

Micromelia in Little Penguins (*Eudyptula minor*)

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Abstract: Two cases of unilateral micromelia are described in wild juvenile little penguins (*Eudyptula minor*). The first bird was found at San Remo, Phillip Island, Victoria, Australia. The bird's left flipper was reduced in length, and radiography demonstrated severe shortening and dysplasia of the humerus. The second bird was found having difficulty swimming off the coast near Fremantle, Western Australia. Clinical examination revealed that the bird was underweight (0.55 kg) but otherwise in good condition with subadult plumage and had probably only recently fledged from nearby Garden or Penguin Islands. The left wing was markedly reduced in size and had limited range of elbow and carpal joint movement but sensation and motor control were normal. Radiography demonstrated a severe reduction in size and distortion of the humerus and shortening and fusion of the ulna, radius, metacarpals, and phalanges. The furcula was asymmetrical because the left clavicle was slightly thinner and more radiolucent than the right and was also slightly deviated to the right side. Necropsy results of histopathologic examination revealed no other significant external abnormalities other than a mild focal heterophilic ulcerative proventriculitis from a mild burden of *Contracaecum eudyptulae*. Concentrations of heavy metals in kidney, liver, and brain were: cadmium, <6 mg/kg; mercury, <0.05 mg/kg; lead, <2 mg/kg; and selenium, 1.30 mg/kg. Possible causes of unilateral micromelia in these penguins are discussed.

Key words: micromelia, brachymelia, skeletal abnormality, congenital defect, avian, *Eudyptula minor*, little penguin

Case 1

A little penguin (*Eudyptula minor*) was found by a member of the public in January 1993 at San Remo, Phillip Island, Victoria, Australia. The bird had a markedly shortened left flipper (Fig 1A) and was euthanatized by cervical dislocation by a wildlife caregiver. The bird's plumage and morphometry data were consistent with a subadult bird or recent fledgling. Postmortem radiographs demonstrated a normal right flipper and pectoral girdle and a markedly shortened and distorted left humerus (Fig 1B).

Case 2

In December 2004, a juvenile little penguin with an abnormally small left flipper was found at the

South Fathom Bank west of Garden Island near Fremantle, Western Australia, by a Department of Conservation and Land Management wildlife officer. The bird was in good condition and bright and alert when presented to Murdoch University Veterinary Hospital for clinical examination. It had significant unilateral brachymelia of the left flipper (Fig 2) and was markedly underweight (0.55 kg, reference range, 1.0–1.5 kg); otherwise, the bird was behaving normally and in relatively good body condition with subadult plumage. It had probably only recently fledged from the nearby Garden or Penguin Islands. Normal deep pain sensation and motor control of the left flipper was present, but the range of elbow and carpal joint flexion was limited.

The bird was determined not suitable for rehabilitation and release into the wild or for zoological exhibition. For that reason, it was anesthetized for radiographic examination and euthanasia. Ventrodorsal and lateral radiographs showed ateliosis of the humerus and metacarpophalangeal synostosis and ateliosis and phalangeal aplasia (Fig 3A). The left clavicle was slightly thinner and radiographically less dense than the right and was also slightly deviated to the right

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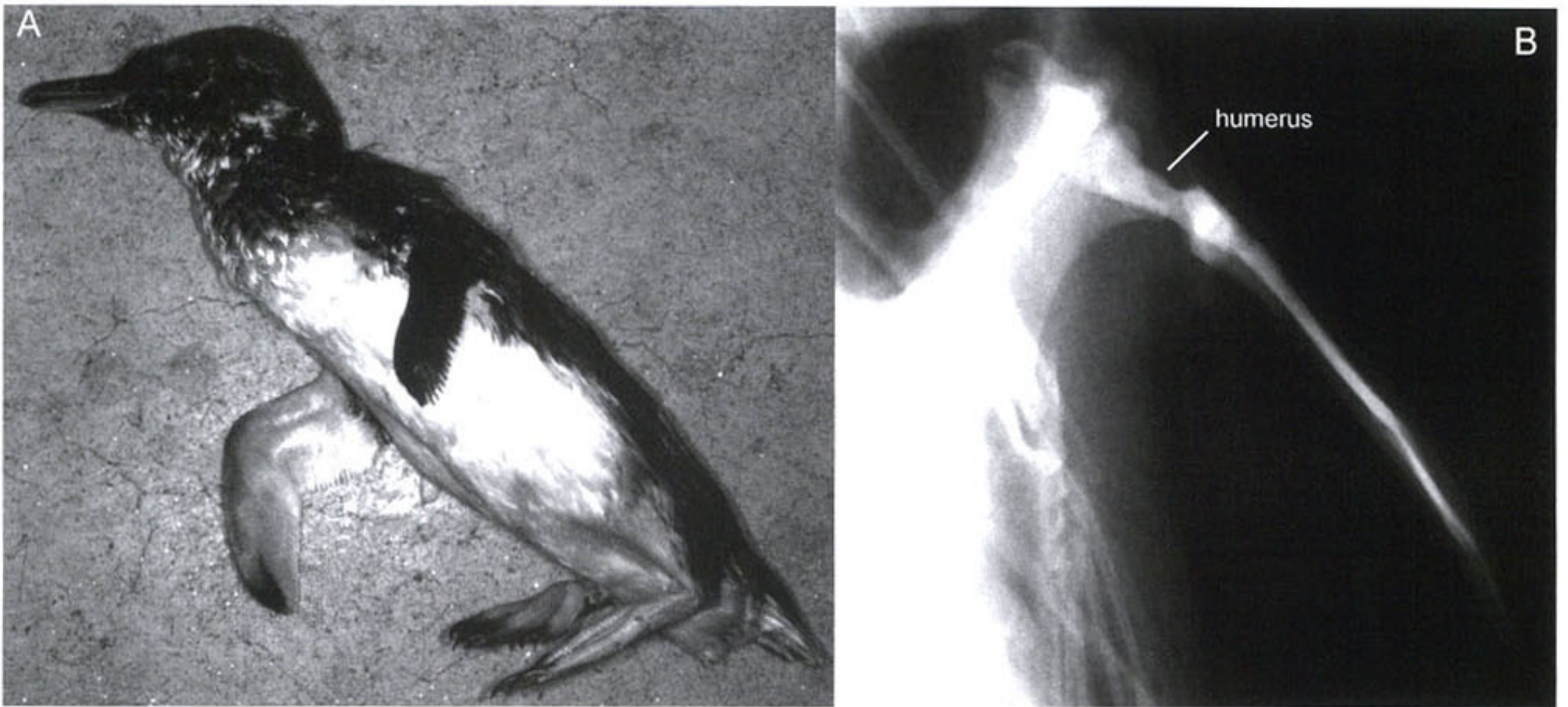


Figure 1. Juvenile little penguin found at Phillip Island, Victoria, Australia, demonstrating approximately 50% reduction in length of the left wing (A), mainly because of markedly reduced and distorted development of the humerus (B), as observed radioscopically.



Figure 2. Juvenile little penguin found west of Garden Island, Western Australia, demonstrating a severely shortened left flipper.

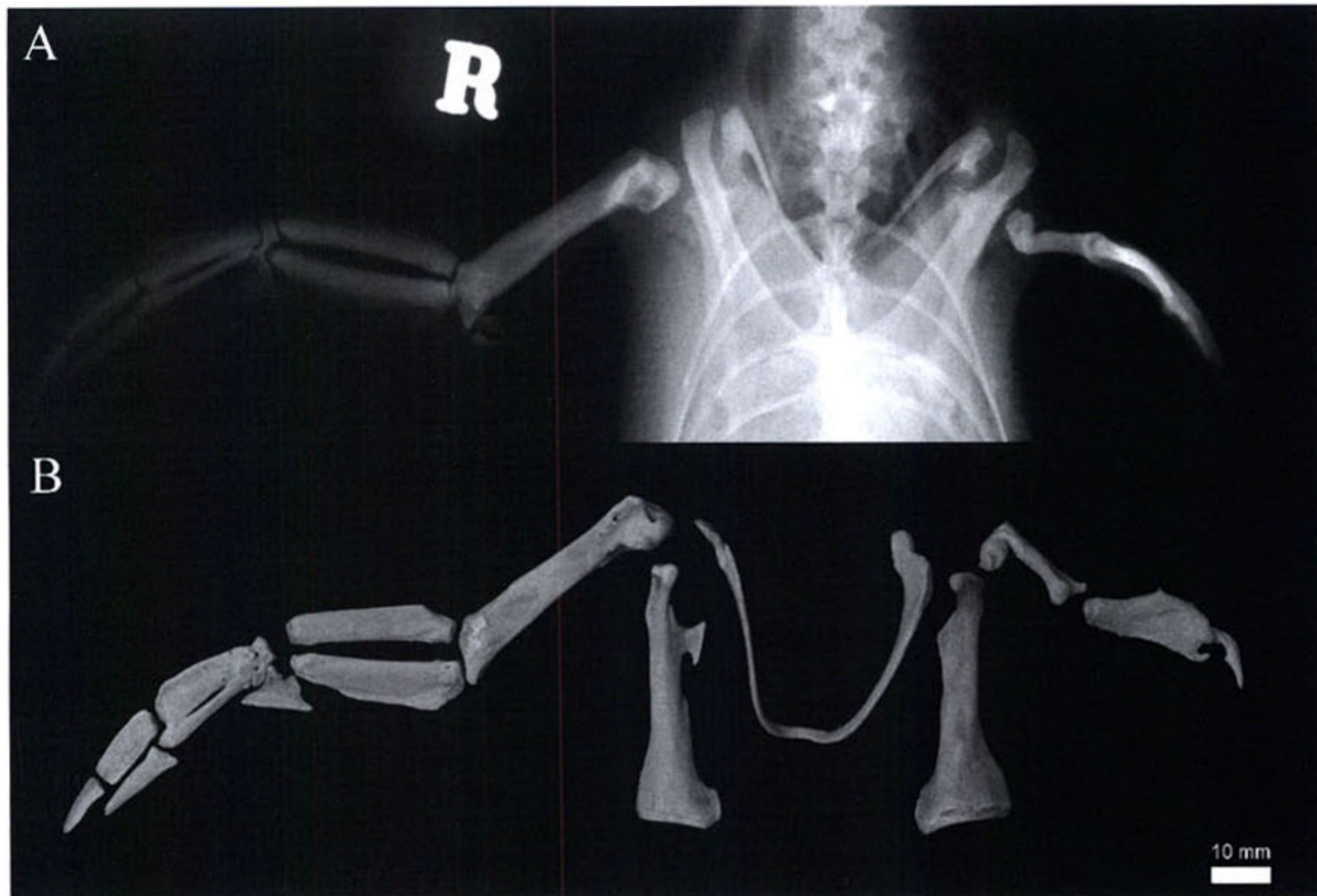


Figure 3. Ventrodorsal radiograph (A) of the bird shown in Figure 2 and an anatomical preparation of the pectoral girdle without the scapulae (B). Both figures demonstrate a markedly shortened and distorted left humerus and metacarpophalangeal synostosis, distortion, and phalangeal aplasia. Hypoplasia of the procoracoid process is evident on the medial aspect of the left coracoid.

side, presumably as a result of the differing muscle tensions placed on the left and right sides.

Immediately after radiography, the bird was euthanatized with intravenous sodium pentobarbital via the metatarsal vein and a necropsy was performed. There were no other external abnormalities visible apart from the flipper malformation. Internal examination revealed normal visceral organs, except for a minor proventriculitis because of low numbers of *Contracaecum eudyptulae*, which is a relatively common infection of penguins in the area (R. Hobbs, oral communication, 2005).

Duplicate samples of kidney, liver, and brain were also taken for heavy metal analysis (Analytical Reference Laboratory (WA) Pty Ltd, East Perth, Western Australia). Concentrations of cadmium in the kidney, liver, and brain were 5.7, 3.7, and 4.9 mg/kg (wet weight), respectively. Concentrations of mercury in the kidney, liver, and brain were all below the limits of detection (<0.05 mg/kg wet weight), and concentrations of lead in the kidney, liver, and brain were 1.25, 0.5, and 1.75 mg/kg (wet weight), respectively. The liver selenium concentration was 1.30 mg/kg (wet weight). These results were less than or similar to

values obtained from samples collected from 3 adult penguin carcasses collected from Penguin Island that had been submitted for necropsy for other reasons and from published results for other waterfowl species in Australia.¹

Samples of brain and all coelomic visceral organs were taken and fixed in formalin for routine paraffin embedding and histopathological examination. Abnormal lesions included a mild focal ulcerative heterophilic proventriculitis associated with the attachment of *C eudyptulae*. Closer examination of the pectoral girdle and bones of the flippers was facilitated after dissection and thermal hydrolysis of soft tissues and ligaments. Boney abnormalities observed in radiographs were confirmed, and hypoplasia of the winglike procoracoid process on the medial aspect of the proximal surface of the left coracoid was also noted (Fig 3B). The left scapula was normal.

Discussion

The little, blue, or fairy penguin (*E minor*) is the world's smallest penguin species and is restricted in range to the warmer waters along coastal southern Australia and New Zealand.² The breeding colonies of ~1000–1200 little penguins

nesting on the central part of Penguin Island (32°17'S, 115°41'E) and on nearby Garden Island near Perth are the species' most northerly breeding sites and are in close proximity to major cities, industrial ports, and a large naval base located on Garden Island. Artificial nest boxes placed on Penguin Island have been used by penguins for breeding activity^{3,4} because sand on the island is too soft for burrows and penguins here naturally nest in limestone caves, in rock crevices, and under natural bushes.⁵ Other seabird species that breed on Penguin Island include silver gulls (*Larus novaehollandiae*), bridled terns (*Sterna anaethetus*), and, more recently, the Australian pelican (*Pelecanus conspicillatus*).

A small breeding colony of little penguins on the mainland in Sydney harbor is listed as endangered because of its proximity to Australia's biggest city and busiest port. These urban penguin populations are subject to increasing human interference, which justifies monitoring the causes of mortality for the species.⁶⁻⁸

In this paper, we described 2 cases of naturally occurring, probably congenital, developmental skeletal abnormalities in wild little penguins. Congenital musculoskeletal disorders have not been observed in past surveys of the causes of mortality in this species,⁶⁻⁸ but during the summer of 1971-1972, a chick with "no sign of any flippers and with no scars" was found on the beach at Wilson's promontory in Victoria.⁹ The conjecture that this bird had complete agenesis of both pectoral limbs was supported by body measurements indicating that it had recently fledged. The same authors also had observed sibling chicks in a nest at Lawrence Rocks, Victoria, that both had bill abnormalities.⁹ One had scissor-bill deformity and the other had an incompletely developed, shortened rhamphotheca. A scissor-bill deformity and a ventral body wall defect have also been observed in penguin chicks in Victoria (R. Norman, unpublished data), and in 2004, a pelican chick with a beak deformity was noticed on Penguin Island (N. Dunlop, oral communication, 2004).

These cases probably represent rare events and are likely to be of no great consequence to the survival of any species if they are the result of random nonheritable genetic defects that occur during limb bud development. However, another possible primary cause for such lesions is exposure to teratogenic toxins, and this alone should warrant ongoing monitoring of breeding populations of little penguins and other species of high conservation status, especially those close to

potentially contaminated major industrial areas such as Cockburn Sound near Penguin Island.¹⁰

Micromelia is relatively rare but is recognized as a naturally occurring lesion in poultry,¹¹⁻¹³ and a syndrome associated with a lethal genetic mutation is recognized in turkeys.¹⁴ The organophosphate pesticides diazinon and metathion,¹⁵⁻¹⁷ as well as cadmium, selenium, and possibly other heavy metals, are known to be teratogenic in a wide range of bird and animal species and have been reported as a cause of micromelia.¹⁸⁻²⁰ This was the main reason for determining selenium, cadmium, mercury, and lead concentrations in the tissues from the second animal. However, the data generated and the unilateral nature of the condition in this penguin suggest that a systemic toxicosis was unlikely.

Hyperthermia is also recognized as being teratogenic in eutherian mammals,²¹ the result of thermally induced apoptosis of cells during organogenesis. Avian embryos are subject to greater variations in temperature than mammals and, depending on the stage of incubation, can be very resistant to periods of hypothermia.^{22,23} Embryonic stress, expressed as an increase in heart rate, occurs with even mild increases in ambient temperature, and irreversible arrhythmias and deaths occur quickly in chicken embryos at 46°C-47°C (115°F-177°F).²³⁻²⁵

Given that the optimum incubation temperature of Sphenisciformes is lower than that for other birds,²² penguin embryos could have a lower tolerance to thermal stress than chicken embryos. It is not unusual for maximum daily temperatures in Perth to be >40°C (104°F) in the middle of summer, and previous research has shown that temperatures inside nest boxes placed in areas with no shade cover on Penguin Island can reach >40°C (104°F), even when the ambient temperature is much lower.⁴

Heat stress and death do occur in molting penguins on Penguin Island during the hottest days in summer (B. Cannell, unpublished data). This is because during their annual molt in late summer, molting birds are restricted to the island and do not swim and feed as they normally would during the day. Given that the incubation period of the little penguin is 33-37 days and that fledging normally occurs by 7-8 weeks of age, the bird we examined most likely hatched in October from an egg laid in September 2004. Although neither were exceptionally hot months, with maximum daily temperatures of 24.9°C-29.5°C (77°F-85°F) high environmental nest box temperatures cannot be ruled out as a possible cause of the lesion if the egg was laid in a nest box with little shade.

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