

The Pearl Oyster
Pinctada maxima (Jameson, 1901)

**An Atlas of Functional Anatomy,
Pathology and Histopathology**

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**PROJECT NO. 97/333
FINAL REPORT
(2006)**



Australian Government

**Fisheries Research and
Development Corporation**



Queensland Government
Department of Primary Industries and Fisheries



Northern Territory Government
Department of Primary Industry, Fisheries and Mines

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1997/333 **The Pearl Oyster *Pinctada maxima* (Jameson, 1901)**
An Atlas of Functional Anatomy, Pathology and Histopathology

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OBJECTIVES:

1. To develop a comprehensive histological photographic database of the normal and diseased tissues of the pearl oyster *Pinctada maxima*
2. To compile a computerised atlas showing the basic anatomy of *Pinctada maxima* with explanatory text and labelled photographs of normal and diseased tissue.
3. To publish this data in a book and /or compact disk format.

NON TECHNICAL SUMMARY

The commercial farming of the pearl oyster *Pinctada maxima* and the production of pearls from this species comprise a major industry in northern Australia. Although this industry is entirely dependent on the mollusc, the histology, pathology and physiology of *P. maxima* remain poorly described. An understanding of the normal anatomic and microscopic structure is a pre-requisite for the recognition of disease or pathological states characterised by altered structural changes at the gross and cellular level.

This atlas describes and illustrates the functional anatomy, histology and histopathology of *P. maxima*, together with a range of inflammatory and degenerative processes and infectious and non-infectious conditions which occur in the species and which may be associated disease. The aim of the atlas is to provide a practical and "user-friendly" guide to assist in the day to day management of pearl oyster health and production by providing the comparative pathologist with a basis for recognising and interpreting the normal gross and microscopic structure of *P. maxima* and abnormalities which may occur as a result of disease processes. The atlas also aims to assist biologists, aquaculturalists and farm technicians in understanding the structure and function of *P. maxima*, in the recognition of disease processes and in providing guidelines for the collection and sampling of oysters for disease or other investigations.

The atlas is organised into eight major sections.

- Section 1 addresses the general anatomy of *P. maxima* at the larval, spat and mature stages, the on-farm examination of disease outbreaks and the gross pathological examination of diseased oysters.
- Section 2 describes the functional anatomy of larvae, spat and mature oysters, the normal histology and the histopathology associated with a spectrum of infectious and non-infectious agents affecting *P. maxima*. This section is arranged on a systematic basis such that the histology and known histopathology of any particular organ system can readily be ascertained.
- Section 3 described artefacts commonly encountered in the handling and processing of samples of *P. maxima* for pathological and histopathological examination and which may be confused with disease processes.
- Section 4 describes methods for the sampling and dispatch of oysters for laboratory examination.
- Section 5 gives a brief overview of the prevalence of histopathological changes found in *P. maxima* during a comprehensive survey of northern Australian waters.
- Sections 6, 7 and 8 provide a glossary of terms, a bibliography and an index, respectively.

ACKNOWLEDGMENTS

The authors thank the Northern Territory Department of Primary Industry, Fisheries and Mines, the Queensland Department of Primary Industries and Fisheries, and the Western Australian Department of Agriculture for their support for this project. Thanks are given to the pearl farming companies and their staff in Western Australia, the Northern Territory and Queensland who generously assisted in the collection of material for gross and histopathological examinations on the oysters, and to the Queensland Boating and Fisheries Patrol, Thursday Island, for transport to pearl farms in Queensland.

Thanks are due to Dr Bob Rose and his staff of the Darwin Hatchery Project for the supply of pearl oyster larvae and spat, the Cooperative Research Centre Aquaculture for their financial support for the collection and preparation of histological specimens and to Dr Judith Handler of the Tasmanian Department of Primary Industries, Water and Energy during this work with hatchery-reared molluscs.

Dr Brian Jones, Western Australian Department of Agriculture, is especially thanked for providing a number of figures for the atlas and for valuable and informed discussions on the nature and significance of a range of parasites, diseases and conditions found in pearl oysters. Dr Dave Mills provided considerable insight into pearl farm management and the role that a work of this nature may play in assisting the pearl oyster aquaculture industry. His comments, advice and suggestions are gratefully acknowledged. Dr Richard Weir and Dr Alex Hyatt are thanked for their assistance with electron microscopy and ultrastructural interpretations.

The preparation and staining of the large number of histological sections from which the illustrations were selected represented a major undertaking. Special thanks are due to Ms Cheryl Day, Ms Lisa Simington, Ms Linda McLean, Ms Nikki Elliot, Ms Natalie Cox and Ms Sue Aumann of the Berrimah Veterinary Laboratories, Department of Primary Industry, Fisheries and Mines, Darwin, and to Ms Michelle Hoogland of the Oonoonba Veterinary Laboratories, Department of Primary Industries and Fisheries, Townsville, who assisted in this regard over a number of years. The technical assistance of Ms Maria Connell in collating and indexing the large number of histological sections from which much of the photographic material was derived is also gratefully acknowledged.

The cover images of the atlas were provided courtesy of Paspaley Pearls.

Constructively critical comments and rigorous proof reading substantially enhance a document of this nature and the authors wish to specifically acknowledge the generous assistance of Mr Murray Barton in this regard.

Finally, the authors wish to acknowledge the vision of Dr Colin Shelley and Mr Murray Barton who foresaw the need for the atlas and the Fisheries Research Development Corporation for funding the atlas under project 1997/333.

BACKGROUND

Despite the current and future economic importance of the pearl farming industry, little was known of the diseases and parasites that may adversely impact upon pearl oyster production and the culture of quality pearls in Australian waters. A comprehensive study of wild-harvested and farmed pearl oysters *Pinctada maxima* to determine the occurrence, prevalence and distribution of pathogens, parasites and diseases of pearl oysters in northern Australian waters funded by the Fisheries Research and Development Corporation was completed in 1998 (Humphrey 1998). The study was based on gross and microscopic or histological examinations of pearl oysters to further define the spectrum of pathogens and potential pathogens which exist in *P. maxima* across tropical Australia and to determine the major disease problems likely to be encountered. In addition to determining disease data, the study established and collated histological and histopathological reference data relating to pearl oysters. This reference data was principally in the form of stained histological sections on glass slides and not available as a diagnostic or research aid.

NEED

The normal histology of the pearl oyster is poorly described, as is the response to infectious or non-infectious agents. This lack of published data is compounded by the fact that there are only a few pathologists in Australia with significant experience and knowledge to interpret histology sections from pearl oysters.

The publication of the histopathology photographs collected during the health survey and during routine health investigations plus reference material collected by previous researchers along with explanatory text will help to overcome this problem. The ability to be able to recognise what is normal or abnormal is critical in the interpretation of histology sections and hence will affect the quality of diagnostic services that can be provided to the pearling industry.

The publication of this material will also act as a reference book for a range of other investigations into pearl oysters, such as, nutritional, husbandry and biology studies. It will ensure that the comprehensive collection of histological data gathered during the health survey will be preserved for the future benefit of the pearling industry.

OBJECTIVES:

1. To develop a comprehensive histological photographic database of the normal and diseased tissues of the pearl oyster *Pinctada maxima*
2. To compile a computerised atlas showing the basic anatomy of *Pinctada maxima* with explanatory text and labelled photographs of normal and diseased tissue.
3. To publish this data in a book and /or compact disk format.

METHODS

The publication of this Atlas was divided up into four parts.

Part A

Collection of raw data: Most of the material used for this publication was collected as part of the health survey. Additional material was gathered from samples submitted to the state and territory diagnostic laboratories and from scientists involved in pearl oyster research to make the document as comprehensive as possible.

Part B

Defining the format and content: The format and content was finalised after assessing all the material available from part A and reviewing other atlases for their style and format.

Part C

Compiling the publication: This was compiled following the format as determined in part B by the authors.

Part D

Book published: Liaise with staff of the government printers to produce draft copies of book for review and print final copy.

RESULTS/DISCUSSION

Style

After reviewing a range of atlases available it was determined that the best and most useful atlas has the following features:

1. Quality photographs at reasonable magnification.
2. Quality text captions associated with the photograph
3. Quality text relating to the illustrations.
4. The ease with which text can be related to the illustration and vice versa and,
5. Clear arrows or markers pointing out or highlighting structures of special interest.

The suggested style for the atlas was to be similar to layout used in Randall and Reece (1996). In this atlas the text is generally on the right-hand page or left-hand page as appropriate, illustrations, pictures and captions generally on the facing page and where appropriate, text is included on the same page as illustrations. The large number of illustrations and the large textual component in this present publication, however, did not lend itself to the Randall and Reece style and a format was adopted whereby references to figures in the text were accompanied by the figures being shown on that particular page or the immediate following page.

Layout

The following was adopted as the content layout for the atlas.

Section 1. General Anatomy, Clinical Examinations and Gross Pathology

Line drawings and photographs to illustrate the orientation and major gross features of the mature pearl oyster including a section on the juvenile stages of oysters. Photographs to be of the whole oyster plus a series of slices through the whole animal (dorsal-ventral and anterior-posterior) to show the major anatomical relationships.

Section 2. Functional Anatomy, Histology and Histopathology

Anatomy and Histology. Text describing the structure and function of these tissues and organs in each of the body systems, illustrated by low and high power photomicrographs with captions describing structural arrangements (low power) and cellular detail (high power) of normal oysters.

Histopathology. Text where appropriate and illustrations with captions describing non-specific lesions and specific lesions and agents according to the body system.

Section organised and described on the basis of body systems as follows. The order to be histology of the organ followed by histopathology of that organ.

Mantle	Circulatory system
Respiratory system	Muscular system
Alimentary / Digestive system	Nervous system
Labial Palps	Reproductive system
Mouth	Excretory system
Oesophagus	Byssal organ
Stomach	Foot
Digestive Gland	Interstitial tissue
Intestine	The Pearl Sac and Pearl Formation

Section 3. Artefacts

Descriptions and illustrations of histological artefacts encountered in histological examinations. Mainly photomicrographs with captions.

Section 4. Techniques and Stains

A guide of how to collect and submit samples to the laboratory for examination.

Section 5. Glossary

Comprehensive glossary of terms used to assist user.

Section 6. Bibliography

References used in the text and

Section 7. Index

Comprehensive index to assist user.

BENEFITS AND ADOPTION

The book was produced as there is no text available which describes the anatomy and histology of the pearl oyster *P. maxima* and the histopathological changes that occur with infectious and non-infectious conditions and diseases. The recognition of normal from abnormal is fundamental to disease diagnosis and it is anticipated that the atlas will be adopted by diagnosticians, biologists and technicians involved in pearl oyster health and production as a useful test for the interpretation of disease states and histological changes. It is specifically designed as a "hands-on" publication to be used at the bench or on the farm and provides for the first time a comprehensive coverage of those disease states and conditions likely to be found in Australian *P. maxima*.

PLANNED OUTCOMES

The publication of the book meets the planned outcomes of the project, i.e., to produce a "user friendly" monograph on the structure, function and diseases of pearl oysters and to make it available to diagnosticians, research workers, technicians and farm managers and farm staff. It was also intended that the book should be a practical and useful reference document for people working in the field or at the bench. The format of the book with its water-resistant paper and spiral binding fulfils this planned outcome. The book fills a significant gap in knowledge relating to the spectrum of infectious and non-infectious conditions of pearl oysters as no such work existed previously.

FURTHER DEVELOPMENT

With the passage of time, new information on the functional anatomy and physiology of pearl oysters will accrue, as will the emergence of previously unrecognised infectious and non-infectious conditions and diseases. It may be desirable to revise the atlas periodically to ensure the work meets the contemporary needs of industry.

CONCLUSION

The atlas presents for the first time a comprehensive overview of the anatomy, histology and histopathology of the pearl oysters *P. maxima* in Australia. It is anticipated that the atlas will form a valuable reference document to those individuals working in pearl oyster health and production, especially in regard to the recognition of disease and the interpretation of changes seen in at the histological level.

REFERENCES

- Humphrey, J.D., Norton, J.H., Jones, J .B., Barton, M.A., Connell, M.T., Shelley, C.C. and Creeper, J.H. 1998. *Pearl Oyster (Pinctada maxima) Aquaculture: Health survey of Northern Territory, Western Australia and Queensland Pearl Oyster Beds and Farms*. Fisheries Research and Development Corporation Final Report 94/079, 108pp
- Randall, C.J., and Reece, R.L., 1996. *Color Atlas of Avian Histopathology*; Mosby-Wolfe, London.