



## **Main pathways in the evolution of Antarctic fossil penguins (Seymour/Marambio Island, La Meseta Formation, Eocene): cooling events and marine circulation**

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The evolution of the Southern Ocean during the Paleogene played an important role in the origin of fossil penguins. Seymour/Marambio Island (La Meseta Formation, Eocene) contains one of the most complete records of the group in the world. The oldest undisputed record of penguins comes from the late Paleocene. The lower levels of the La Meseta Formation (Ypresian, late early Eocene Acantilados Allomember, ~52–54 Ma) have recently yielded a low diversity penguin fauna (2 species) of a few specimens; the middle levels (Lutetian, Cucullaea I Allomember, middle Eocene, ~49 Ma) record a moderate diversity (8 species) whereas the highest levels (Priabonian, late Eocene, Submeseta Allomember, ~34–36 Ma) document a major taxonomic and body size diversity with 14 species co-occurring sympatrically. During the Paleogene climatic optimum the northern Antarctic Peninsula experienced a very warm, wet, non-seasonal climate, which persisted until early Eocene (~47 Ma). Temperatures thereafter became progressively cooler during a wet, strongly seasonal period in the mid middle Eocene that lasted until ~42 Ma. The distribution of living penguins is strongly linked to cool temperate waters, and the origin of this group was related to watercooling resulting from the evolution of circulation patterns in the Southern Ocean. Our data suggest that the highest diversity (14 species) and wider geographical distribution (Antarctica, South America and Australasia) in the late Eocene were linked to watercooling triggered by the opening of the Drake Passage and subsequent onset of the Antarctic Circumpolar Current.

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