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Stable Isotopic signatures of Adélie penguin remains provide long-term paleodietary records in Northern Victoria Land (Ross Sea, Antarctica)

Sandra Lorenzini (1), Carlo Baroni (1,2), Anthony Edward Fallick (3), Ilaria Baneschi (2), Maria Cristina Salvatore (4), Giovanni Zanchetta (1,2), and Luigi Dallai (2)

(1) Università di Pisa, Dipartimento di Scienze della Terra, Pisa, Italy (lorenzini@dst.unipi.it, +390502215800), (2) Istituto di Geoscienze e Georisorse, Consiglio Nazionale delle Ricerche, Pisa, Italy, (3) Scottish Universities Environmental Research Centre, East Kilbride, Scotland, UK, (4) Dipartimento di Scienze della Terra, Università di Roma "La Sapienza", Roma, Italy

The stable isotopes geochemistry of carbon and nitrogen provides a powerful tools for investigating in animal dietary patterns and shifts during the past. The signature of C and N isotopes provide direct information about the diet of an individual and its dietary patterns, especially when the dietary sources consist of prey from different trophic levels (i.e. different C and N isotopic composition) (DeNiro and Epstein 1978, Minawaga and Wada 1984, Koch et al. 1994, Hobson 1995).
By analyzing the isotopic composition of penguin remains, we present a new detailed Adélie penguin (Pygoscelis adeliae) paleodietary record for the area of Terra Nova Bay (Victoria Land, Ross Sea). Adélie penguins primarily feed on fish (mainly the silverfish Pleuragramma antarcticum) and krill (Euphausia superba, Euphausia crystallorophias) (Ainley 2002, Lorenzini et al. 2009) that belonging to two different trophic levels. Consequently, they are characterized by different isotopic signatures. Specifically, we analyzed 13C/12C and 15N/14N ratios of more than one thousand of modern and fossil Adélie penguin eggshell and guano samples collected from ornithogenic soils (penguin guano-formed) dated back to ≈7,200 years BP (Baroni and Orombelli 1994, Lambert et al. 2002, Baroni and Hall 2004, Hall et al. 2006).
The expanded database of stable isotope values obtained from Adélie penguin remains define a detailed paleodietary record with an excellent temporal continuity over all the investigated time period. Our data indicate a significant dietary shift between fish and krill, with a gradual decrease from past to present time in the proportion of fish compared to krill in Adélie penguin diet. From 7200 yrs BP to 2000 yrs BP, 13C and 15N values indicate fish as the most eaten prey. The dietary contribution of lower-trophic prey in penguin diet started becoming evident not earlier than 2000 yrs BP, when the 13C values reveal a mixed diet based on fish and krill consumption. Modern eggshell and guano 15N values document a major dietary contribution of krill but not a krill-dominated diet, since 13C values remain much too high if krill prevail in the diet. According to the Holocene environmental background attested for Victoria Land, Adélie penguin dietary shifts between fish and krill seem to reflect penguin paleoecological responses to different paleoenvironmental setting with different conditions of sea-ice extension and persistence.

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