

Ontogenetic Changes in Body Size and Shape of Antarctic and Subantarctic Fur Seals: Constraints Imposed by Lactation Duration?



Sebastián P. Luque^{1,2}, Christophe Guinet², Edward H. Miller¹, John P.Y. Arnould³, Jeniffer Kingston⁴, Magaly Chambellant², Nicolas Servera², and Laurent Dubroca²

¹ Memorial University of Newfoundland, Canada

² Centre d'Etudes Biologiques de Chize, France

³ Deakin University, Australia

⁴ Macquarie University, Australia



ABSTRACT

All other factors being equal, short lactations are expected to be associated with faster rates of development and attainment of adult traits than long lactations. We present the growth pattern and allometry of two closely related fur seal species with large differences in lactation duration, at Crozet Islands, a sympatric site. Longitudinal measurements were collected from Antarctic *Arctocephalus gazella* (120d lactation) and Subantarctic (*A. tropicalis*) (300d lactation) fur seals during lactation. Neonate body mass was not different among the two species, but standard length and flipper size were larger in *A. gazella*. Rates of growth in standard length, and flipper dimensions were higher in *A. gazella* than in *A. tropicalis* pups, which show a higher rate of growth in girth. The scaling of flipper span squared on flipper surface area showed more similarities between female pups and adults among *A. gazella* than among *A. tropicalis*. The scaling of the position of foreflippers along the body with standard length showed a similar trend, suggesting that *A. gazella* pups acquire adult body shape faster than *A. tropicalis*. Our results indicate that preweaning growth involves significant changes in body shape of fur seal pups, involving the acquisition of a long, slender body with relatively large flippers in *A. gazella* vs. a stockier body with shorter flippers in *A. tropicalis*. We suggest that the two growth patterns reflect the constraints imposed by an early, compared to a late, transition to an aquatic mode of life.

INTRODUCTION

We investigated comparative growth in *Arctocephalus gazella* and *A. tropicalis* to determine the presence and nature of differences that may be linked to the large disparity in lactation length between them; 116 d long in *A. gazella* vs. 300 d in *A. tropicalis*. Despite this large difference, adult body mass and length are similar in both species. Functional demands on body size and shape may change sharply between pre- and post-weaning ages in young pinnipeds, especially in otariids because of their long pre-weaning association with land. We expected that these species should differ in growth trajectories and in the rate at which they acquire adult body form or shape.

METHODS

Research was carried out at La Mare Aux Elephants (MAE; 46°22'29" S, 51°40'13" E), at the western end of Ile de la Possession, Crozet archipelago, Southern Indian Ocean, during the 2001-02 and 2002-03 breeding seasons (2001 and 2002 hereafter). Pups from the colonies were individually marked over a 6- (2001) or 13- (2002) day period. Pups were subsequently weighed every 5-9 d. The following variables (Figure 1) were also measured on pups upon capture and every 12-16 d subsequently: standard length, girth around four different planes of the body (G1-G4), and length of segments from the tip of the nose to each of these planes (RL1-RL4) (Figure 1). Additionally, length and width of flippers were measured directly, while their surface area was estimated from their outlined traced on a digital photograph taken at the time of measurement.

To determine whether growth trajectories varied according to species or sex, a linear mixed effects model was designed for the j th observation on the i th individual:

$$y_{ij} = (\beta_{00} + \beta_{01}\text{species}_i + \beta_{02}\text{sex}_i + \beta_{03}\text{species}_i\text{sex}_i + b_{i0}) + (\beta_{10} + \beta_{11}\text{species}_i + \beta_{12}\text{sex}_i + \beta_{13}\text{species}_i\text{sex}_i + b_{i1})x_{ij} + \varepsilon_{ij}$$

To assess whether growth trajectories gave rise to interspecific differences in the rate at which pups acquire adult body shape, two allometric relationships that might influence aquatic locomotory performance were studied: (1) flipper span squared vs pectoral flipper surface area, and (2) RL3 vs. standard length. One random measurement per female pup where 80 d < age < 120 d, was selected for this analysis. A single measurement for each variable was available from a sample of the pups' mothers for this analysis.

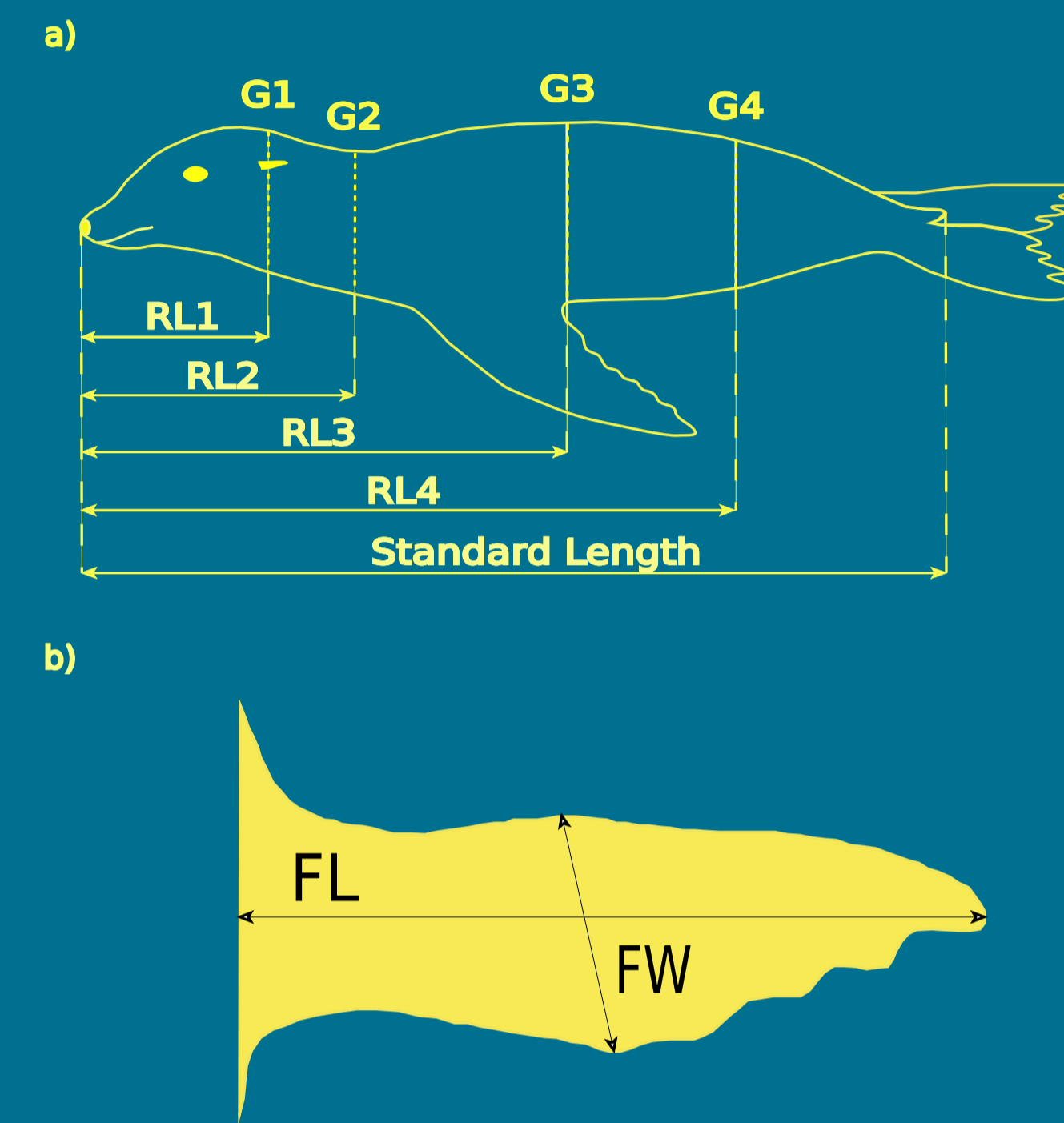


Figure 1: Measurements obtained from pups and adult females: a) RL1-RL4: reference lengths, and G1-G4: girth; b) flipper length (FL) and flipper width (FW).

RESULTS AND DISCUSSION

- No interspecific differences in neonatal mass or mass growth rates (Figure 2), despite reported higher daily energy expenditure in *A. gazella* pups (Arnould et al. 2003). This result suggests that *A. tropicalis* pups may be allocating a higher proportion of energy intake for body fat storage.
- *A. gazella* pups are born longer and grow faster than their congeners, suggesting that body shape differences between species are evident from birth, and they become larger with pup age.

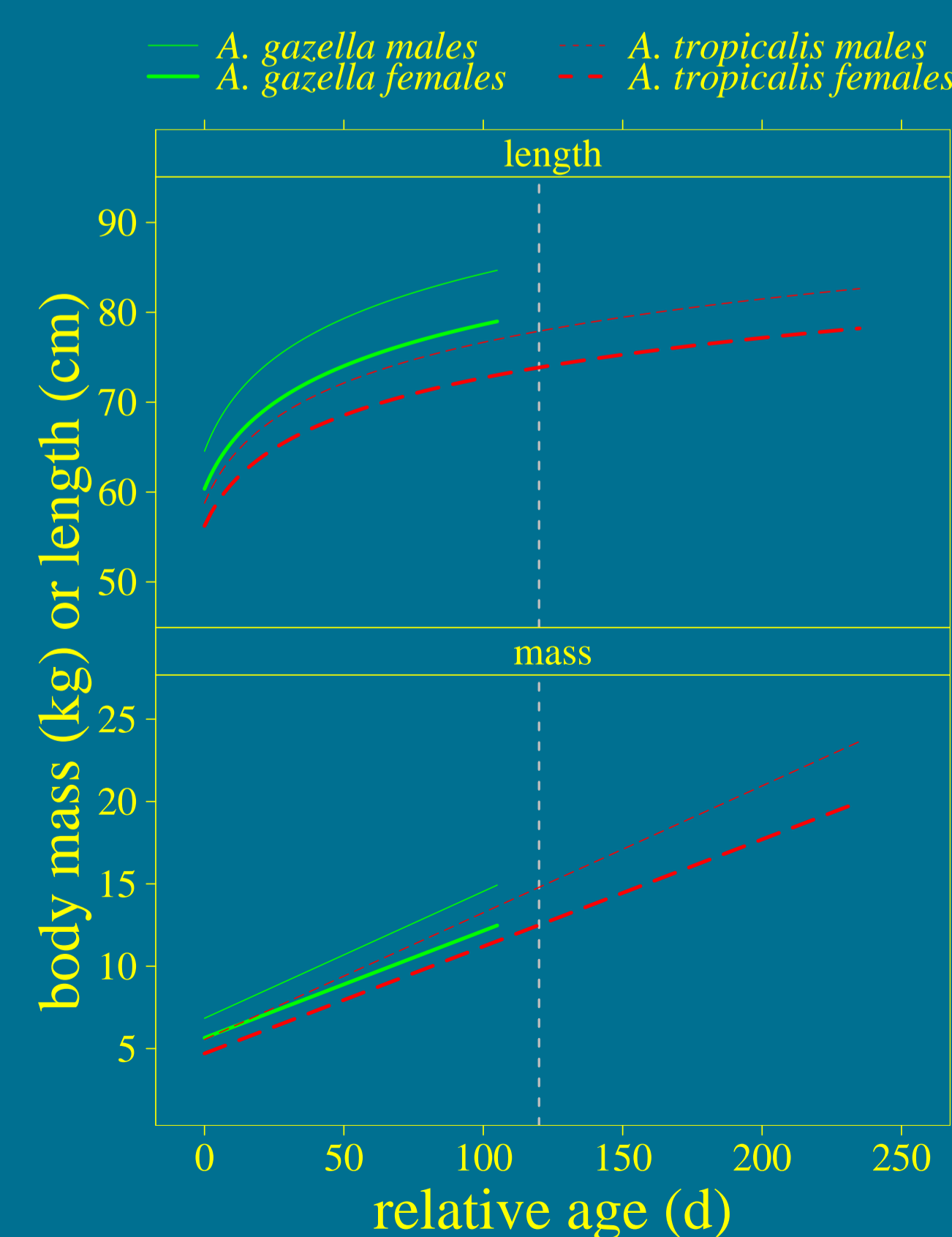


Figure 2: Mass and length growth trajectories.

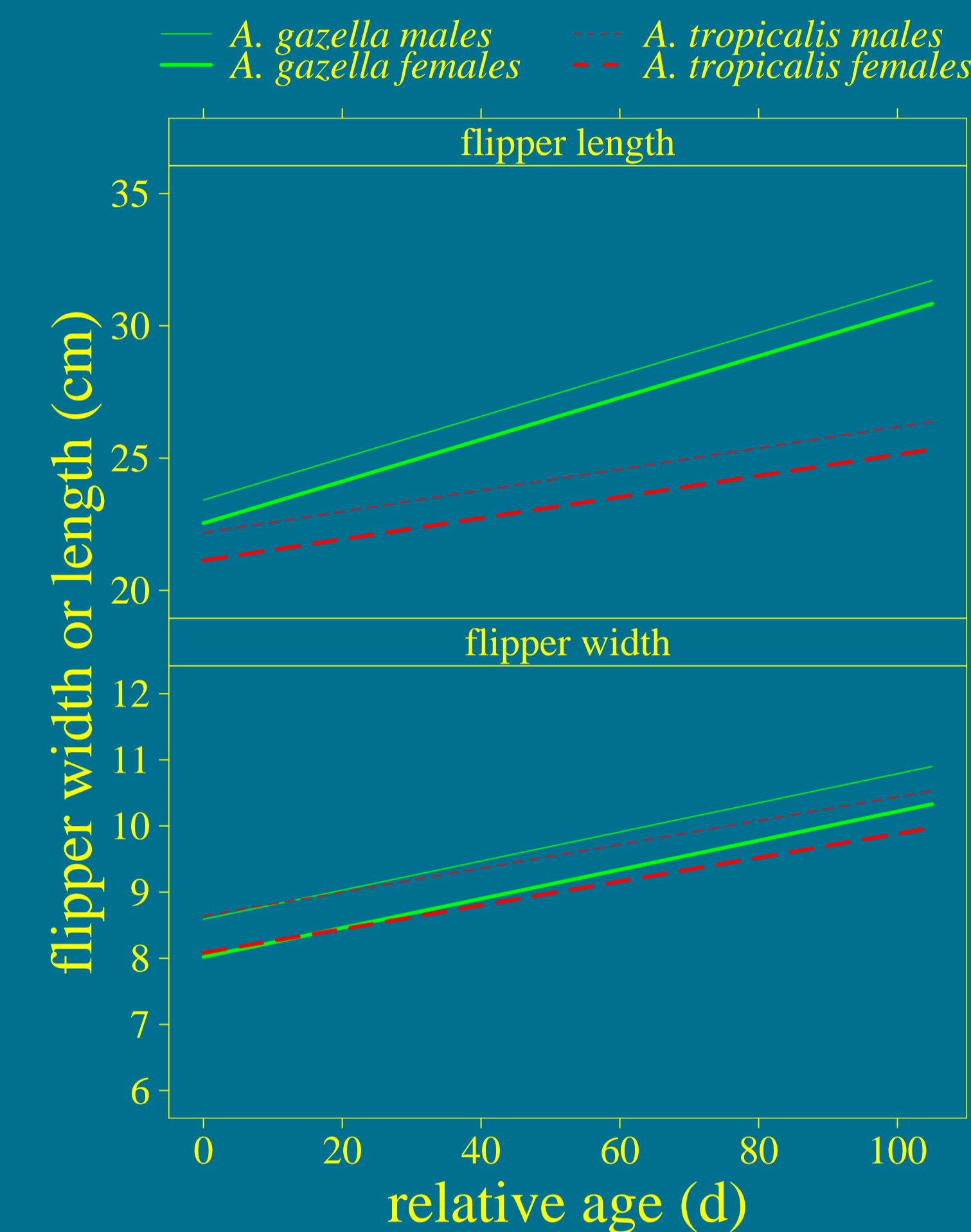


Figure 3: Flipper length, width, and surface area growth trajectories.

- Significant interspecific differences in flipper measurements, notably for length and surface area (Figure 3). *A. gazella* pups are born with larger flippers, which grow faster with age.
- The position of the flippers along the body axis was significantly different, as revealed by RL1-RL3 growth rates. The relative position of the flippers along the body axis increased significantly in *A. gazella* pups, compared to their congeners.
- At approximately 4 mo old, *A. gazella* pups showed more similarities in aspect ratio with their adult counterparts, than *A. tropicalis* pups of the same age (Figure 4). This difference suggests that aquatic capabilities may be more developed in *A. gazella* pups at this age.

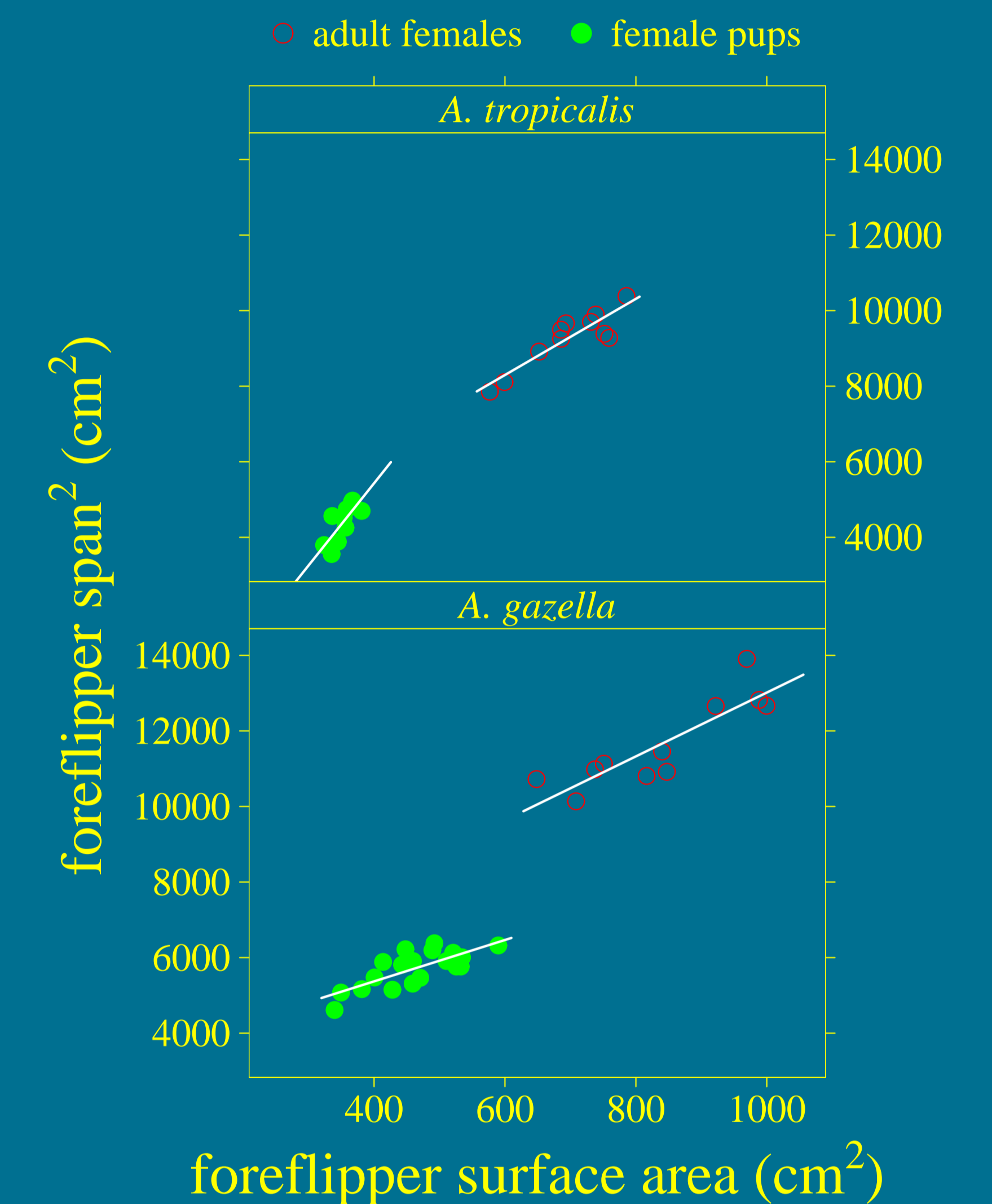


Figure 4: Relationship between flipper span and surface area between 4 mo old female pups and adult females.

CONCLUSIONS

- *A. gazella* pups, having a shorter nutritional dependence period, develop longer, slender bodies, with large foreflippers during lactation, compared to *A. tropicalis* pups.
- Allometric relationships suggest that, at about 4 mo of age, *A. gazella* pups are more physically mature than their congeners.

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