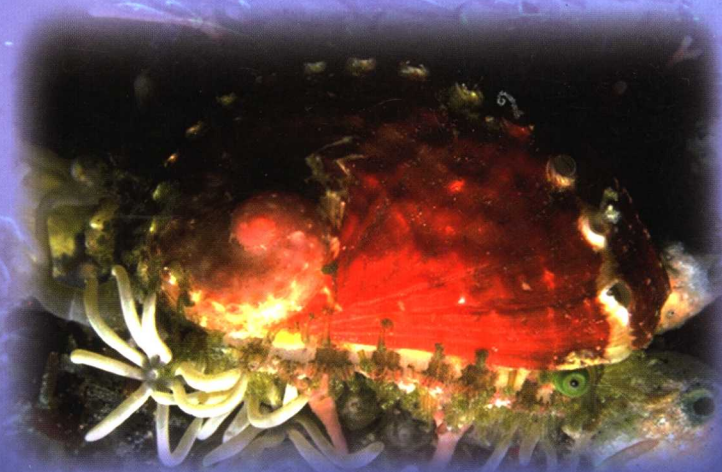


# 鲍的生物学

李太武 苏秀榕 丁明进 宋林生 刘保忠 编著



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北 京

## 内 容 简 介

本书介绍了鲍的形态、组织结构、超微结构、分类以及鲍的渔业和养殖业概况,涉及了鲍的养殖与加工、营养与药用价值、鲍的疾病与防治等内容。相当部分是作者工作的总结和理论概括,还包括世界最新的鲍的研究成果。

本书图文并茂,既有实际操作方法,也有理论评述,可用于指导技术人员进行养殖育苗、病害防治,也适合做大专院校、科研院所生物、水产专业的教学和参考用书。

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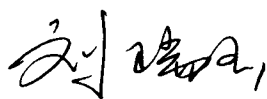
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## 序

鲍亦称鲍鱼,属于软体动物门腹足纲,是名贵的水产珍品,被列为“海产八珍”之首。由于其市场价格很高而稳定,明显高于其他水产品,故又有“软黄金”之美誉。因市场需求量很大,自然资源有限,其人工养殖业在世界范围迅速发展。关于鲍的养殖、育苗、生物学、生物技术等研究极受重视,目前已经扩及全世界许多临海国家,国际研讨会已经开过五次。我国是养鲍大国,养殖技术发展、提高很快,其他有关高新技术也不断向该领域渗透,大大促进了养殖生产,使其规模不断扩大。但是,近年来养鲍生产中病害频发,死亡量大,损失惨重,产业的持续发展受到极大威胁。这种情况大大刺激了科研工作的迅速发展,创造了各种防治病害和健康养殖方法,因此,总结国内外研究成果和先进技术,适时出版能指导养殖生产的专著显得十分必要。

由宁波大学生命科学与生物工程学院浙江省海洋生物工程重点实验室李太武教授等编写的《鲍的生物学》,反映了当前该领域国内外研究的重要成果和最新进展。全书共分11章,包括鲍的形态、分类、分布与资源、渔业及养殖概况、生态、生理、繁殖与人工育苗、饵料、养殖与加工、营养与药用价值、疾病与防治、生物工程等内容。作者在撰写过程中,参阅了大量文献资料和有关著作,在积极吸收其精华的同时,还对相互矛盾的资料和数据作了认真的订正。特别是有关鲍的分类鉴定和名称使用,一直存在混乱,许多种没有中文名称,作者根据学名的拉丁文和英文的含义给出了中文名,进一步规范了60余种鲍的分类地位,订正了学名。形成了一部有特色的、内容丰富完整的鲍的生物学专著。

该书的作者都是在研究工作第一线承担国家和地方重要课题的专业负责人或优秀科技专家,他们利用业余时间,花费多年的心血,收集大量第一手资料,刻苦工作,完成了这部书的编写。该书图文并茂,文字流畅,术语规范,技术水平较高,有重要科学意义和实用价值。作为李太武教授的博士后导师,我由衷地向他们表示祝贺。我深信,该书的出版,必将大大推动我国鲍鱼养殖及相关研究的持续发展。



中国科学院院士  
中国科学院海洋研究所 前所长  
中国海洋湖沼学会 名誉理事长  
2004年4月17日于青岛

## Preface

Abalones are one of the largest members of marine gastropods naturally occurring in all oceans of the world. Generally, they are found in rocky inter-tidal and sub-tidal habitats where water qualities are superior and dissolved oxygen concentrations are high. They are mostly nocturnal and never venture far from their home of protected rock crevasses. Often, they camouflage themselves so well that it takes an experienced diver to spot them. After cleaning, abalone shells prove to be one of the most beautiful seashells in existence, with its unique ear shape outline, natural holes, and mother-of-pearl lining. Most of them also incorporate various color pigments obtained from their algal diet into very colorful patterns on their shells. In spite of their disproportionately large and massive foot, abalones do not move much faster than common garden snails. Some abalones are found to sit in one spot on a rock all their life. In nature, they manage to live a very long life. The red abalone in California takes several years to reach sexual maturity, but continues to grow slowly tens of years to reach a size over 14 inches across. Their favorite food is red and brown algae, but they do not dine with sharp claws or powerful jaws. Instead, they gently scrape the algal salad with a long tongue equipped with rolls of countless microscopic teeth like a nail file. The muscles in their mouthparts must work for long hours in order to finish a small piece of algae. These muscles are aided by the presence of hemoglobin-like molecules that constantly deliver oxygen to the red muscles from the blue blood pigment, hemocyanin, which is present in the general circulation. In addition to the interesting physiology and ecology, abalones are very sensitive to organic and heavy metal pollutions, which make them an important indication species for the water quality of their natural environment.

To many cultures, abalone is synonymous with the most precious delicacy from the sea, far beyond the reputation of lobsters or oysters. Abalone, fresh or preserved in all different forms such as canned or dried, has become one of the most expensive sea foods in the marketplace. In order to meet the heavy commercial demand, abalone culture has become one of the most economically important aqua cultural enterprises in many coastal countries. The problems of diseases and their prevention, and efficient methods of growth have been hot topics for scientific studies for many years.

I am pleasantly surprised to see this first complete treaty on world abalone in the history of marine sciences. The authors are leading scholars, breeders and practitioners of aquaculture of abalone in the world. Now, they compile a tremendous amount of information, including morphology, taxonomy, natural history and all aspects of aquaculture for abalone, as well as an atlas of color pictures of over sixty recognized species of abalone found in all oceans of the globe.

The authors have made a hereto forth unseen contribution to nature lovers, students of ma-

rine biology, professional invertebrate zoologists, environmental workers, and practitioners of abalone aquaculture by spending more than ten years of effort putting together a beautiful as well as all-inclusive volume easily accessible to everyone. I am sure readers of all levels will find it interesting and helpful, whether just for reading to satisfy their own curiosity, or as a reference source to help solve practical problems they may encounter when working directly with abalone. I recommend this book highly.

Professor Paul K. Chien  
In University of San Francisco  
May 12, 2004

## 前 言

作者自 1991 年开始从事鲍病害的研究与防治工作,为了完成辽宁省博士启动基金、农业部和大连市科委重点项目,我们收集了国内外相关资料,其中国外资料大部分是加拿大的 Susan Bower 博士赠送的。1997 年参加了第三届国际鲍研讨会,掌握了更多国内外关于鲍研究的信息。与此同时,作者在鲍的基础生物学、病害防治、人工育苗、增养殖、分子生物学研究等方面取得了重大进展,积累了大量的第一手资料。本书凝集了作者多年的心血,1998 年动笔,2001 年完成初稿。

有关鲍的书籍目前问世的有 5 本,大都从各自不同的角度描述了鲍的增养殖等内容。而目前有关鲍的命名分类还比较混乱,许多没有中文名,作者根据学名的英文和拉丁文的含义给出了中文名,进一步规范了 60 余种鲍的分类地位并订正了学名。作者在撰写过程中,参阅了大量的文献资料和著作,在积极吸收其精华的同时,还对已发现的相互矛盾的资料和数据作了认真的订正。为了使该书图文并茂,我们收集了大量分类资料和照片。在有关资料的编排与取舍方面,强调注重科学性、先进性、系统性和条理性,同时也努力反映国内外学者的研究成果。我们的宗旨是,力求使本书能够准确、全面、系统地反映本学科的历史与现状,形成一部有自己特色的、比较完整的鲍的生物学论著。

本书的出版得到了浙江省重点扶植学科、浙江省自然科学基金、宁波大学出版基金的资助;同时得到了恩师——中国科学院院士刘瑞玉先生和中国工程院院士张福绥先生的审阅和推荐;也得到了美国旧金山大学的钱锺教授,美国东新墨西哥大学刘志明博士,高绪生、王仁波、常亚青等先生,杨文新、刘艳、杨志彪、刘慧慧等同学的大力帮助。再次向他们表示衷心的感谢。

由于作者的水平所限和资料收集的不足,难免有错误和不足之处,衷心希望广大的读者和专家指正、赐教。

作者

2004 年 3 月

## Description

Abalones are members of a large class, Gastropoda, of molluscs. They belong to genus *Haliotis* and family Haliotidae. The genus *Haliotis* means sea ear referring to the flattened shape of the shell. The shell of each abalone is rounded or oval with a large dome towards one end and has a row of respiratory pores. The muscular foot has strong suction power permitting the abalone to clamp tightly to rocky surfaces. The epipodium, a sensory structure and extension of the foot that bears tentacles, circles the foot and projects beyond the edge of the shell in the living abalone. The large foot is popular seafood for its nutritive and medicinal value. Natural resources of abalone have been exhausted in some regions of the world due to the excessive catch and water contamination from large-area aquaculture. Fisheries biologists have conducted extensive research aiming to recover and sustain the natural resource. The purpose of this publication is to summarize the important research.

Abalones are scattered all over the world, but mostly found along west and east outer coast of Pacific ocean and islands of south of the Pacific ocean. *H. pustulata* , *H. unilateralis* can be found in the Red Sea; *H. clathrata* , *H. mariae* , *H. ovina* , *H. pustulata* and *H. rugosa unilateralis* can be found in Indian Ocean; *H. clathrata* , *H. pustulata* , *H. squamosa* and *H. unilateralis* also distributed in Madagascar; In Africa ,you can found *H. midae* , *H. parva* , *H. pustulata* , *H. queketti* , *H. spadicea* , *H. speciosa* and *H. marmorata* . In the European-Mediterranean area can found species of *H. pustulata* , *H. stomatiaeformis* , *H. tuberculata* . *Tuberculata* and *H. tuberculata coccinea* . There is *H. aurantium* and *H. pourtalesii* in the Caribbean and South America. *H. dalli* and *H. roberti* live in the Panamaic area. The following species can be found in the north – eastern Pacific (Aleutians to Baja California): *H. corrugata* , *H. cracherodii* , *H. fulgens* , *H. k. kamtschatkana* , *H. kamtschatkana assimilis* , *H. rufescens* , *H. sorenseni* , *H. walallensis* . The following species of *H. discus* , *H. discus hannai* , *H. diversicolor* , *H. exigua* , *H. gigantean* , *H. madaka* and *H. planata* can be found in temperate waters of Japan and China. *H. asinina* , *H. clathrata* , *H. dissona* , *H. diversicolor* , *H. dohrniana* , *H. exigua* , *H. fatui* , *H. glabra* and *H. jacnensis* can be found in Indo-Malayan area. The following species can be found in Australia: *H. asinina* , *H. brazieri* , *H. clathrata* , *H. coccoradiata* , *H. cyclobates* , *H. dissona* , *H. elegans* , *H. hargravesi* , *H. laevigata* , *H. ovina* , *H. planate* , *H. roei* , *H. rubra* , *H. rubiginosa* , *H. scalaris* , *H. semiplicata* , *H. squamata* , *H. thailandis* and *H. varia* . In New Zealand can found *H. australis* , *H. iris* and *H. virginea* . Nine species of abalone occur in North America: *H. cracherodii* , *H. walallensis* , *H. fulgens* , *H. corrugata* , *H. kamtschatkana* , *H. rufescens* , *H. assimilis* , *H. pourtalesii* and *H. sorenseni* .



This book reported the histology and ultrastructure of mental, tentacle, eyes, and adductor muscle, gill, hepatopancreas, male and female reproductive system. Except for black abalone, hybridization among abalone species is not uncommon in areas where several species occur together. There are 12 recognized hybrids in southern California and northern Baja California. The molecular mechanism of reproductive isolation in abalones has been revealed. Lysin, a kind of acrosin found in the acrosome of abalone sperm plays a very important role in the process of fertilization. Abalones reach sexual maturity at a small size, and fertility is high and increases exponentially with size. Sexes are separate and fertilization is external. The eggs and sperm broadcast into the water through the pores with the respiratory current. A 1.5 – inch abalone may spawn 10,000 eggs or more at a time, while an 8 – inch abalone may spawn 11 million or more eggs. The spawning season varies among species with black, green and pink abalone spawning between spring and fall, and pinto abalone spawning during the summer. Red abalones in some locations spawn throughout the year. The fertilized eggs hatch into floating larvae that feed on plankton until their shells begin to form. Planktonic abalone larvae dispersed by currents; tend to settle in recently grazed areas, attracted by chemicals secreted by colonizing algae. Once the shell forms, the juvenile abalone sinks to the bottom where it clings to rocks and crevices with its single powerful foot. Settling rates appear to be variable. After settling, abalones change their diet and juvenile abalones feed on rock – encrusting coralline algae and on diatom and bacterial films. The adult abalones attach to firm (rocky) substrate in waters with high salinity and some wave or current action; Adult abalones feed primarily on loose pieces of marine algae drifting with the surge or current. Large brown algae such as giant kelp, bull kelp, feather boa kelp and elk kelp are preferred, although other species of algae may be eaten at various times.

This book also reported disease prevention and control in abalones. Diagnosis and biological control techniques of the viral diseases, bacterial diseases, parasite diseases and other kinds of diseases were described.

Genetic breeding and Genetic diversity of abalone was analyzed by polyploid, cross, gene transfer and polymerase chain reaction (PCR) of 18S and 16S rDNAs, with randomly amplified polymorphic DNA (RAPD) and restriction fragment length polymorphism (RFLP). Species-specific RAPD markers were found in each abalone species.

Today, abalones are widely used fresh or frozen in Asian restaurants for soups and other dishes. The abalone shell is used as traditional Chinese medicine and can be found in most part of China. Abalone shells are also sold to shell collectors as souvenirs and are used in making jewelry.

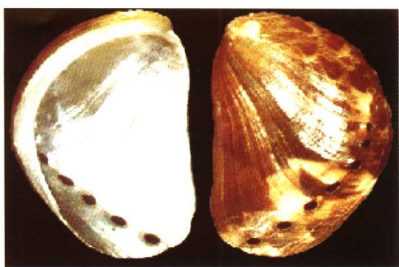


图 1 耳鲍 (*Haliotis asinina* Linnaeus)

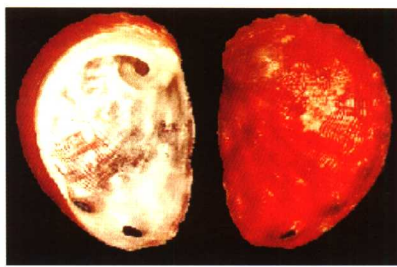


图 2 血鲍 (*Haliotis aurantium* Simone)



图 3 澳洲鲍 (*Haliotis australis* Gmelin)



图 4 钵形鲍 (*Haliotis brazieri* Angas)



图 5 地图鲍 (*Haliotis coccoradiata* Reeve)

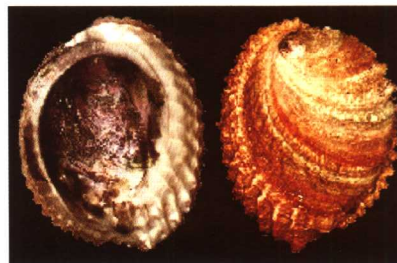


图 6 桃红鲍 (*Haliotis corrugata* Wood)

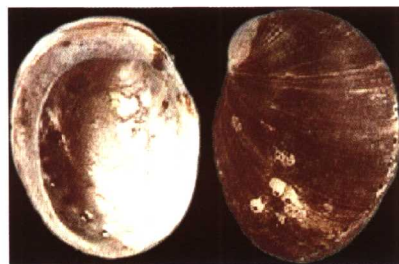


图 7 黑鲍 (*Haliotis cracherodii* Leach)

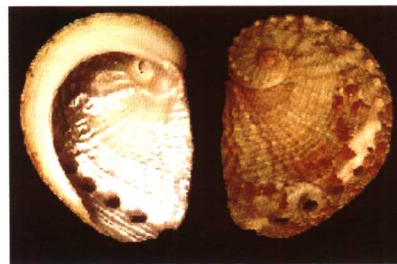


图 8 密纹鲍 (*Haliotis crebrisculpta* Sowerby)



图 9 圆盘鲍 (*Haliotis cyclobates* Péron)

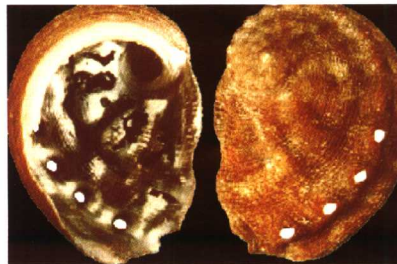


图 10 多尔鲍 (*Haliotis dalli* Henderson)



图 11 盘鲍 (*Haliotis discus* Reeve)



图 12 皱纹盘鲍 (*Haliotis discus hannai* Ino)



图 13 双肋鲍 (*Haliotis dissona* Iredale)



图 14 杂色鲍 (*Haliotis diversicolor* Reeve)



图 15 多恩鲍 (*Haliotis dohrniana* Dunker)



图 16 埃勒根特鲍 (*Haliotis elegans* Philippi)



图 17 袖珍鲍 (*Haliotis exigua* Dunker)



图 18 法徒氏鲍 (*Haliotis fatui* Geiger)

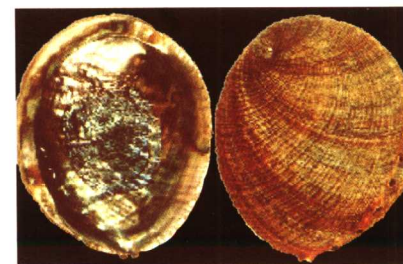


图 19 绿鲍 (*Haliotis fulgens* Philippi)



图 20 大鲍 (*Haliotis gigantea* Gmelin)



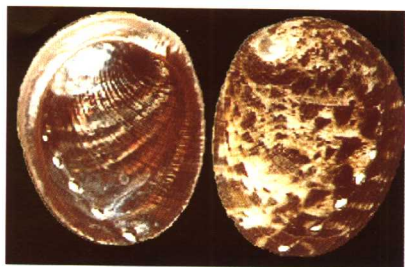


图 21 平滑鲍 (*Haliotis glabra* Gmelin)



图 22 哈格雷夫鲍 (*Haliotis hargravesi* Cox)



图 23 虹鲍 (*Haliotis iris* Martyn)



图 24 杰氏鲍 (*Haliotis jacquensis* Reeve)



图 25 勘察加鲍 (*Haliotis kamtschatkana* Jonas)



图 26 螺纹鲍 (*Haliotis kamtschatkana assimilis* Dall)



图 27 光滑鲍 (*Haliotis laevigata* Donovan)



图 28 马达卡鲍 (*Haliotis madaka* Habe)



图 29 玛丽亚鲍 (*Haliotis mariae* Wood)



图 30 大理石鲍 (*Haliotis marmorata* Linnaeus)

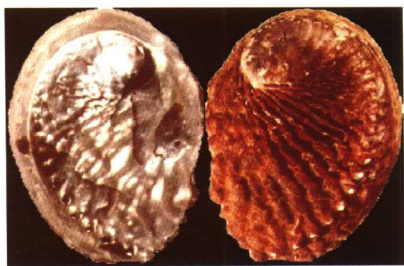


图 31 中间鲍 (*Haliotis midae* Linnaeus)



图 32 羊鲍 (*Haliotis ovina* Gmelin)

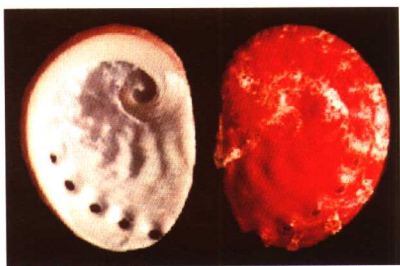


图 33 泰国帕特鲍 (*Haliotis patamakanthini* Dekker, Regte & Gras)

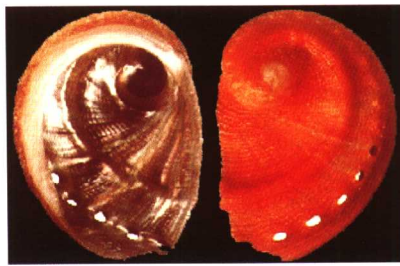


图 34 肋纹鲍 (*Haliotis parva* Linnaeus)



图 35 平鲍 (*Haliotis planata* Sowerby)



图 36 葫芦鲍 (*Haliotis pourtalesii* Dall)



图 37 极美鲍 (*Haliotis pulcherrima* Gmelin)



图 38 疱疹鲍 (*Haliotis pustulata* Reeve)

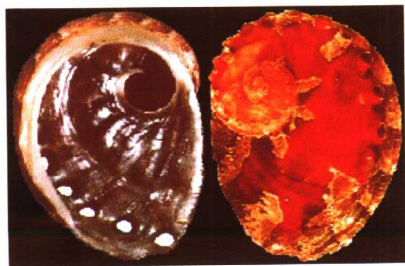


图 39 奎克鲍 (*Haliotis queketti* Smith)

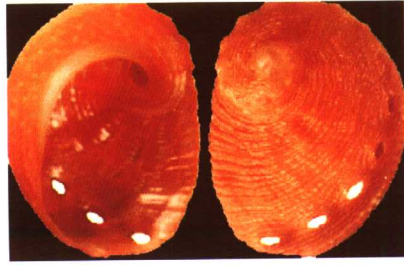


图 40 罗伯特鲍 (*Haliotis roberti* Mclean)



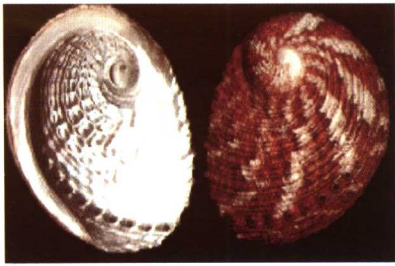


图 41 罗氏鲍 (*Haliotis roei* Gray)



图 42 豪华鲍 (*Haliotis rubiginosa* Reeve)



图 43 橘红鲍 (*Haliotis rubra* Leach)

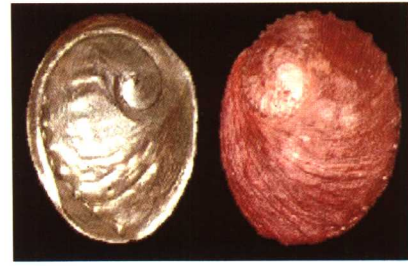


图 44 锥形橘红鲍 (*Haliotis rubra conicopora* Péron)



图 45 红鲍 (*Haliotis rufescens* Swainson)



图 46 多皱鲍 (*Haliotis rugosa* Lamarck)

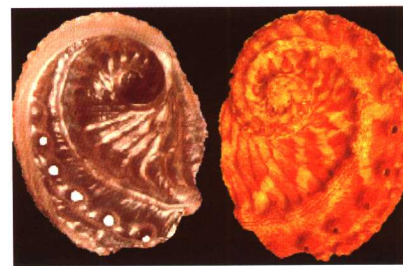


图 47 梯纹鲍 (*Haliotis scalaris* Leach)

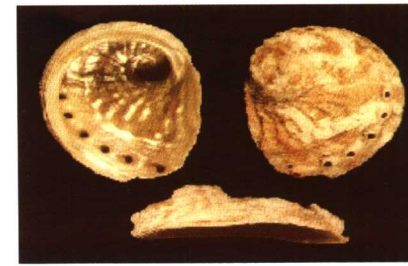


图 48 埃玛梯纹鲍 (*Haliotis scalaris emmae* Reeve)



图 49 半月鲍 (*Haliotis semiplicata* Menke)

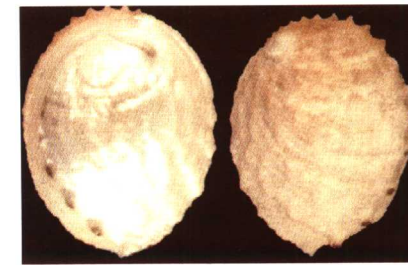


图 50 白鲍 (*Haliotis sorenseni* Bartsch)



图 51 血点鲍 (*Haliotis spadicea* Donovan)



图 52 光彩鲍 (*Haliotis speciosa* Reeve)



图 53 多鳞澳洲鲍 (*Haliotis squamata* Reeve)

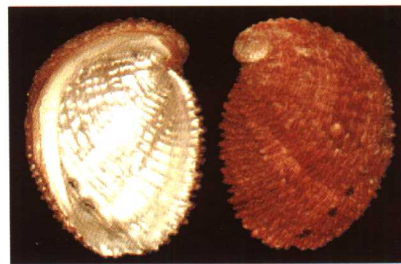


图 54 马岛鳞状鲍 (*Haliotis squamosa* Gray)



图 55 汤加口形鲍 (*Haliotis stomatiformis* Reeve)

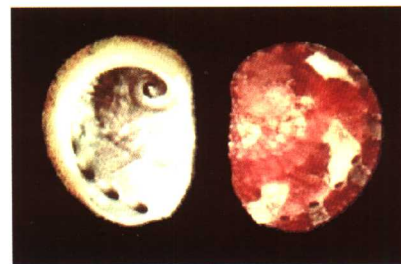


图 56 泰国鲍 (*Haliotis thailandis* Dekker & Pakamanthin)

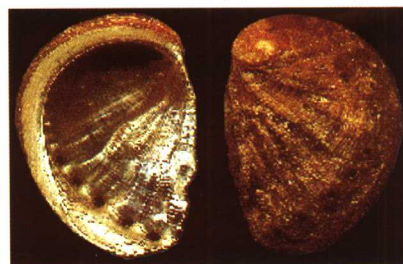


图 57 疣鲍 (*Haliotis tuberculata* Linnaeus)



图 58 球形疣鲍 (*Haliotis tuberculata coccinea* Reeve)



图 59 片层疣鲍 (*Haliotis tuberculata lamellosa* Lamarck)



图 60 单侧鲍 (*Haliotis unilateralis* Lamarck)





图 61 多变鲍 (*Haliotis varia* Linnaeus)



图 62 美女鲍 (*Haliotis venusta* Adams & Reeve)



图 63 处女鲍 (*Haliotis virginea* Gould)



图 64 桑葚形处女鲍 (*Haliotis virginea morioria* Powell)

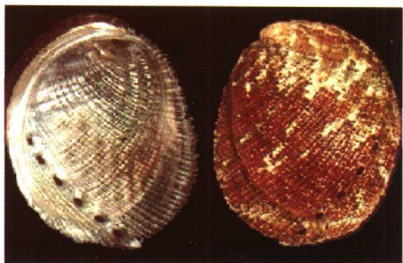


图 65 弗吉尼亚鲍 (*Haliotis virginea virginea* Gmelin)



图 66 扁鲍 (*Haliotis walallensis* Stearns)

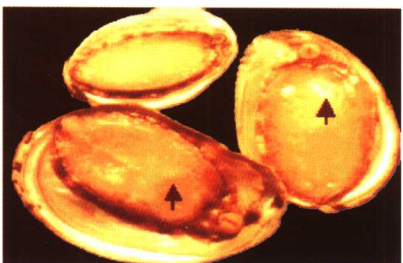


图 209 箭头示腹足上的脓疱



图 210 正常鲍腹足的组织结构



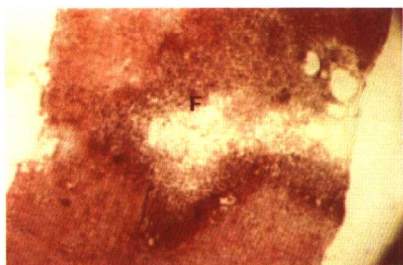


图 211 示病灶的形成 (纵切)

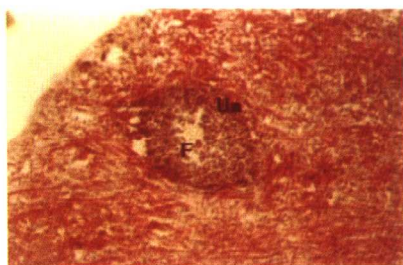


图 212 示病灶 (横切)

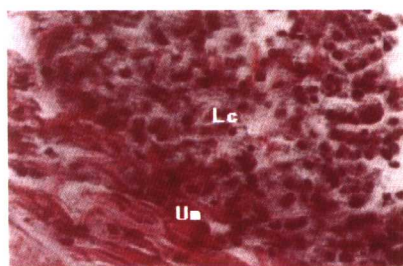


图 213

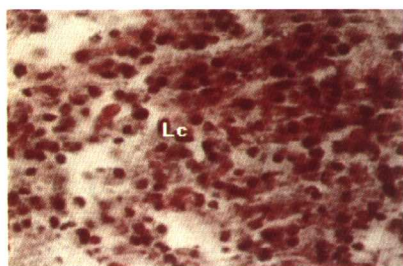


图 214

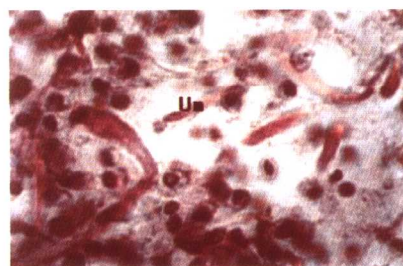


图 215

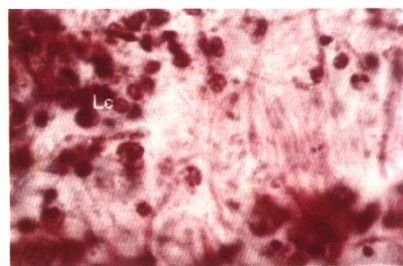


图 216

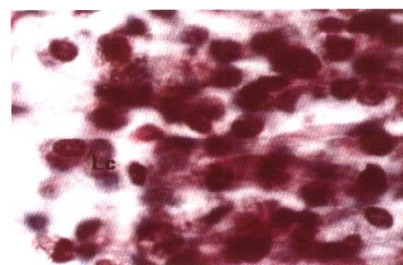


图 217



图 218

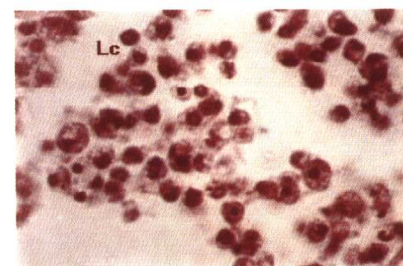


图 219

图 213 ~ 219 示病灶的不同形态: 开始时肌纤维断裂, 结缔组织溶解, 最后所有组织细胞全部溶解, 病灶内只剩下少量细胞核和河流弧菌 II

图 234 示体外吞噬实验结果, 血淋巴细胞可像变形虫样捕捉细菌

