HEAVY METAL RESIDUES IN PACIFIC BLACK DUCK *ANAS SUPERCILIOSA* FROM GRIFFITH, NEW SOUTH WALES

Many heavy metals are widely distributed in the environment. Their biological availability depends on local abundance, which is dependent on their environmental dynamics, and on natural circumstances and human activity (Hartung 1976). In excessive amounts and in certain forms, heavy metals can be harmful to wildlife and man (e.g. Hart 1974). In Australia there are a few reports on residues of mercury and other heavy metals in estuarine fish and shellfish (Neuhaus *et al.* 1973; Thrower & Eustace 1973a,b; Mackay *et al.* 1975; Williams *et al.* 1976) and Crested Tern *Sterna bergii* (Howarth *et al.* 1981).

During a study of organochlorine contamination of ducks shot during the hunting season in s.e. Australia (Olsen *et al.* 1980, a few samples were also analysed for heavy metals.

METHODS

Wings from eight individual adult Pacific Black Duck *Anas superciliosa* were collected from Barrenbox Swamp, New South Wales, in March 1977. They were plucked of feathers, ground and stored frozen in glass jars. In 1978 nineteen adult male Pacific Black Duck were collected from the same area. A breast muscle was removed from each Duck, wrapped in aluminium foil and stored frozen. Wings or breast muscle containing shotgun pellets were discarded.

The analytical techniques used were:
(1) for *Cd, Cu, Pb, Zn*, the homogenised sample was digested with dilute H_2SO_4 followed by dry ashing at 500°C. The ash was dissolved in dilute HNO_3 and determination of metals was by AA using direct aspiration;

(2) for *Hg*, the homogenised sample was digested with $HNO_3 - H_2SO_4$ followed by reduction to elemental Hg with excess stannous chloride. Determination was by flameless AA using a Coleman Mercury Analyser;

(3) for *Se*, the homogenised sample was digested with $HNO_3 - HClO_4$ followed by reduction to selenite and complexing with 2, 3 diaminonaphthalene. Determination was by spectrophotofluorimetry.

Blanks were run at frequent intervals. The relevant limits of detection in mg/kg were: in wings, mercury and cadmium 0.005, selenium 0.05; and in breast muscle, mercury 0.01, cadmium 0.02, and lead 0.20.

RESULTS AND DISCUSSION

All samples contained detectable amounts of zinc and copper, and all but one contained selenium (Table I). Duck wings contained higher amounts of zinc and lead than did muscle, whilst muscle contained higher amounts of copper and selenium than did wings. Although wing and muscle samples were not from the same Ducks, these differences are probably attributable to different rates of uptake and retention of heavy metals. For example, the uptake of lead by bone is rapid and loss is low, therefore residues in bones tend to reflect the history of exposure. Residues in muscle, on the other hand, tend to reflect circulating levels from more recent exposure (e.g. Blus *et al.* 1977; Stendell *et al.* 1979).

The breast muscle of two out of nineteen Ducks contained a greater quantity of mercury than the limit recommended by the National Health and Medical Research Council (NHMRC 1981) in food for human consumption (Table I). However, mercury residues in all of the samples of breast muscle were within the lower part of the range of residues found in ducks collected in parts of the U.S.A. not known to have high environmental mercury levels (Baskett 1975).

Lead residues were generally low in muscle samples. However, muscle from two out of nineteen Ducks contained more than the recommended level for food, as did two of the six wings. These results are difficult to compare with a survey of lead levels in Black Duck *Anas rubripes* wings in U.S.A. (Stendell *et al.* 1979) because the methodology is different, but suggest a similar degree of contamination. White & Stendell (1977) found a correlation between lead residues in the wing bone of ducks and the presence of ingested lead shot in the gizzard, on a population basis, in the U.S.A. Norman (1976) reported an 'extremely low' intake of shotgun pellets by ducks in south-eastern Australia, while Lavery (1971), in Queensland, reported intake as high as that found in the U.S.A. but found little evidence of the lead poisoning often associated with it. However, there are other sources of environmental contamination by lead which could result in ingestion by ducks.

The breast muscle of two Ducks contained greater than 1.4 mg/kg (wet weight) of lead. Longcore *et al.* (1974) reported lead levels averaging 1.4 in muscles of experimentally poisoned Mallards *Anas platyrhynchus*. However, liver is generally thought to be a more useful tissue in diagnosing acute lead poisoning (e.g. Szymczak &

TABLE I

Concentrations of mercury, zinc, copper, cadmium, lead, arsenic and selenium in individual Pacific Black Duck from Barrenbox Swamp: (a) wings 1977; (b) breast muscles 1978.

Body weight (g)	Residues, mg/kg wet weight						
	Mercury Hg	Zinc Zn	Copper Cu	Cadmium Cd	Lead Pb	Arsenic As	Selenium Se
(a) *Wing*							
-	0.01	29.0	2.7	nd	0.51	0.27	0.10
-	0.01	54.0*	3.3	0.04	10.70*	1.24*	0.10
-	0.01	30.0	2.9	nd	0.45	0.42	0.10
-	0.01	39.0	3.8	0.02	0.31	0.14	0.10
-	0.01	24.0	2.1	0.02	-	0.16	nd
-	nd	37.0	3.3	nd	-	0.29	0.10
-	nd	27.0	7.2	nd	3.40*	0.31	0.10
-	nd	37.0	5.7	nd	1.50	0.27	0.10
Median	0.01	33.5	3.3	nd	1.01	0.28	0.10
mean	0.01	34.6	3.9	0.01	2.81*	0.39	0.09
(b) *Breast muscle*							
1050	nd	11.0	7.6	0.05	0.67	-	0.40
1250	0.02	10.0	5.2	0.06*	nd	-	0.39
1150	nd	8.8	4.3	0.03	nd	-	0.45
1200	0.03	11.0	5.7	0.03	1.70*	-	0.48
1120	0.02	10.0	7.6	0.03	0.50	-	0.42
1100	nd	10.0	9.5	0.04	nd	-	0.23
1325	nd	10.0	7.3	0.03	nd	-	0.56
1350	nd	9.3	4.3	0.03	nd	-	0.39
1225	0.01	11.0	7.9	0.02	nd	-	0.47
1275	nd	11.0	6.0	0.03	0.20	-	0.65
1140	0.06*	13.0	7.3	0.02	0.20	-	0.43
1000	0.01	11.0	6.0	0.02	1.80*	-	0.34
800	0.05*	9.5	5.0	0.03	nd	-	0.30
1050	0.02	9.5	5.5	0.02	nd	-	0.36
950	0.01	13.0	5.0	0.03	nd	-	0.23
1350	0.03	12.0	6.5	nd	nd	-	0.35
1350	0.01	11.0	5.5	nd	nd	-	0.39
1100	0.03	13.0	4.8	0.02	nd	-	0.40
900	0.02	10.0	5.3	0.03	nd	-	0.26
Median	0.01	11.0	6.0	0.03	nd	-	0.40
mean	0.02	10.7	6.1	0.03	0.26	-	0.39

Residues marked by an asterisk are greater than those allowable in food for human consumption by the NHMRC (1981): mercury < 0.03 mg/kg; zinc < 150 mg/kg; copper < 10 mg/kg; cadmium < 0.05 mg/kg; lead < 1.5 mg/kg; arsenic < 1.0 mg/kg as arsenious oxide = 1.44 mg/kg as the metal; selenium < 1.0 mg/kg. nd = not detected. Correlation between body weight and selenium $r = 0.589$, $p < .01$; that with other metals, not significant.

Adrian 1978).

The site where the Ducks were collected is a swamp used for the reticulation and drainage of irrigation water in an area of intensive agriculture. The wing of one Duck contained relatively high levels of three metals - zinc, arsenic and lead. As Pacific Black Duck move extensively (Frith 1967), this suggests a possible past association by this Duck with an area where there is some industrial or agriculture contamination by these heavy metals.

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OLFACTORY EXPERIMENTS ON SOME ANTARCTIC BIRDS

Some ornithologists have suggested that certain Procellariiforms are able to detect the smell of fish or animal oil (Murphy 1936; Miller 1942; Kritzler 1948), and anatomists have noticed the highly developed olfactory bulbs and sensory epithelium in this group of seabirds (Bang 1960, 1965, 1966, 1971). Over the last ten years a few experimental studies have been carried out in this field. Grubb (1974) indicated the possibility of olfactory homing in Leach's Storm-petrel *Oceanodroma leucorrhoa* and (Grubb 1972) of foraging at sea by smell in both the Great Shearwater *Puffinus gravis* and Wilson's Storm-petrel *Oceanites oceanicus*. Similar experiments have also been recently carried out by Hutchinson & Wenzel (1980).

Since it is difficult to keep petrels in captivity and as they seem to show limited learning capacities, few laboratory tests have been performed. However, Jouventin (1977) showed that the Snow Petrel *Pagodroma nivea*, which has the largest olfactory bulbs (Bang 1965, 1966; Bang & Cobb 1968), was able to smell and to locate its food by olfactory cues alone.

The experiments reported here were designed to complement, in field conditions, the previous experiments on the Snow Petrel, as well as to extend our knowledge of the use of olfaction in other birds breeding in Terre Adelie (Antarctica). Our experiments were carried out during the austral summer of 1981-1982. The location was in Terre Adelie close to the French base, which is on the Petrels Island in the archipelago of Pointe Geologie, 1 km from the Antarctic continent.

During the summer Prevost (1963) estimated that, over an area of 1 km radius, there are breeding about 1000 Snow Petrels, 1000 Cape Petrels *Daption capense*, 1000 Wilson's Storm-petrels. Our most recent counts show that, in addition to these there is breeding by about 70 Antarctic Fulmars *Fulmarus glacialoides*, 30 Southern Giant-petrels *Macronectes giganteus* and 80