POLAR SYSTEMS | POL 4

Foraging Ecology of Emperor Penguins

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Introduction

Emperor penguins, *Aptenodytes forsteri,* play an important role as top predators in high Antarctic marine ecosystems. Long foraging cycles enable chick-rearing birds to range widely in their quest for food. The present study focuses on the critical two month-period before fledging, when maximum growth of chicks occurs and food demand is high at the Pointe Géologie emperor penguin colony of about 3000 breeding pairs (Fig. 1).

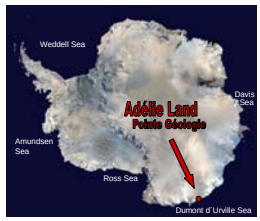

Fig. 1. *Study site at 66°40´S, 140°00´E*

Objectives were to:

- identify the foraging distribution and feeding grounds by satellite tracking chick-rearing penguins.
- determine the length and duration of feeding trips.
- characterise the pattern of movements and diving relative to the bottom topography and sea ice distribution.
- examine the diet of emperor penguins.

Methods

- Study period: October – December 2005
- Study site: Pointe Géologie near Dumont d´Urville station.
- Collaboration: Centre d´Ecologie et Physiologie Energétique (CEPE/CNRS) in Strasbourg, France.
- Devices: Two types of ARGOS transmitters (Fig. 2); a Multi Channel Logger (Fig. 3).
- 18 adult penguins were equipped with devices (Fig. 4).
- Parameters measured: At-sea locations, dive depth, swimming speed, body orientation (pitch, roll).
- Dietary studies: Stomach contents of dead chicks were analysed.

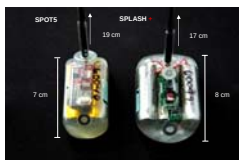

Fig. 2. *Satellite Transmitter Wildlife Computers, USA*

Fig. 3. *Multi Channel Logger Driesen & Kern, Germany*

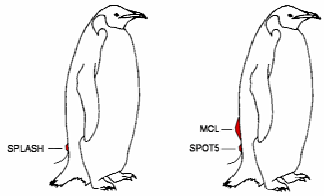

Fig. 4. *Devices attached on the lower back feathers of a penguin with watertight tape.*

First results

Foraging distribution

Trips during the late chick-rearing period (Fig. 5a):

- Birds centred foraging over the shelf north-east of the colony.
- Median trip duration was 7.5 days (range 1-19 days).
- Median trip length was 370 km (range 75-932 km).

Trips prior to the moulting period (Fig. 5b):

- Birds dispersed widely to forage over deep water up to 600 km off the coast, and then moved back to the coastal shelf to moult.
- Median trip duration was 39 days (range 30-57 days).
- Median trip length was 2945 km (range 1940-3395 km).
- Last transmission occurred mid January.

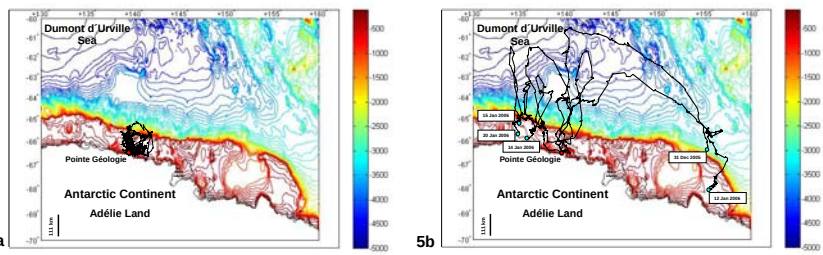

Fig. 5. *Bottom topography off Adélie Land as calculated from ETOPO1 minute gridded evaluation database. Foraging trips (n=24) of chick-rearing emperor penguins (n=10) in Nov/Dec 2005 (**a**). Pre-moult trips (n = 5) between Nov 2005 – Jan 2006; the last at-sea positions are shown by date (**b**). Position processing in progress (OPTIMARE, Bremerhaven), presented data filtered manually.*

Diving patterns

Trip records (n=5) of four chick-rearing penguins show:

- Diving activity concentrated at daylight hours (Fig. 6a).
- Variability in dive depths amongst and within individuals (Fig. 6a).
- Shift of a series of shallow to deep dives (Fig. 6b).

Dive-per-dive analyses show:

- Dive duration increased in relation to dive depth.
- Bottom phase duration increased in relation to dive depth from 10 to ~150 m, before becoming virtually stable (Fig. 7a).
- Descent and ascent rates increased rapidly until ~200 m, before increasing more slowly at deeper depths (Fig. 7b).

Swim speed and body angle data in relation to dive depth at high resolution (Fig. 8) will further allow:

- Detailed differentiation of dive types.

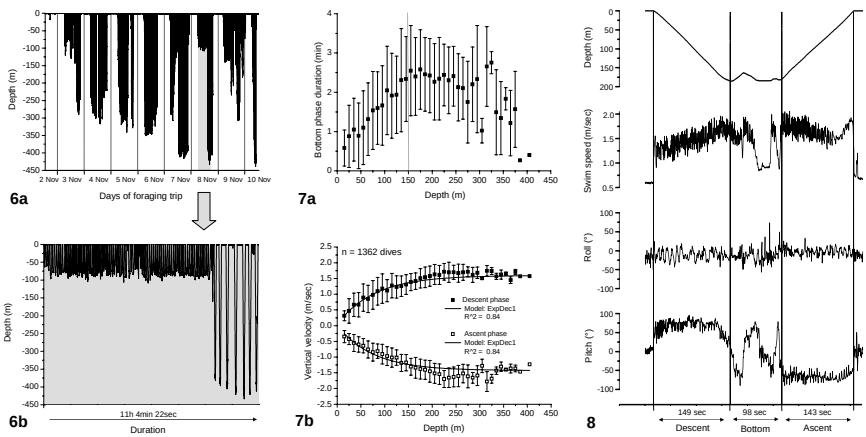

Fig. 6. *Foraging trip of 7.5 days (n = 860 dives > 10 m) over the shelf (**a**). Dive series to different water depths at a frequency of 2 sec (**b**).* ***Fig. 7.*** *Bottom phase duration (**a**), descent and ascent rates (**b**) as a function of dive depth. Values as means ± SD averaged per 10 m depth interval.* ***Fig. 8.*** *Dive depth, swim speed, roll and pitch angle data over time at a frequency of 2 Hz.*

Stomach contents

- Dominant food items in chick stomach samples (n = 32) were: fish, crustacean, squid.
- Squid beak analysis (Fig. 9a, b) provides crucial information on emperor penguin prey and squid biology.

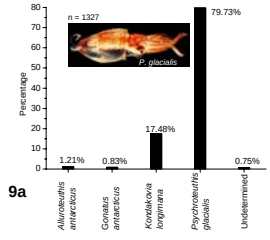

Fig. 9a. *Four squid species were identified,* Psychroteuthis glacialis *was the most abundant.*

Fig. 9b. Psychroteuthis glacialis *beaks show a bimodal size distribution. LRL can be transferred into mantle size and wet mass estimates by allometric equations.*