcon, *Falco kreyenborgi*. This southernmost member of the family Falconidae is known from only five specimens (Stresemann and Amadon, 1963), one of which was taken in the area of our field work.

Laboratory analysis

All the material was analyzed at the laboratory of the Canadian Wildlife Service, Ottawa. The four robins were pooled, ground to a homogenate in a Waring blender, and treated thereafter as a tissue sample. Whole brains and livers from four caranchos were pooled to form tissue homogenates. All tissues were ground with anhydrous sodium sulfate, and the fat was removed by Soxhlet extraction with hot hexane:acetone (2:1, vol:vol) for at least 8 hours. Procedures used thereafter have been described in detail elsewhere (Bowes and Lewis, 1972; Bowes and Jonkel, 1972).

Observed residue levels in the *Buteo* and *Turdus* (table) are lower by two orders of magnitude or more than in comparable species from Alaska (Cade *et al.*, 1971; Lincer, *et al.*, 1970). The DDE residues in the peregrines are also lower than in North American peregrines (Enderson and Berger, 1968; Berger *et al.*, 1970), but only by a factor of 4 to 8. The male and female show a significant difference in the ratio of DDE to PCB. Similar differences between members of the same breeding pair of falcons are known (Walker, unpublished data).

We interpret this to indicate differences in the prey composition of males and females in the months preceding breeding.

We know of only two clutches (three eggs each) of peregrine eggs recently collected in Chile. Both were taken in 1966 by Millie. One of these is now in the museum of the Western Foundation for Vertebrate Zoology, Los Angeles, where we were able to measure eggshell parameters with the assistance of Lloyd Kiff, curator. Measurements of the other clutch were supplied by Millie. The mean measurements for all six eggshells are: eggshell weight—3.39 (3.16-3.76) grams, and thickness index—1.60 (1.54-1.68). The mean thickness of the three shells in the museum at Los Angeles was 0.315 (0.310-0.323) millimeter.

We know of no other peregrine eggs that have been collected from this region. Measurements of *F. p. cassini,* however, would indicate that it is not different in size from the populations of the interior of arctic North America (Amadon and Brown, 1968). In addition, both the length and breadth of the Chilean eggs (n=6) fall within the ranges of eggs from interior arctic North American peregrines (D. W. Anderson and J. J. Hickey, unpublished data). For lack of a pre-1945 Chilean sample, we have compared the measurements of the 1966 Chilean eggs to these North American eggshells in an attempt to assess possible shell thinning. Mean measurements and the 95 percent confidence limits for the North American eggshells are as follows: shell weight—3.933 ± 0.087 grams (n=59), thickness—0.3678 ± 0.0058 millimeter (n=40), and thickness index—1.881 ± 0.032 (n=59). The values of each of these three parameters suggest that the 1966 Chilean eggshells are thinner than the expected normal. The regression equation calculated by Cade *et al.* (1971) for thickness index versus DDE residues in the northern peregrine shows that comparable thinning is associated with residue concentrations equivalent to those we have found in the Chilean peregrine.

Chlorinated hydrocarbons in tissues sampled.

Species, tissue	Lipid weight	% lipid	ppm, lipid p,p'-DDE	ppm, lipid PCD
Turdus falcklandii				
Pooled sample of four, whole body	1.614	1.4	0.03	<0.01
Polyborus plancus				
Pooled sample of four, livers	0.725	N.D.	0.05	<0.01
Pooled sample of four, brains	1.011	6.1	0.25	0.20
Buteo polyosoma, female				
liver	0.921	N.D.	0.02	0.25
brain	0.344	10.4	<0.01	<0.01
fat	0.903	26.9	0.02	0.09
Falco peregrinus cassini				
Biopsy fat, male	0.025	45.8	60	152
Biopsy fat, female	0.044	70.8	120	167

Collection details in text. N.D. = not determined.

Acknowledgements

Research was supported by National Science Foundation grant GV-36080 from the Office of Polar Programs to the Bodega Marine Laboratory and by the Canadian Wildlife Service. We thank the persons mentioned in the text for generous and invaluable assistance.

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