

STOMACH STONES FROM EMPEROR PENGUIN *APTENODYTES FORSTERI* COLONIES IN THE WEDDELL SEA

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SUMMARY

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More than 300 hundred stones collected at three Emperor Penguin *Aptenodytes forsteri* breeding colonies in the Weddell Sea were examined to ascertain their composition and provenance. The movements of stones carried by glaciers is discussed with special reference to the movement of glaciers in Antarctica. The function of stomach stones is also reviewed.

INTRODUCTION

It has been known for a long time (Peale 1848) that Emperor Penguins *Aptenodytes forsteri* ingest stones, presumably while feeding, but why is uncertain. It may be accidental, but may also be related to the need for ballast for deep diving, or as a grinding agent for food. Stones might be swallowed along with their prey which have stones in their guts. Penguins could also pick up stones while foraging along the sea bottom or while the stones sink through the water after release from melting ice (thus resembling food). Whatever the reason, these stones are often found when penguin stomachs are stomach-flushed to obtain diet samples (Klages 1989, Pütz 1995). Some Emperor Penguin chicks observed in the Drescher Inlet colony, Weddell Sea (72°51'S, 19°25'W, Fig. 1. Colony No. 5) with protruding stomachs, seemingly fat with food, were actually bulging with stones, apparently unable to purge the stones by vomiting or passing them through the digestive tract (K. Pütz pers. comm.). Klages (1989) and Pütz (1995) did not comment on the origin or reasons for ingestion of the stones they observed.

Several investigators have conducted studies of foraging distances and diving depths of Emperor Penguins (e.g. Kooyman *et al.* 1971, Ancel *et al.* 1992). With fast ice extending to many tens of kilometres, the adults are forced to walk to the edge to reach open water and dive for food, unless there are local leads in the ice. Ancel *et al.* (1992) for example reported a foraging distance of 895 km from the breeding colony and diving to a depth of 400 m or more when studying Emperor Penguins at Cape Washington (74°39'S, 165°25'E) in the Ross Sea. Foraging and diving limits become important when examining the stomach stones for information on correlations with the geology in the vicinity of the colonies. Because Emperor Penguins do not breed on exposed rock, or usually traverse rocky areas in their lifetimes, the source of the stones must be derived from the marine environment.

The object of our study was to determine the reason(s) for ingestion of stones by Emperor Penguins and from where they are collected, as well as to make rough estimates of the original source of bedrock in the Weddell Sea region of Antarctica, where there is little exposed rock.

METHODS

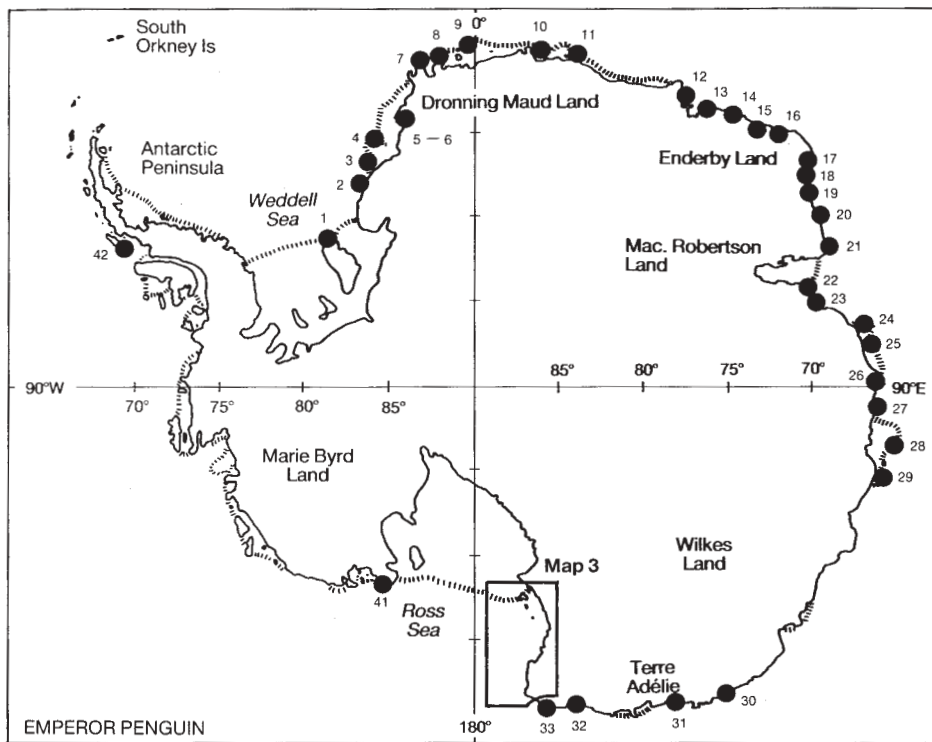
We analysed more than 300 samples of stomach stones taken from three Emperor Penguin colonies (Table 1) along the eastern coast of the Weddell Sea, Antarctica (Fig. 1). All samples were taken from guano or regurgitated material (Fig. 2) found on the fast ice that the penguins occupied in their breeding season. We also collected *c.* 10 samples of stones from regurgitated boluses of South Polar Skuas *Catharacta macormicki*, which may have ingested them while feeding on Emperor Penguin carcasses, although skuas can undertake large movements (e.g. Splettsstoesser 1981) and therefore the stones could have been collected from a considerable distance away.

RESULTS

Stones which we collected from three colonies in the eastern Weddell Sea from 1991–1996 range up to 35 mm in their longest dimension (Fig. 3). All are igneous or metamorphic in nature, with our identifications going no further than basalt/dolerite, andesite and varieties of volcanics matching the coastal geology of the area. Samples in regurgitated food imply that some of these stomach stones are passed from adults to chicks during feeding and that the chicks may eliminate them by vomiting, or the regurgitated material is the result of a failed feeding attempt.

Stones collected from South Polar Skua boluses did not differ geologically from those derived from Emperor Penguins.

We observed a number of Adélie Penguins *Pygoscelis adeliae* in the same three Emperor Penguin colonies, some attempting nesting and breeding (Fig. 4). In the absence of a rock outcrop source these Adélie Penguins built their nests out of stones they scavenged from material regurgitated by the Emperor Penguins and also from pieces of loose ice. Although we have seen many Adélie Penguins nesting in Emperor Penguin colonies, and some incubating, we have never observed chicks.



Scale: Distance between latitude marks (e.g. 80°–85°) is 300 nautical miles (555 km).

Fig. 1. Distribution of breeding colonies of the Emperor Penguin, after Woehler (1993).

DISCUSSION

The history of discoveries of stomach stones in Emperor Penguins includes reports from as early as the U.S. Exploring Expedition of 1838–42 by Peale (1848), who described basaltic pebbles in the stomach of an Emperor Penguin that was caught on the ice at 66°52'S, 150°25'E in January 1840. Murphy (1936) mentioned that stones are practically always present in the stomachs of both adult and chick Emperor Penguins, mostly angular pieces ranging in size from coarse sand to pebbles 33-mm long. Stewart (1934) analysed 400 stones from Emperor Penguins taken by Byrd's 1929/30 Expedition in the Bay of Whales (78°30'S, 164°20'W). Some stones were comprised of kelyte, a rock limited to the Ross Archipelago to the west, implying that the penguins had moved some 550–650 km from the geological source area. Murphy (1936) also cites Sclater (1888) who referred to masses of stones weighing as much as 10 pounds (4.5 kg). Clarkson (1988) examined 686 stomach stones from Emperor Penguins collected during 1957–1959 on sea ice and on the ice shelf near Halley Station

(75°40'S, 27°14'W, Fig. 1, Colony 3) in the Weddell Sea. Sizes of stones ranged from 5–20 mm, although one reached 40 mm in maximum diameter. He reasoned that the stones were derived from glacial sources which included typical rocks of the Transantarctic Mountains, although some had no obvious exposed rock source.

Stomach stones from Emperor Penguins can be assumed to be from glacial marine sediments that have been derived from a land source and deposited from glacier ice, with the possible exception of sea-bottom rocks formed in place, such as lavas from the Explora Wedge, a feature within foraging range of the penguin colonies in the eastern Weddell Sea. The stones could also represent geological features that are not exposed upstream because of total immersion by ice, or rock units that have been completely removed by erosion with only their sedimentary deposits remaining on the floor of the Weddell Sea. Sediments of the Weddell Sea have been sampled by various investigators (Goodell *et al.* 1973), and in one case classified according to provenance and lithologies (Anderson *et al.* 1991).

TABLE 1

Emperor Penguin colonies visited during the study

No. *	Colony	Locality	No. breeding pairs (Woehler1993)
2	Dawson-Lambton	76°30'S 29°00'W	11 700
6	Riiser Larsen	72°00'S 17°00'W	5900
8	Atka Bay	70°30'S 9°00'W	8000

* See Fig. 1

Sources of stomach stones, however, may not be limited to the local coastal geology. Stones from the sea bottom could also have been melted out of icebergs, which can move great distances around the continent, making interpretation difficult. Eights (1846) was the first to report on the significance of rocks in icebergs as being representative of the geology of Antarctica as a result of his participation in an expedition to the South Shetland Islands in 1829/30. Work by Stewart (1934), Clarkson (1988) and Anderson *et al.* (1991), however, suggests that the majority of stones are of local origin or can be explained as to their source. Thus the possibility of correlating penguin stomach stones with coastal geology appears valid within limits.

The uncertainty pertaining to the reasons for the penguins ingesting stones, and where they find them, remains. FST's design of the Penguin Encounter at Sea World, San Diego, U.S.A. did not include pebbles in the habitat of the Emperor Penguins; but did include chunks of ice to simulate their natural breeding habitat on sea ice. Emperor Penguins in captivity appear to have no need to ingest stones, but without a source, and no need for ballast for diving or for grinding food (such as squid beaks) in the stomach, behaviour of captive penguins cannot be readily compared with that in nature.

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REFERENCES

- ANCEL, A., KOOYMAN, G.L., PONGANIS, P.J., GENDNER, J.-P., LIGNON, J., MESTRE, X., HUIN, N., THORSON, P.H., ROBISSON, P. & LE MAHO, Y. 1992. Foraging behaviour of Emperor Penguins as a resource detector in winter and summer. *Nature* 306: 336–339.
- ANDERSON, J.B., ANDREWS, B.A., BARTEK, L.R. & TRUSWELL, E.M. 1991. Petrology and palynology of Weddell Sea glacial sediments: implications for subglacial geology. In: Thomson, M.R.A., Crame, J.A. & Thomson, J.W. (Eds). *Geologic evolution of Antarctica*. Cambridge: Cambridge University Press. pp. 231–235.
- CLARKSON, P.D. 1988. Glacier erratics from the Brunt Ice Shelf. *Br. Antarct. Survey Bull.* 8: 1–10.
- EIGHTS, J. 1846. On the icebergs of the Ant-Arctic Sea. *Amer. Quart. J. Agric. Sci.* 4: 20–24.
- GOODELL, H.G., HOUTZ, R., EWING, M., HAYES, D., NAINI, B., ECHOLS, R.J., KENNETT, J.P. & DONAHUE, J.G. 1973. Marine sediments of the Southern Oceans. *Am. Geogr. Soc. Antarct. Map Folio* No. 17.
- KLAGES, N.[T.W.] 1989. Food and feeding ecology of Emperor Penguins in the eastern Weddell Sea. *Polar Biol.* 9: 385–390.
- KOOYMAN, G.L., DRABECK, C.M., ELSNER, R. & CAMPBELL, W.B. 1971. Diving behavior of the Emperor Penguin *Aptenodytes forsteri*. *Auk* 88: 775–795.
- MURPHY, R.C. 1936. *Oceanic birds of South America*. New York: American Museum of Natural History.



Fig. 2. Regurgitated stomach contents of an Emperor Penguin containing stones from the Dawson-Lambton breeding colony.



Fig. 3. Stones extracted from regurgitated material found in Emperor Penguin breeding colonies in the Weddell Sea. The coins are 24 mm in diameter.



Fig. 4. Adélie Penguins with a stone-lined nest site breeding on ice at the Dawson-Lambton Emperor Penguin Colony.

- PEALE, T.R. 1848. U.S. exploring expedition during the years 1838–1842. *Phila.*, 8, *Mammalia and Ornithology*: 5–299.
- PÜTZ, K. 1995. The post-moult diet of Emperor Penguins (*Aptenodytes forsteri*) in the eastern Weddell Sea, Antarctica. *Polar Biol.* 15: 457–463.
- SCLATER, P.L. 1888. Notes on the Emperor Penguin. *Ibis Fifth Series* 6: 325–334.
- SPLETTSTOESSER, J.F. 1981. Bird sightings in the Ellsworth Mountains and other inland areas. *Antarct. J. U. S.* 16: 177–179.
- STEWART, D. 1934. Anorthoclase crystals as an index of the migration of penguins. *Am. J. Sci.* 27: 454–456.
- WOEHLER, E.J. 1993. The distribution and abundance of Antarctic and Subantarctic penguins. Cambridge: Scientific Committee on Antarctic Research.
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