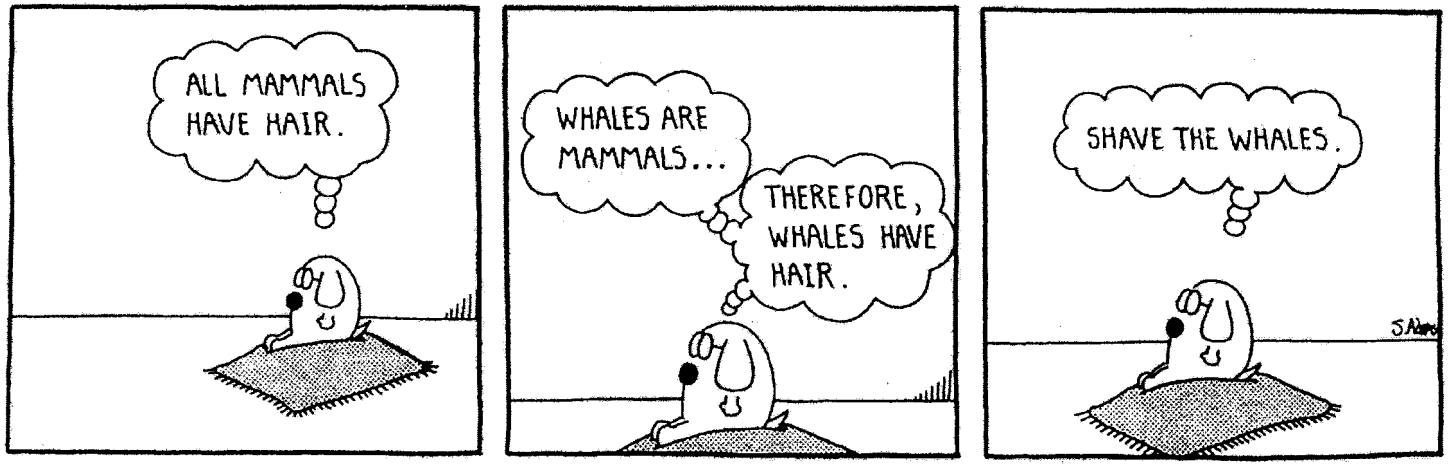
ALL MAMMALS HAVE HAIR.
WHALES ARE MAMMALS...
THEREFORE, WHALES HAVE HAIR.
SHAVE THE WHALES.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Structure, development and composition of the integument of the southern right whale, *Eubalaena australis*.

by

Desray Reeb

Submitted in partial fulfilment of the
requirements for the degree of

Philosophiae Doctor

in the
Faculty of Natural and Agricultural Science
University of Pretoria
Pretoria

September 2001

© University of Pretoria

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Structure, development and composition of the integument of the southern right whale, *Eubalaena australis*.

by

Desray Reeb

Supervisor: Dr Peter B. Best
Mammal Research Institute
Department of Zoology and Entomology
University of Pretoria
Pretoria, 0002

Co-supervisor: Dr Eddie. C. Webb
Department of Animal and Wildlife Sciences
University of Pretoria
Pretoria, 0002

Co-supervisor: Prof. Rudy J. Van Aarde
Department of Zoology and Entomology
University of Pretoria
Pretoria, 0002

Abstract

The general architecture of the skin of the southern right whale, *Eubalaena australis*, is comparable to that described for other cetacean species. As found in bowhead whales, *Balaena mysticetus*, of the same family, southern right whales possess an acanthotic epidermis and a notably thick hypodermis. Epidermal rods and extensive papillomatosis support these unique characteristics. A "fat-free" reticular dermis makes the integument of southern right whales more like that of odontocetes than that described for balaenopterids. Skin samples taken in South African and Antarctic waters showed evidence of superficial moulting throughout the austral winter and in mid-summer. Unidentified "microflora" and fungal microbes were detected on the skin of whales sampled in both South African and Antarctic waters. The predominance of "microfloral"

aggregations on cows and calves in October/November suggests that these micro-organisms are acquired in coastal waters. A *Candida*-like invasive fungal infestation of the skin of a stranded neonate was recorded for the first time in this species and may be related to the demise of this animal. The film-forming diatom, *Bennettella* [*Cocconeis*] *ceticola*, was not detected on any skin samples. This may imply that southern right whales exhibit high cellular proliferation rates, which prevent diatomaceous films from forming. Neonatal southern right whales undergo a spectacular form of ecdysis approximately 6-7 days after birth. Histologically, "rough-skinned" neonates possess a distinct "fault line" above the distal tips of the dermal papillae, that becomes characterised by intercellular oedema, which causes all the cell layers above the plane to separate from those below it. The fatty acid composition of the dermal and hypodermal layers provides indications of prey species consumed as well as reflecting physiological processes within the digestive system of the southern right whale. Total lipid values in the blubber of late season cows and calves are reported for the first time. A new hand-held biopsy system for collecting deep-core integument samples from free-swimming balaenids is described. It is a practical and cheaper alternative to projectile systems and the head design allows for the collection of samples that can be used for multidisciplinary research on right whales (e.g. histology, toxicology and blubber composition studies).

Keywords: Southern right whale, integument, histology, ecdysis, microbial aggregations, *Candida* sp., blubber, fatty acid composition, total fatty acid, deep-core biopsy.

ACKNOWLEDGEMENTS

Besides the acquisition of invaluable academic knowledge I gained while researching my Ph.D., the assistance I received from so many wonderful people is the one facet of my study that has left an everlasting impression on me. So much so, that I could not wait to get to this part of my thesis - my time to put down on paper how I feel, for everyone to see. With this in mind, I never could have imagined that I would have such difficulty in actually doing it and saying my "thank yous". I could never have achieved this dream without the help I received, how does a person use words to express this kind of gratitude?

So although I thought the "thesis" challenge was over and that all in all I am satisfied that I applied myself and did my best, if the people who helped and supported me so tremendously can know how truly grateful I am, then I will really have accomplished my goal.

Bob Pitman, Lars Kleivane and the crews on the 1998/1999 IWC/SOWER Circumpolar Cruise for collecting samples from the Antarctic and to Hideyoshi Yoshida from the National Research Institute of Far Seas Fisheries, Japan for organising the necessary CITES export permit.

Mike Paterson from Marine and Coastal Management for his skilled construction of the hand-held biopsy system.

Carolyn Miller and Michael Moore from Wood's Hole Oceanographic Institute, Massachusetts, for assisting with sampling and funding a portion of the field work.

Yolanda Davies, Helen Ilsley, Dr Maureen Duffield, Mary Wolfe, Sharon Marshall, Heather McLeod, Dr Dirk Lang, Liz Van Der Merwe and Prof Sue Kidson from the Departments of Anatomy and Anatomical Pathology, University of Cape Town, Groote Schuur Hospital.

Dr Rachel Alexander, Michelle van der Merwe, Liz Hoenson, Aubrey Byron, Rina Krynauw, Vicky McCrae, Jackie Truman-Baker, Brenda Commins, Cedric Hunter,

Cedric Goliath and James Bolton from the South African Museum who helped in so many ways, from acquiring literature, processing of SEM photographs, computer glitches, illustrations to general motivation and support. I know how busy you all are, thank you for making time to help me.

Dr Alf Botha and Owen Rhode from the Department of Microbiology, University of Stellenbosch for assisting with the preparation of the microbial culturing and general advice on the topic.

Dr Sara Iverson from Dalhousie University, Canada; Prof J. D. Buck (ex University of Connecticut, USA); Prof Roberta Fulthorpe from the University of Toronto, Canada; Prof C. von Holt and Dr J. de A. Rodrigues from the University of Cape Town; Dr Derek Du Preez from the University of Port Elizabeth and Prof Richard Pienaar from the University of the Witwatersrand, for their guidance and advice.

All the staff at the Department of Animal and Wildlife Sciences, University of Pretoria, especially my co-supervisor Dr Eddie Webb, Mr Bertus Spreeth, Karen Steenkamp, Christine Jansen van Rensburg and Adri O'Neill.

Hannetjie Boshoff and Gerda Ehlers at Academic Information Services, University of Pretoria.

Dr Paul van Jaarsveld, De Wet and Martelle Marais and Dr Marius Smit at the Medical Research Council, Cape Town.

Dane Gernecke and Miranda Waldron at the Electron Microscopy Unit, University of Cape Town.

Prof. Johan T. Du Toit, Martin Haupt and Elmarie Cronje from the Mammal Research Institute, University of Pretoria.

Rudy Cloete-Hughes, Derek Kemp and Mark Addison for skippering during my field work. Steve Stafford and Susan and Basie Uys for providing accommodation in Gansbaai and Witsand.

All the staff at the South African Museum who make every day special, especially, Danita, Danie, Karim, Olga and Ilana.

The love and support that I have always received from my dearest mom, dad, sisters, brother, aunts, uncles, grannies, "brotherS-in-law", cousins, niece and nephews, has always been unconditional and the very spark that keeps me going. Together with the love and support from my "angel network", Dani and Gill, Berny, Gavin and Payton, Carolyn, Yin, the Orwin, Friedman & Sebba families, Leonie, Meredith and André, Marc, Stuart, Simon and Maggi Best.

My precious Zeider, thank you for always being with me, for being a continual source of inspiration and for loving me from where you are.

I have to single out the person who had to deal with all my moods, my tears, my laughter, my moans and groans and general "Ph.D-ness" every single day, Dov. Koeks, I hope you always get your "glape jeuws"! Thank you for helping me on this journey.

To all the people who were kind enough to share their time, be it 5 minutes or 5 hours, a smile or a kind thought - it all made the world of difference to me, thank you all so very much.

Saving the "best for last", my supervisor, Dr Peter B. Best, who is without a doubt one of the finest whale biologists that ever sailed the seas. Thank you for being a mentor and friend. Your supervision has equipped me with a solid foundation for my future career. A career that I hope includes many more hours of shared "sea time".

And of course, this list would not be complete without thanking the precious creatures that this study is based on - the southern right whales. May they always grace us with their presence.

This study was made possible by funding provided by the National Research Foundation, with grateful thanks.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

LIST OF CONTENTS

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

LIST OF TABLES

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

LIST OF PLATES

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

LIST OF FIGURES Page

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA