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Berlin-Dahlem

Internationale Bibliographie von 1965 - 1992 zum Thema

"Angewandte Malakologie"

Beziehungen zwischen Mensch und Mollusken

International Review of "Applied Malacology"
in the years 1965 - 1992
Relationship between Man and Molluscs

von
Dr. Dora Godan

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Einleitung

Die Malakologie gehört zu den kleinen Fächern, die es schwer haben, sich zur Geltung zu bringen, oder sogar um das Überleben ringen müssen. Dies gilt um so mehr für die angewandte Malakologie als Teilbereich des Faches. Früher konnte die Biologische Bundesanstalt für Land- und Forstwirtschaft eine Spezialistin für Schadschnecken beschäftigen. Heute ist dies nicht mehr möglich, da andere Fragen dringlicher geworden sind, insbesondere die hoheitlichen Aufgaben der Prüfung und Zulassung von Pflanzenschutzmitteln und die damit in Verbindung stehenden Forschungen und Richtlinienarbeiten. Darüber hinaus setzt auch die notwendige Entwicklung integrierter und umweltfreundlicher Pflanzenschutzverfahren neue Maßstäbe.

Dennoch sind die Probleme mit Schadschnecken in der garten- und ackerbaulichen Praxis nicht geringer geworden. Es macht im Gegenteil den Eindruck, daß Schäden durch Schnecken zugenommen haben. Die Beschäftigung mit den freilebenden Schnecken und anderen Weichtieren ist aber für den Pflanzenschützer auch im Rahmen seiner Aufgaben zum Schutz des Naturhaushalts erforderlich.

Frau Dr. Godan, obwohl bereits seit längerem nicht mehr in aktiven Diensten der Biologischen Bundesanstalt für Land- und Forstwirtschaft, hat es dankenswerterweise übernommen, auf der Grundlage ihrer lebenslangen Erfahrungen in der malakologischen Forschung eine Übersicht über den gegenwärtigen Kenntnisstand in diesem Bereich zu erstellen. Frau Dr. Godan legt mit dem vorliegendem Band eine Literaturübersicht über die vielfältigen Beziehungen des Menschen zu den Weichtieren vor. Dieser erste Teil behandelt die ausgewählte Literatur zur Nutzung von Mollusken durch den Menschen, ihre Ausstrahlung auf die Kunst, ihre Bedeutung als Indikatoren für Umweltbelastungen, aber auch Zusammenstellungen zur Rolle als Überträger von Krankheiten und anderem mehr. In einem zweiten Teil wird auf die phytomedizinische Malakologie eingegangen.

Die Einführungen in die verschiedenen Teilbereiche und die Literaturanregungen sind als Einheit zu sehen. Die Ausführungen sollen das Interesse für eine vertiefende Beschäftigung mit den Mollusken wecken, insbesondere in angewandten Fragen. Der Band kann die Arbeit einer Literaturdokumentation zum Beispiel in der Biologischen Bundesanstalt für Land- und Forstwirtschaft nicht ersetzen. So bezieht sich das Register der Sachgebiete auch nur auf die Angaben im Titel der Arbeiten. Die Veröffentlichung soll vielmehr diesem Bereich neue Freunde gewinnen und helfen, die Lücken in der heutigen Forschung nicht noch weiter aufreißen zu lassen.

Prof. Dr. Fred Klingauf
Präsident der Biologischen Bundesanstalt
für Land- und Forstwirtschaft

Introduction

Malacology falls under the small disciplines which don't have it easy to bring out their importance or which even have to fight for their survival. This all the more applies to applied malacology as part of the discipline. Formerly the Federal Biological Research Centre for Agriculture and Forestry engaged an expert in pest snails and slugs. This is no longer possible because other problems have become more pressing, in particular, the legal tasks of testing and licensing pesticides, research work necessary in this connection as well as performance of administrative functions. In addition, the necessary development of integrated and environmentally clean plant protection methods is of higher priority.

Nevertheless the problems caused by pest snails and slugs in horticulture and agriculture didn't grow down. Just the opposite, it seems that damages caused by snails and slugs are increasing. Moreover, the occupation with freeliving pulmonates and other molluscs is necessary for plant protectors within their task to protect the ecosystem energetics.

Therefore thanks are due to Dr. Godan for undertaking the work to give a review on the present knowledge in this discipline on the basis of her lifelong experiences in malacological research, especially, after her active service in the Federal Biological Research Centre for Agriculture and Forestry ended long ago. Dr. Godan presents in this publication a compilation of literature on the various relations between man and molluscs. This first volume includes the selected literature on using molluscs by man, their influence on art, their importance as indicators of environmental load as well as their role as vector of diseases. In a second volume the phytomedical malacology will be treated.

The introductions to the various chapters and the literature suggestions are to consider as unit. It is hoped that this book should stimulate deepening studies on molluscs and particularly on applied questions. This book cannot substitute the work of a literature documentation such as in the Federal Biological Research Centre for Agriculture and Forestry. So the index of subject areas only refers to data in the title of the papers. The purpose of this publication is much more to make new friends of this discipline and an attempt to fill the gaps in recent research.

Prof. Dr. Fred Klingauf
President of the Federal Biological Research Centre
for Agriculture and Forestry

Vorwort

Bei dem Meeting der IOBC (International Organisation of Biological Control) in Wien 1990 wurde im Rahmen der Arbeitsgruppe "Integrated Control of Soil Pests" die Untergruppe "Applied Malacology" gegründet und mir die Aufgabe erteilt, die internationale Literatur von 1965 - 1992 auf diesem Gebiet zu erfassen und auszuwerten. Die "Angewandte Malakologie" stellt die Beziehung des Menschen zu den Mollusken dar. Unter den insgesamt 7000 ermittelten Publikationen sind phytomedizinische Themen (Pflanzen- und Vorratsschutz), etwa 3000 Titel, vorherrschend und erfordern daher eine gesonderte Veröffentlichung. Der vorliegende 1. Teil der Review (mehr als 4000 Titel) in der Beziehung "Mensch und Mollusken" umfaßt Bereiche wie Nahrungsmittel (hier ebenfalls vorherrschend), Human- und Veterinär-Medizin, Umwelt- und Naturschutz.

Mein besonderer Dank gilt vor allem dem Präsidenten der Biologischen Bundesanstalt für Land- und Forstwirtschaft (BBA), Herrn Professor Dr. F. Klingauf, für sein Interesse an dieser Arbeit und sein Einverständnis, daß ich bei der technischen Durchführung der inzwischen etwa 7000 Publikationen umfassenden Review die Hilfe von Kolleginnen und Kollegen der BBA in Anspruch nehmen durfte. So danke ich herzlich Herrn Dr. Ch. Reichmuth für seinen Beistand. Frau D. Lendt danke ich für ihre unermüdliche Geduld und Sorgfalt bei der für die Drucklegung erforderlichen exakten schriftlichen Erfassung meiner Titelsammlung und Herrn Ch. Ulrichs für weitere Hilfe.

Berlin, im Sommer 1994 Dr. Dora Godan, Berlin

Preface

At the meeting of the Working-Group "Integrated Control of Soil Pest", member of the IOBC (International Organisation of Biological Control) in Vienna 1990 there was founded the Subgroup "Applied Malacology". I was given the task to make a review of the international publications about "Applied Malacology" in the years 1965-1992. I have sampled now some 7000 titles. At the "Applied Malacology" - Relationship between Man and Molluscs the highlight is the Phytomedicine (Plant Protection and Stored Product Protection) with more than 3000 references. Therefore it is necessary for that part to have an extra issue of the series "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem".

The following 1. part of the review (more than 4000 titles) contains also marine foodstuffs as highlight, as well as human- and veterinary-medicine, environmental pollution and protection of the molluscs-biotopes. I wish to thank very much Professor Dr. F. Klingauf, President of the Federal Biological Centre for Agriculture and Forestry, Berlin-Dahlem and Braunschweig, for his great interest in this work. Special thanks to my colleague Dr. Ch. Reichmuth for his help to arrange the technical details, and to Mrs. D. Lendt for her infinitive patience and accuracy to make a good script for printing, and Mr. Ch. Ulrichs also for help.

Berlin, summer 1994 Dr. Dora Godan, Berlin

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I. Interpretation zur "Internationalen Bibliographie (1965 - 1992)" "Angewandte Malakologie" - Beziehungen zwischen Mensch und Mollusken

Die Grundlage der "Angewandten Malakologie" bilden die Beziehungen zwischen dem Menschen und den Mollusken. Im allgemeinen werden mit "Applied" oder "Economic Malacology" die durch Schnecken verursachten Schäden im Pflanzenschutz und die Züchtung eßbarer Mollusken sowie ihr Wert auf dem Markt, schließlich die Rolle der Schnecken in der Human- und Veterinärmedizin verstanden. Doch gehören auch Bereiche dazu, die GODAN (im Druck) beschreibt und die das Studium des "Zoological Record", Sektion "Mollusca", Abteilung "Animal and Man", vermittelt.

Die Wechselwirkung "Mensch und Gastropoden" im internationalen Pflanzenschutz hat GODAN (1979, 1983) nach Auswertung von 1.500 Publikationen beschrieben. Inzwischen hat sich das Schrifttum in der "Angewandten Malakologie" stark vergrößert, besonders in der Phytomedizin, Mollusken-Kultur sowie Human – und Veterinärmedizin. Im Trend liegen umfangreiche Reviews, allerdings nicht im Hinblick auf den Pflanzen- und Vorratsschutz. Es erschienen die Liste "Recent publications on medical and applied malacology" (J. med. & appl. Malacol., Vol. 2, 1990); "Actes de Colloque" (Brest 1990) der Société Française de Malacologie (Paris)/IFREMER, und zwar "Aspects Recents de la Biologie des Mollusques" in Nr. 13 (1991) und "Les Mollusques Marins, Biologie et Aquaculture" in Nr. 14 (1992); "Snail Farming Research" (Vol. 2, 1992) der Associazione Nazionale Elicicoltori (A.N.E.); ferner Abstracts und Proceedings von internationalen malakologischen Kongressen, wie Proc. 10th Intern. Malacol. Congr. (Tübingen 1989) 1991 (Ed.: C. MEIER-BROOK, Part 1, 316 pp. und Part 2, 636 pp.); Abstr. 11th Intern. Malacol. Congr. (Siena, Italien, 1992), ebenfalls organisiert von der Unitas Malacologica (Eds.: F. GIUSTI & G. MANGANELLI, 536 pp.); Intern. Congr. OILB (Organisation Internationale de Lutte Biologique et integrée contre les Animaux et les Plantes Nuisibles) in Tours, (Frankreich), 1992.

Eine Hilfe für Interessenten geben Bibliographien und Datenbanken wie "Mollusk Culture", Quick Bibliography Series, United States Department of Agriculture; Datenbank "PHYTOMED", Internationale Datenbank für Literatur zu Pflanzenkrankheiten und Pflanzenschutz, inklusive Vorratsschutz (Biologische Bundesanstalt für Land- und Forstwirtschaft) Berlin-Dahlem; "Bibliographie der Pflanzenschutzliteratur", herausgegeben von der Dokumentationsstelle für Phytomedizin, Berlin-Dahlem.

Die Mollusken sind seit altersher mit dem Menschen eng verbunden; die Beziehungen zwischen beiden sind heute äußerst vielseitig und betreffen alle Lebensbereiche des Menschen. Als dieser noch Sammler und Jäger war, gehörten Schnecken und Muscheln zu seinen Nahrungsquellen; sie dienten als Werkzeug und ritueller sowie profaner Schmuck. Später wurden sie ihm Symbol, Talisman und sogar Heilmittel. Die Mollusken sind dem Menschen aber nicht immer ein "Freund", sondern auch ein "Feind". Der Mensch allerdings betätigt sich ihnen gegenüber stets als "Feind", und wenn er sie schont und behütet, dann nur zu seinem späteren Vorteil. Auch ist er dabei, ihre Lebensräume, auf dem Land und im Wasser, zu belasten und sogar zu zerstören.

Die Themenvielfalt im Bereich der "Angewandten Malakologie" vermittelt die folgende Gliederung, das Resultat der Auswertung von Untersuchungsbefunden aus fast 7.000 internationalen Publikationen der Jahre 1965 bis 1992.

Gliederung der Beziehungen "Mensch und Mollusken"
(...) = Anzahl der Veröffentlichungen

I. Beitrag des Menschen zur Kenntnis der Mollusken (100)
Sammlungen, Museen u.a.

II. Der Mensch als "Nutznießer", die Mollusken als "Freund"

1. Nahrungsmittel (insgesamt 1.117)

1.1 Freilandfänge (Landschnecken), Mast
1.2 Züchtung, Aquakultur
1.2.1 Gastropoda (Terrestrische und Marine) (308)
1.2.2 Bivalvia (689)
1.2.3 Cephalopoda (121)

2. **Schmuck** (31)
   2.1 Perlen (Natur- und Zuchtperlen)
   2.2 Gehäuse, Schalen rezenter und fossiler Mollusken

3. **Bekleidung** (9)
   Purpurstoffe, "Meeresseide", Kleiderschmuck

4. **Schutz- und Heilmittel** (12)
   4.1 Symbol, Talisman, Maske
   4.2 Heilmittel, Medikament

5. **Begleiter im Tagesverlauf** (4)
   5.1 Gebrauchs- und Ziergegenstand
   5.2 Kommunikation: Signalgeber, Zahlungsmittel, Postsache, Dokument
   5.3 Namensgeber: Körperteile von Mensch und Tier; Bereich der Wirtschaft und Technik

6. **Kunst** (16)
   6.1 Architektur (Volute, Koncha, Rocaille, Shellwork, Intarsie)
   6.2 Malerei, Graphik, Zeichnung u.a.

7. **Forschung** (insgesamt 942)
   7.1 Objekte zum Studium der Lebensfunktionen des Menschen (Physiologie, Immunität, Blut, Karzinom u.a.)
   7.1.1 Terrestrische Gastropoda (437)
   7.1.2 Süßwasser- und marine Mollusca (377)
   7.1.3 Cephalopoda (45)
   7.2 Indikatoren für Belastungen der Umwelt und tektonische Veränderungen (84)

III. Der Mensch als "Geschädigter", die Mollusken als "Feind"

1. **Vernichtung seiner pflanzlichen Nahrungsgrundlage:**
   Phytomedizin (etwa 3000)
   1.1 Pflanzenschutz
   1.1.1 Schadwirkung, Schneckenarten
   1.1.2 Bekämpfung
   1.1.2.1 Mechanische und ökologische Maßnahmen
   1.1.2.2 Biologische Maßnahmen, Probleme
   1.1.2.2.1 Krankheitserreger (Viren, Bakterien, Pilze)
   1.1.2.2.2 Parasiten
   1.1.2.2.3 Räuber (Mollusken, Arthropoden, Vertebraten)
   1.2 Vorratsschutz
   1.2.1 Schadwirkung (Fraß, Verschmutzung mit Kot, Schleim), Schneckenarten
   1.2.2 Bekämpfung
   1.3 Schadwirkung durch nicht-heimische, vom Menschen verschleppte Schneckenarten
   Quarantäne

2. **Übertragung von Krankheiten bei Mensch und Tier**
   Human- und Veterinärmedizin (insgesamt 845)
   2.1 Transportwirte für Viren, Bakterien, Pilze
   2.2 Zwischenwirte im Entwicklungsverlauf von Wurmparasiten
   2.2.1 Badedermatitis
   2.2.2 Parasitische Würmer: Trematoden, Nematoden, Zestoden
   Schistosoma sp. (Bilharziose) (262)
   Übrige Wurmparasiten (320)
   2.2.3 Bekämpfung der Schnecken-Zwischenwirte (261)

3. Beschädigung meerumspülter Bauten, Verstopfung der Kanalisationsrohre u.a. (13)

IV. Der Mensch als "Feind" (595)
Belastung, Zerstörung der Biotope der Mollusken und des Ökologischen Gleichgewichts

1. Ausbreitung der Industrie, landwirtschaftlichen Nutzflächen, des Verkehrs u.a.
- 1.1 Nicht-chemische Veränderungen
- 1.2 Belastung mit Schwermetallen, Pestiziden, Öl, organischen Stoffen u.a.
- 1.2.1 Landgebiete
- 1.2.2 Flüsse, Seen, Meere und deren Küsten

2. Freizeitgestaltung
- 2.1 Massentourismus, Wandern, Camping, Motorboote, Surfen u.a.
- 2.2 Nichtbeachtung der Naturschutzgebiete

V. Der Mensch als "Beschützer" (358)
Maßnahmen zum Schutz der Mollusken

1. Bestandserhebung, Kartierung, "Rote Liste"

2. Gesetze, Verordnungen, Reservate

Die Gliederung zeigt, wo das Hauptinteresse des Menschen in seiner Beziehung zu den Mollusken liegt. Es ist der **Nahrungsmittelsektor**: In erster Linie der Schutz der Kulturpflanzen und des Ernteguts bei der Aufbewahrung und Lagerung; in zweiter Linie ist es die Züchtung eßbarer Schnecken, Muscheln und neuerdings auch Cephalopoden, vorrangig die Aquakultur: also auf den Gebieten **Phytomedizin** (etwa 3.000 Titel = III.1.) und **Mollusken-Kulturen** (insges. 1.117 Titel = II.1.). Als Nächstes kommt die **Forschung**, da viele Faktoren in der Physiologie und im Immunsystem der Mollusken den Zuständen und Funktionen bei Wirbeltieren und dem Menschen ähneln; hervorzuheben ist ferner die zunehmende Bedeutung der Schnecken und Muscheln als Indikatoren für Umweltbelastungen auf dem Land und im Wasser (insgesamt 942 Titel = II.7.). Ebenso wichtig ist die **Human- und Veterinärmedizin** mit wachsendem Interesse an Süßwasser- und Landschnecken, die als Zwischenwirte für parasitische Würmer bei Mensch und Tier eine große Rolle spielen (insgesamt 845 Titel = III.2.). Zur Zeit noch wesentlich geringer ist die Anzahl der Publikationen über die durch den Menschen verursachte **Umweltbelastung**, Zerstörung der Biotope und des Ökologischen Gleichgewichts, in dem die Mollusken als Humusbilder und wichtige Glieder von Nahrungsketten, auch für den Menschen, Bedeutung haben (595 Titel = IV.). Veröffentlichungen zum Thema **Schutz der Mollusken** gibt es bisher noch relativ wenige, ausgenommen Studien im Rahmen der "Projektgruppe Molluskenkartierung" (JUNGBLUTH) über Bestandserhebungen und Kartierungen der Molluskenbiotope, die als Grundlage für die "Roten Listen" der gefährdeten, also schutzbedürftigen Arten von Wichtigkeit sind (358 Titel = V.). Abbildung 1 verdeutlicht die gegenwärtige Situation.
Die gesamte hier dargestellte Bibliographie ist entsprechend den Kapiteln der Gliederung auf Disketten übertragen worden.
Für das Kapitel III.1. "Phytomedizin" ist wegen seines beachtlichen Umfangs (etwa 3.000 Titel) ein eigenes Heft der "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem" vorgesehen, zumal die jetzige Review mehr als 4.000 Veröffentlichungen umfaßt.

I. Beitrag des Menschen zur Kenntnis der Mollusken
Ein beachtliches Schrifttum - wesentlich mehr, als hier aufgeführt ist - behandelt die Stellung der Mollusken im System der Tiere, Bestimmungsmerkmale der Ordnungen, Familien und Arten, deren Aussehen, Verhalten und Lebensweise, ferner Charakteristika ihrer Biotope. Es vermittelt wichtige Fakten auch im Hinblick auf die Beziehung zwischen Mensch und Mollusken.
Mit der Erforschung fremder Länder und Kontinente von Anfang des 17. Jahrhunderts an wuchs das Interesse an den bisher unbekannten Gehäusen und Schalen; ihre Bestimmung wurde notwendig. Es entstanden berühmte Conchylien-Kabinette, und die Mollusken-Sammlungen in den Naturkunde-Museen mehrten sich. Erwähnenswert sind die damaligen Molluskenbücher mit Kupferstichen von hohem künstlerischem Wert, wie die "Historia Conchyliorum" von LISTER mit 1.000 Stichen, und der 1742 in Florenz erschienene "Index Testarum Conchyliorum" von GUALTIERI. Nach Carl von LINNAEUS sind viele entdeckte Mollusken-Arten

benannt. Die interessante Geschichte der "Shell-Collecting" beschreibt DANCE (1986) mit Fotos von 22 berühmten Mollusken-Forschern aus dem 17. bis 20. Jahrhundert. DIAZ - MERLANO (1985) nennt 365 Veröffentlichungen aus dieser Zeit.

Zu den bekannten Naturkunde-Museen mit beachtlicher malakologischer Abteilung gehören das Museum of Natural History (London), Musée d'Histoire Naturelle (Paris), Institut Royal des Sciences Naturelles de Belgique (Brüssel), Rijkes Museum van Natuurleyke Historie (Leiden), Zoologisk Museum (Kopenhagen), Naturhistorisches Museum (Wien), Museum für Naturkunde (Berlin) und Forschungsinstitut und Natur-Museum Senckenberg (Frankfurt/M.).

II. Der Mensch als "Nutznießer", die Mollusken als "Freund"

1. Nahrungsmittel

Die Bedeutung der Mollusken für die Ernährung des Menschen wuchs ständig. Heute sind sie zu einem wichtigen Faktor in der Nahrungsmittelindustrie geworden.

Da jedoch infolge intensiver Freilandfänge die Schnecken- und Muschelbestände drastisch dezimiert wurden, sollte die große Nachfrage mit Hilfe der Züchtung befriedigt werden. Sie gelang relativ früh bei Gastropoden und Bivalvien, aber erst in letzter Zeit bei Cephalopoden.

Es gibt heute ein umfangreiches Schrifttum über Zuchtmethoden, Krankheiten, Parasiten und Räuber bei den unter der Obhut des Menschen stehenden Mollusken, ferner über Umwelteinflüsse und des zur optimalen Ernährung notwendigen marinen Planktons. Hierfür sind auch Zuchtmethoden erarbeitet worden. Zahlreiche Publikationen behandeln die Verhältnisse im Watt der Nordsee, in dem sich kommerzielle Muschelbänke befinden, und vor allem die Gefährdung des Watts durch inzwischen besorgniserregende Belastungen mit Umweltchemikalien.

In den Zeitschriften "Haliotis" der Société Française des Malacologie (Paris) und "Malacologia" der Unitas Malacologica (Wien) werden diese Themen vorrangig behandelt. Der "Haliotis"-Band 17 (1987) bringt auf 63 Seiten einen "Catalogue des Thèses de Malacologie 1958 - 1986" (TRICLOT et BOUCHET 1987). Es gibt die Zeitschrift "Snail Farming Research" der Associazione Nazionale Elicicoltori (A.N.E); Italian Snail Farmers Association). Bei GODAN (im Druck) findet sich eine Übersicht der eßbaren Mollusken, ihrer Zuchtmethoden und -bedingungen sowie der Probleme. Die zunehmende Bedeutung der Héliciculture, Ostréiculture, Mariculture und Aquaculture bekunden zahlreiche Kongresse und Symposien, die vorwiegend in Frankreich und Italien stattfinden. Einige Beispiele: III. "Symposium Européen de Biologie marine" in Arcachon 1968; Internationales Seminar in La Rochelle 1985; IFREMER ("Shellfish Culture Development and Management"); I. "International Award for Research on Snail Farming" (A.N.E.) 1986; "Symposium de Rochefort" 1986; "Symposium de Rennes" 1987; "Symposium international sur la seiche" "La Seiche/The Cuttlefish" Caen 1989; VIII. "Congrès Nationale: Aspects Récents de la Biologie des Mollusques" IFREMER, Brest 1991; "Biologie appliquée à la Conchyliculture et à l'Héliculture", Colloque Scientifique "Bordeaux Aquaculture" 1992, Bordeaux Convention Center mit folgenden charakteristischen Themen: Intensive fishfarming and environment, Genetics and pathology in shellfish farming, Waterquality in shellfish farming, Tropical aquaculture.

In Europa, den USA und Kanada werden folgende Land- und Meeresschnecken bevorzugt: *Helix pomatia* L., *Helix aspersa* Müller, *Helix aperta* Born, *Helix lucorum* L., *Achatina*-Arten, *Haliotis lamellosa* Lamarck, *Haliotis tuberculata* L., *Haliotis gigantea* Gmelin, *Strombus gigas* L., *Buccinum undatum* L., *Murex brandaris* L., u.a.

Die amphibischen *Ampullaria*-Arten sind als geschätztes Lebensmittel von Südamerika nach Asien eingeführt worden: *Ampullaria canaliculata* (= *Pomacea canaliculata*) nach Taiwan (1985) und Japan (1987), *Ampullaria glauca* L. nach West-Indien (1988) und *Ampullaria gigas* Reeve nach Hong Kong (um 1989). Möglicherweise ist *A. gigas* um 1985 nach China gelangt.

1.1 Freilandfänge (Landschnecken), Mast

Die für Europa charakteristischen Weinbergschnecken bewohnen verschiedene Gegenden: die große *Helix pomatia* Mittel- und Nordeuropa, die gefleckte *Helix aspersa* West- und Südeuropa (Frankreich, Spanien, Italien), die kleine *Helix aperta* Südeuropa und *Helix lucorum* Griechenland.

Vor allem *Helix pomatia* wurde von den alten Römern auf ihren Kriegszügen nach Westeuropa gebracht und gelangte später im Verlauf der Christianisierung mit den Mönchen als "Fastenspeise" in den Norden. In "Schneckengärten" wurde sie mit aromatischen Kräutern "gemästet". Es entwickelte sich ein lebhafter Handel, dessen Grundlage die das ganze Jahr über im Freien gesammelten Schnecken waren. Infolge des übermäßigen Sammelns gingen die Bestände zurück, und es wurden Schutzmaßnahmen notwendig.

In der Bundesrepublik Deutschland ist das Sammeln der Weinbergschnecken nur vom 1. April bis 15. Juni erlaubt und im selben Gebiet erst wieder nach drei Jahren. Der Gehäusedurchmesser muß mindestens 32 mm betragen. In Frankreich, Belgien, den Niederlanden gibt es verschärfte Schutzbestimmungen. So stehen in Frankreich mehrere *Helix*-Arten unter Schutz, und zwar:

zeitweise erlaubt:
Helix pomatia L. (Escargot de Bourgogne)
Helix aspersa Müller (Escargot Petit-Gris)
Zonites algirus (L.) (Escargot péson)

zu allen Zeiten verboten:
Helix aperta Born (Escargot naticoïdes)
Helix tristis Pfeiffer (Helix de Corse)
Helix melanostoma Draparnaud (Escargot terrassier).

In Belgien dürfen nach dem Gesetz "L'Exécutiv Régional Wallon" von 1984 die Weinbergschnecken nur vom 1. August bis 30. September gesammelt werden. Minimalumfang des Gehäuses bei *H. pomatia* 30 mm und bei *H. aspersa* 25 mm. In den Niederlanden hat BUTOT durch mehrjährige Bestandserhebungen bei *Helix pomatia* die Grundlage für deren gesetzlichen Schutz geschaffen.

Heute haben die Achatschnecken den Markt erobert. Ihre kommerzielle Bedeutung begann mit der Afrikanischen Riesenschnecke *Achatina fulica* Bowdich, die in Ostafrika beheimatet ist. Wie auch andere Achatinen ist sie zu einem beachtlichen Devisenbringer für die Länder am Pazifischen Ozean und die Inseln geworden. In den USA und Europa haben sie die Rolle der Weinbergschnecken übernommen und werden als "Snail-Escargot" gehandelt.

1.2 Züchtung, Aquakultur

Das Schrifttum über Züchtung und Aquakultur ist beachtlich. Einen ersten Überblick geben die Titellisten in den Quick Bibliography Series (Aquaculture Information Center) für die Jahre 1979-1986 (Shellfish Culture) von HANFMAN (1987) und für 1985-1990 (Mollusk Culture) von Ms VEY (1990) zum Beispiel.

1.2.1 Land- und Meeresschnecken

Von Bedeutung für die Zucht sind Temperatur, Licht (Helligkeit und Dunkelheit im Wechsel), Feuchtigkeit und geeignete Nahrung. Diese Faktoren beeinflussen die Aktivität der Schnecke, Fortpflanzungsintensität, Eiablage- und Fraßverhalten. Sie spielen bei den terrestrischen Heliciden und Achatiniden eine große Rolle, während für marine Schnecken die Qualität des Meerwassers, seine Temperatur und die Herbeischaffung des optimalen Nahrungsangebots (Plankton, Algen u.ä.) den Vorrang haben.

Auch die Bestandsdichte ist ein wichtiger Faktor für den Zuchterfolg. Großes Gedränge verursacht starken Streß für die Schnecken, wie auch beim Menschen. Eine extreme Bevölkerungsdichte im Zuchtareal setzt die Reproduktivität herab. Die streßbedingte übermäßige Schleimabsonderung behindert die Schnecke selbst und ihre Nachbarn. Es wird sogar die Biomasse des Phytoplanktons negativ beeinflußt. Sie wurde bei übergroßem Bestand von *Strombus gigas*-Zuchtschnecken so gering, daß deren optimale Ernährung nicht mehr gewährleistet war.

Helix sp. und *Achatina* sp. werden in der ganzen Welt gezüchtet. Die Héliciculture, Elicicoltori, Snail-Farming finden sich für *Helix aspersa* in Frankreich bei Besançon, Fusterouau (Riscles), Bretagne, Finistère, Normandie, Loire-Atlantique, ferner in Italien bei Cherasco, Cuneo, Piedmont und für *Helix aperta* in Sizilien sowie *Helix lucorum* in Griechenland (Peleponnes, Thrakien, Mazedonien), *Helix pomatia* in Polen. *Achatina marginata* (Swainson)-Zuchten sind in England und Italien, neuerdings auch Ghana vorhanden.

Bei dem Snail-Farming werden Eiproduktion der Adulten, Schlüpfen der Jungen und deren Wachstum bis zur Verkaufsreife vom Menschen kontrolliert. Die Bedingungen sind recht schwierig. Probleme verursachen besonders die Haltung der adulten Schnecken über einen längeren Zeitraum und die Schaffung optimaler Umweltverhältnisse im Zuchtareal, um die Fortpflanzungsfähigkeit und -willigkeit zu erhalten. Außerdem werden die abgelegten Eier und frisch geschlüpften Schnecken von Austrocknung, Fütterungsfehlern, Krankheiten (Viren, Bakterien), Parasiten und Räubern bedroht.

Die Überwinterung (Zeitpunkt des Beginns und ihre Dauer) ist für die jungen *Helix aspersa* von großer Bedeutung, da sie die Eiproduktion im Erwachsenenalter stimuliert. Der Beginn kann bei jungen Schnecken sogar künstlich induziert werden.

Krankheiten sowie Endo- und Ektoparasiten schmälern den Erfolg der Snail-Farming. *Helix aspersa* wird vorwiegend von Nematoden befallen, und zwar *Alloionema appendiculatum* (Schneider), *Angiostoma aspersae*, *Nemhelix bakeri* Morand & Petter (Parasit im Genitaltrakt) und *Rhabditis gracilicaudata*.de Man. Als Zwischenwirt für den Protostrongyliden *Muellerius capillaris* (Müller) spielt *Helix aspersa* in der

Tourraine (Frankreich) im Frühjahr eine große Rolle, während die Nacktschnecke *Deroceras reticulatum* (Müller) im Herbst den Hauptwirt darstellt. Die jungen *Helix* infizieren sich während der Schlüpfphase aus den vom Muttertier in die Erde abgelegten Eiern. Zur Prophylaxe sollen diese aus der Erde genommen und für 30 Sekunden im fließenden Wasser gründlich gewaschen werden. Neuerdings machen sich *Rhabditis*-Arten schädigend bemerkbar, auch hier ist diese Maßnahme für alle Schnecken einer Héliciculture von hygienischer Bedeutung.

Ein wichtiger Ektoparasit ist die Milbe *Ricardoella limacum*.(Schrank). Der Name "L'Acarien des Limaces" deutet darauf, daß sie früher ausschließlich *Limax*-Arten befallen hat. In den letzten Jahren ist sie in den Farmen zu einem bedrohlichen Parasiten geworden. Die Milbe lebt in der Mantelhöhle der *Helix* und ernährt sich von der Hämolymphe des Wirts, schwächt ihn sehr und beeinträchtigt dessen Wachstum und Eiproduktion.

Die ersten Untersuchungen über die Möglichkeit einer Zucht von Weinbergschnecken wurden in Frankreich durchgeführt. CHEVALLIER (1979, 1983 u.a.) hat die Héliciculture für *Helix aspersa* zur kommerziellen Reife entwickelt. Das Schrifttum ist groß und behandelt auch Arbeiten zur Klärung der besprochenen Umwelt- und Populationseinflüsse.

Für Meeresschnecken, vorwiegend *Haliotis* (Abalone)-Arten, *Buccinum undatum* (Whelk, Wellhorn) und *Strombus gigas* (Conch) gibt es Zuchtstätten (Conchyliculture, Mariculture, Aquaculture) ebenfalls überall in der Welt:

Haliotis lamellosa Lmck.	- Frankreich, Spanien
Haliotis discus (Reeve)	- Spanien (seit etwa 1983)
Haliotis gigantea Gmelin	- Karibik
Haliotis sp.	Japan (erste Experimente 1962), Taiwan (seit etwa 1975)
Buccinum undatum L.	- Frankreich (Golf Normano-Breton)
Strombus gigas L.	- Türkei, Mexiko, Karibik, Caicos-Inseln, Puerto Rico, Bahamas.

1.2.2 Muscheln

Wichtige eßbare Muscheln sind Austern (*Ostrea*- und *Crassostrea*-Arten), Miesmuscheln (*Mytilus edulis* L., *Mytilus galloprovincialis* Lamarck Jacobs-, Herz- und Venus-Muscheln wie *Pecten jacobaeus* L., *Pecten maximus* L., *Chlamys opercularis* L., *Chlamys varia* L., *Cerastoderma (Cardium) edule* (L.), *Tapes rhomboides* (Pennant), *Venus*-, *Venerupis*- und *Ruditapes*-Arten u.a.

Die Mytili-, Ostréi- und Aquakulturen liegen in den Küstenregionen der Meere, wie an der Atlantikküste von Europa und Amerika. Es gibt sie in Frankreich, Belgien, Holland, England, Irland, Schottland u.a., und zwar in Frankreich: Basse Normandie, la baie de l'Aiguillon, l'Etang de Thau, Baie du Mont Saint Michèle, Bassin d'Arcachon, Bassin de Marennes-Oléron, Baie de Somme, Baie de Seine (Calvados), Golfe Normano-Breton, Station de Wimereux, Bretagne, im Gironde-Fluß u.a. *Mytilus galloprovincialis* ist an der Mittelmeerküste angesiedelt. In England werden gezüchtet: *Mytilus edulis* in der Morecambe Bay (Wales), *Ostrea edulis* L. und *Crassostrea gigas* (Thunberg) im Emsworth Harbour. Mytiliculturen sind an der schwedischen Küste und sogar in den Gewässern von Neufundland vorhanden. Für *Cardium edule* L. liegen Zuchtstätten im Wattenmeer der Nordsee (Deutschland und Dänemark).

Außerhalb Europas gibt es sie im Golfe Persique (Iran), in der Lagune de Qualidia (Marokko) (*Crassostrea gigas*), in der Lagune San Matias und Golf San José (beide Argentinien) (*Ostrea puelchana* Orbigny), in der Chesapeake Bay (Maryland, USA) (*Crassostrea virginica* Gmelin). Japan besitzt die "Hanging culture" für *Crassostrea gigas* in der Hiroshima Bay, China in der Jaozhon Bay (Provinz Shandong).

Für Nicht-Austern finden sich Kulturen in der Bay von Brest (*Pecten maximus*) und im Bassin d'Arcachon (Manila Clam) (beide in Frankreich), "Nursery culture" für *Ruditapes philippinarum* Adams & Reeve (Palourde Japonaise) und *Ruditapes decussatus* (L.) in der Lagune de Qualidia (Marokko).

In den Farmen nun gelangen die Muscheln als Larven unter die Kontrolle des Menschen, da Eiablage der Elterntiere und Schlüpfen der Jungen ohne seinen Einfluß im Meere erfolgen.

Austern (huître)-Farmen liegen im Flachwasser mit einer starken Gezeitenströmung. Die Muschelbrut ("Saat") wird im Frühjahr und Sommer gefischt und in Parzellen ausgesät. Die sich entwickelnden Jungaustern werden ein Jahr später in tiefere Parzellen ("Mastparks") umgesetzt. Die "Ernte" der verkaufsreifen Austern erfolgt zwei bis drei Jahre später im Winter.

Früher gab es in der Nordsee ausschließlich die Runde Auster, *Ostrea edulis* L. Ihre Bestände wurden aber von einer Krankheit heimgesucht und so stark dezimiert, daß der kommerzielle Gewinn ausblieb. So wurden die widerstandsfähigen länglichen *Crassostrea virginica* Gmelin aus Nordamerika und *Crassostrea angulata* (Lamarck) aus Spanien und Portugal eingeführt, später kam *Crassostrea gigas* (Thunberg) aus Japan hinzu.

Miesmuschel (moule)-Bänke wurden bereits im vorigen Jahrhundert vom Menschen abgeerntet. Seit einigen Jahrzehnten sind im Watt der Nordsee kommerzielle Zuchtareale vorhanden. Doch infolge zunehmender Verschmutzung des Atlantik an Europas Küsten sind sie gefährdet. In den hiesigen Farmen wird *Mytilus edulis* nach verschiedenen Methoden gewonnen: entweder durch dredging mittels Bagger, der die Miesmuscheln aus den "Bänken" löst, wobei jedoch die Biotope häufig zerstört werden, oder die Jungmuscheln werden in "Parks" aufgezogen. Sie heften sich einzeln an Pfähle ("Pfahlmuscheln"), die in den Sand des Gezeitenmeeres gerammt sind, oder sie heften sich an Taue, die an Flößen ins Wasser hängen.

Das moderne Verfahren der Muschel-Gewinnung ist die **Aquakultur**. Hier unterliegt die Eiablage bereits der Kontrolle des Menschen. Die legebereiten Muscheln müssen aus dem Meer gefischt werden. Schwierig ist es, sie zum Ausstoß ihrer Gameten zu veranlassen. Bewährt haben sich Streßfaktoren wie abwechselndes Eintauchen in Kalt- und Warmwasser oder Trockenliegen für ein bis zwei Stunden. Ablage der Eier und Aufzucht der geschlüpften Muschellarven erfolgen in großen Meerwassertanks. Später werden die Jungmuscheln in die Küstengewässer umgesetzt, wo sie bis zur Verkaufsreife heranwachsen.

Mit der Aquakultur ist die Zucht von Algen und Diatomeen verbunden, denn das marine Phytoplankton ist für die Ernährung der Larven und heranwachsenden wie auch adulten Muscheln äußerst wichtig. Dazu gehören *Calanus helgolandicus*, *Chaetoceros calcitrans* (Paulsen), *Chlamydomonas reinhardi*, *Delesseria sanguinea*, *Nannochloris atomus*, *Stichococcus bacillaris*, *Chlamydomonas bullosa*, *Cladophora subriana*, *Isochrysis galbana*, *Phaeodactylus tricornutum*, *Tetraselmis tetrathele*, *Tetraselmis suecica* und *Thalassiosira pseudonana*. Auch in der Conchyliculture sind Diatomeen-Zuchten notwendig.

Zahlreiche Feinde, Parasiten und Krankheiten suchen Muschelbänke und "Parks" heim, wie die Räuber "Oyster Drill" (*Urosalpinx cinerea* (Say)) und "Slipper Limpet" (*Crepidula fornicata* (L.)), eine Meeresschnecke, deren Larven zwischen den Kiemen der Zuchtmuscheln leben und sich besorgniserregend in den Mytiliculturen der Baie du Mont Saint Michèle ausgebreitet haben, ferner die auch für den Menschen eßbare "Quahog-Muschel" *Mercenaria mercenaria* L. sowie *Macoma balthica*. In der Baie de Somme hat sich der Polychät *Pygospio elegans* als Ursache erhöhter Sterblichkeit und damit einer Krise in der Ostréiculture hervorgetan; auch *Nereis diversicolor* ist gefürchtet. "Austernfischer" (*Haematopus ostralegus* (L.)) und Sturmmöwe (*Larus canus* L.)sind gefräßige Muschelvertilger.

Gefährlich für die Farmen ist eine übermäßige Eutrophierung im Gewässer mit Algenarten, die den Muscheln nicht zur Ernährung dienen. Sie ist die Folge der Wasserverschmutzung und vermindert erheblich den im Wasser vorhandenen Sauerstoff. Die Muscheln leiden an Sauerstoffmangel und sterben.

Großen Einfluß hat ferner das Klima und damit die Temperatur im Gewässer. Bei einjährigen *Crassostrea gigas* im Bassin d'Arcachon wurde eine hohe "Sommer-Sterblichkeit" festgestellt, die sich über die ganze Baie ausbreitete, analog dem Befund in der Baie de Seine und bei *Pecten maximus* in USA und Japan. Ursache war die starke Verschmutzung des Wassers in der Aquakultur; sie hatte die Widerstandsfähigkeit der Larven und erwachsenen Muscheln außerordentlich geschwächt, so daß sie dem Streß der Hitze erlagen.

1986 erschien eine Arbeit über die alarmierend hohe Sterblichkeit der Jungmuscheln in der Baie de Somme; außerdem zeigten sich Anomalien im Wachstum. Auch hier war die Ursache die starke Verschmutzung des Meerwassers im Biotop. Dasselbe Phänomen findet sich heute in den Zuchten der Perlaustern, so daß gebietsweise die Perlenzucht stillgelegt werden mußte.

Die wichtigsten Begrenzungsfaktoren für Muschelbänke und Aquakulturen sind:

1. Bedingungen des Klimas: Hitze, Kälte
2. Überfischung, vorwiegend unkontrolliertes Fischen, dadurch ungenügende Menge an Muschelbrut ("Saat")
3. Zerstörung des ökologischen Gleichgewichts durch den Menschen mit der Folge der Begünstigung der Feinde (*Macoma balthica*, *Pygospio elegans* u.a.)
4. Starke Verschmutzung der Küstengewässer
5. Folge: erhöhte Krankheitsbereitschaft und Sterblichkeit der Muscheln sowie
6. Geringer werdende Eiproduktion der Zuchtmuscheln und
7. Schädigung und damit Rückgang des für die Ernährung wichtigen marinen Phytoplanktons.

Die in den Atlantik mündenden stark belasteten großen Flüsse Elbe, Rhein und Rhône schwemmen ihre Umweltchemikalien in die Schelfmeere und Buchten der Küste, sodaß die Muschel- und Phytoplankton-Kulturen stark beeinträchtigt werden. Außerdem wurden in tropischen Meeren, im Ostpazifik, Adriatischen Meer und in der Ostsee (Baltisches Meer) Radionuklide, Thorium und Uranium auch im Phytoplankton

festgestellt. Für die Industrie der marinen Lebensmittel des Menschen ist das ein in Zukunft sich weiterhin verschärfendes Problem.

1.2.1 Cephalopoden

Obwohl auch Kopffüßer ein beliebtes Nahrungsmittel vorwiegend für Bewohner von Südeuropa sind, gibt es kommerzielle Zuchten relativ spät im Vergleich mit Schnecken und Muscheln. Die erste Aufzucht gelang in Europa 1966 im Berliner Aquarium mit *Sepia officinalis* L., die erste kommerzielle Aquakultur in Japan zu Beginn der 80er Jahre mit *Octopus vulgaris* Lamarck.

Die bisherigen Publikationen beziehen sich auf folgende Cephalopoden-Arten, von denen aber nur wenige für kommerziellen Gewinn in Frage kommen, wie in Japan und Frankreich (Ile d'Oléron, Port-en-Bassin/Calvados):

Sepia officinalis L.	- Frankreich, Normandie, Monaco
Sepia lycidas	- Japan
Sepiella japonica	- Japan
Sepia latimanus Quoy & Gaimard	- Japan
Eledone moschata	- Japan
Eledone cirrhosa Lamarck	- Japan
Dorytheutis bleekeri	- Japan (für physiologische Studien)
Octopus briareus	- Miami (USA)
Octopus joubini Robson	- Texas (USA).

Laborversuche wurden durchgeführt mit *Eledone cirrhosa*, *Dorytheutis bleekeri*, *Illex illecebrosus* Lesueur, *Loligo pealeii*, *Loligo opalescens*, *Loligo vulgaris*, *Octopus vulgaris* Lamarck, *Octopus dofleini* Wülker, *Octopus bimaculatus* Verrill, *Todarodes pacificus* Steenstrup.

2. Schmuck

Den Mollusken kommt große Bedeutung für den Menschen als Schmuckobjekt zu, insbesondere als Perlenlieferanten. Ein großer Industriezweig beschäftigt sich damit. Schönheit, Farbenpracht der Schalen, die früher geheimnisvolle Herkunft der Perle haben den Menschen schon früh veranlaßt, sich mit ihnen zu schmücken, aus profanen oder rituellen Gründen.

2.1 Perlen (Natur- und Zuchtperlen)

Die Perle entsteht in der Muschel als Folge der Immunreaktion gegen fremdes Gewebe, wenn zwischen ihr und der Perlmutterschicht ihrer Schale ein Fremdkörper (Fischei, Alge, Sandkorn u.a.) eingedrungen ist. Die Muschel kapselt ihn ab; das Mantelgewebe der Muschel bildet den "Perlsack", der Perlmutterschichten um den Fremdkörper absondert.

Die **Natur-(Orient)-Perle** wächst ohne Einfluß des Menschen. Im Orient gab es Perlen bereits um 2500 v. Chr.; Hauptlieferant waren aus dem Meer, meist Persischen Golf, gefischte *Pinctada*-Arten. Im Mittelalter kam sie mit dem Handel aus dem Orient nach Europa, daher ihr Name.

Naturperlen waren früher auch in Europa aus Süßwassermuscheln (*Unio*- und *Anodonta*-Arten), hauptsächlich aus der Flußperlmuschel *Margaritifera margaritifera* L. bekannt. Um 1729 bestand eine erfolgreiche "Perlenfischerei" in den Flüssen des Fichtelgebirges und im Main; heute allerdings ist sie verschwunden.

Der großen Nachfrage wegen stehen nun die **Zucht-(Kultur)-Perlen** im Vordergrund. Sie sind eine wichtige Einnahmequelle für Japan, China, die Inseln des Pazifik sowie Borneo, Tahiti, Neu-Guinea u.a. geworden.

Die Zuchtperle bildet sich durch vom Menschen stimulierte Abkapselung des in die Muschel hineinoperierten Fremdkörpers, ein Perlmutterkügelchen aus der Schale einer Süßwassermuschel. In den japanischen Schelfmeeren werden die operierten Muscheln in netzartigen Körben in 6 m Tiefe gehalten; Perlernte ist nach zwei bis drei Jahren. An den Küsten von Nordaustralien, Thailand, Indonesien, Philippinen leben die Muttermuscheln frei im Meere in 30 bis 40 m Tiefe; Ernte der Perlen nach ein bis drei Jahren. Die wichtigsten Muscheln sind *Pinctada* sp. und *Pteria penguin* Röding.

Aus Meeresschnecken stammen Abalone-Perlen (*Haliotis*-Arten) und Conch-Perlen (*Strombus gigas*). Deren Zuchten liegen an den Küsten von Florida, im Golf von Kalifornien (USA), Mexiko und Ostasien.

Perlen aus Süßwassermuscheln liefern heute China und Japan. Gewonnen werden sie aus *Hyriopsis schlegeli* (Martens) (Japan, Biwa-See) und *Cristaria plicata* (Leach) (China).

Auch die Perlenzucht wird durch viele Faktoren behindert, wie Räuber (Seesterne, große Krabben u.a.), heftige, bis zum Meeresgrund reichende Winterstürme und neuerdings die starke Umweltbelastung der Küstengewässer mit Chemikalien und Öl.

2.2 Gehäuse, Schalen rezenter und fossiler Mollusken

Schon die frühzeitlichen Bewohner in Europa, die Sarmaten und Hunnen der Ungarischen Tiefebene, kannten diesen Schmuck. Sie erhielten ihn im Handel mit den Arabern und demonstrierten damit ihren Reichtum. Beliebt waren Ammoniten. Als besonders wertvoll gelten die seltenen "Opal"-Schnecken und –Muscheln aus echtem Opal (Fundorte in den White Cliffs von Australien).

3. Bekleidung

Pupurstoffe, "Meeresseide", Kleiderschmuck

Schon um 1600 v. Chr. waren *Murex*-Arten als Spender für die Purpurfarbe bekannt und die Purpurstoffe der Phönizier und Kreter ("Tyrian-Purpur") begehrt. Im England des Mittelalters war die Meeresschnecke *Nucella lapillus* L. (Dogwelk, pourpre pierre) der Spender. Schneckenfang und Farbstoff-Gewinnung verlagerte sich später nach Japan, China, Malaysia und Zentral-Amerika der vorkolumbianischen Epoche.

Heute gewinnen die Naturfarbstoffe aus "Färbepflanzen", Farbstoffinsekten, Mollusken und Naturpigmenten zum Färben und Bedrucken von Textilien, Leder und Papier wieder an Bedeutung. Neben den Purpurschnecken (*Murex* sp., *Nucella* sp.) und Tintenschnecken (*Thais* sp.) spielt neuerdings auch der *Sepia*-Farbstoff (Sepia-Melanin) von *Sepia officinalis* L. eine Rolle.

Die langen seidigen Fäden aus der Byssusdrüse von *Pinna nobilis* L. wurden zur "Meeresseide" versponnen, ein kostbares Gewebe für Handschuhe und Strümpfe.

Knöpfe, Schnallen aus dem irisierenden Perlmutter, meist von *Pinctada* sp. und *Haliotis* sp. und besonders die ornamentalen Perlenstickereien sind auch heute ein beliebter Kleiderschmuck.

4. Schutz- und Heilmittel

4.1 Symbol, Talisman, Maske

Schon in der Frühzeit des Menschen waren Schnecken und Muscheln Symbole im täglichen Leben und in den Religionen, ferner Talisman gegen Krankheit und zur Abwehr von Ungemach. Die Mollusken stellten Gottheiten dar oder wurden mit diesen in Verbindung gebracht. Sie schmückten die Schädel von Verstorbenen. Schnecken, Muscheln und Perlen waren und sind noch in vielen Religionen Symbole für Auferstehung und Wiedergeburt. Da die Schnecke ihre Fühler und den Kopf aus dem Gehäuse strecken und wieder einziehen kann, ist bzw. war sie das Symbol für den Mond, der ab- und zunimmt. In Indien ist sie auch Symbol für stetige Erneuerung. Weinbergschnecken gelten in Europa als Glücksbringer und zieren daher Masken und Gewänder zur Fasnacht. Die Orientperle ist in China das Symbol für die Sonne, die als größtes Wertobjekt der Erde angesehen wird. Wegen ihrer Härte und relativ langen Lebensdauer war sie auch Sinnbild für die Unsterblichkeit. Die Reihe der Beispiele ist lang.

4.2 Heilmittel, Medikament

Die Volksmedizin des Mittelalters schrieb den Belemniten beachtliche Heilkräfte zu. Sie galten wegen ihrer gelben Farbe und des Geruchs als versteinerter Luchsharn. Sie wurden angewandt bei Nieren- und Blasensteinen, Hexenschuß, Seitenstechen, Asthma und sogar Augenleiden. In Europa wurden Mollusken eingesetzt gegen Husten, Halsweh, Zahnschmerzen, Schwindsucht u.a. Der Schleim von Meeresschnecken wirkt schmerzstillend und ist bakterizid.

Heute gibt es sogar Medikamente mit Wirkstoffen aus Schnecken und Muscheln: Sirup aus Weg- und Egelschnecken gegen Husten, Bronchitis, Verschleimung der Atemwege; Muscheln helfen gegen Schmerzen bei Rheumatismus und Arthritis. Die Südseemuschel *Perna canaliculus* (Fam. *Mytilidae*) ist der Wirkstoff für ein Antirheumatikum des Handels und wird zu diesem Zweck sogar an den Küsten von Neuseeland gezüchtet.

5. Begleiter im Tagesverlauf

5.1 Gebrauchs- und Ziergegenstand

Die Mollusken dienen dem Menschen in jeder Beziehung. Sie sind sein Werkzeug, Eßgeschirr, Trinkgefäß, Ersatz für Fensterglas, Zierschalen, Lampenschirme, Vasen u.a. Es gibt viele Möglichkeiten ihrer Verwendung als Original oder Modell für Nachbildungen in Porzellan, Keramik, Glas, Metall oder Holz.

In Fernost und den Inseln des Indischen und Pazifischen Ozeans werden aus der Schale der großen Auster *Placuna placenta* ("Window-Pam") durchsichtige "Fensterscheiben" hergestellt, ein wichtiger Exportartikel für die Philippinen. Im Europa des 16. und 17. Jahrhunderts lag der Trend bei kunstvoll gravierten Prunkpokalen aus dem Gehäuse von *Nautilus pompilius* L. Die Völkerkunde- und Naturkunde-Museen der Welt haben ein reichhaltiges Anschauungsmaterial.

5.2 Kommunikation: Signalgeber, Zahlungsmittel, Postsache, Dokument

An der Kommunikation von Mensch zu Mensch sind schon seit altersher die Mollusken beteiligt. Die alten Griechen und Römer kannten das Tritonshorn aus Meeresschnecken (*Charonia tritonis* L.). Die Gattung *Charonia* gehört heute zu den bedrohten und daher geschützten Arten. Bekannt als Zahlungsmittel ist die Porzellanschnecke *Cypraea moneta* L., die echte Kauri. Im Altertum war sie das "Geld" in Südostasien, Indien, Japan, China u.a. Sie kam mit dem Handel nach Europa und wurde hier "Indische Valuta" genannt. Es gibt noch das Perlschalengeld "Tapsoka" und das "Dewarra-Geld". Im Postverkehr werden Mollusken auf Karten, Briefmarken und Schmucktelegrammen abgebildet. Bei den Küstenindianern von Südamerika waren die "Wampum" als Garant für die Einhaltung von Verträgen üblich, geheiligte Bänder mit Ornamenten aus weißen und roten Stücken von *Mercenaria*-Schalen.

5.3 Namensgeber: Körperteile (Mensch, Tier); Bereich der Wirtschaft und Technik

"Schnecke", "Muschel" oder "Perle" heißen Körperteile, Apparaturen und Vorkommnisse, wenn deren Aussehen oder Funktion den betreffenden Mollusken entsprechen. "Schnecke" des Innenohres, "Perlen" für makellose Zähne u.a. Das Wort "Perle" ist der Inbegriff des Guten und Schönen, während "Krake" Mißbilligung ausdrückt. Bei Lebensmitteln finden sich Perlzwiebeln, Austernpilz, "Schnecke" als Backwerk, "Meeresfrüchte"-Pralinen u.a.

Die stilisierte *Pecten*-Muschel des Shell-Konzerns ist ein Beispiel aus der Wirtschaft. Die Technik besitzt "Schneckengetriebe" und "Schneckengang" u.a.

6. Kunst

6.1 Architektur (Volute, Koncha, Rocaille, Shellwork, Intarsie)

Bereits in der Antike waren die Mollusken Modelle für Bauelemente, und sie haben die Architektur um Volute, Koncha und Rocaille bereichert. Die Volute ("Eingerollte", Schnecke) ist bei der ionischen Säule der Griechen und Römer der Abschluß des oberen Teils. Im Barock und Rokoko schmückte sie als "Volutengiebel" den First der Häuser vorwiegend in Holland. Der Koncha-("Muschel")-Stil mit der überdachten, an eine *Pecten*-Muschel erinnernden Nische ist in der altrömischen Baukunst für Tempel entwickelt und später von der altchristlichen übernommen worden. Rocaille-("Muschel")-Ornamente zierten im 18. Jahrhundert als kunstvolle Schnörkel aus Stuck Wände und Decken der Kirchen und Gebäude. Das französische "Style Rocaille" für Rokoko weist auf den Zusammenhang mit "Muschel" hin.

Grottenarbeiten (Shellwork) gewannen im Italien des frühen Mittelalters an Bedeutung. Perlmutter war ein beliebtes Material für die Intarsien als Schmuckelement bei Möbeln, Musikinstrumenten und Luxusgegenständen in der Renaissance und im späten Barock.

6.2 Malerei, Graphik, Zeichnung und Literatur (Roman, Erzählung, Märchen, Satire, Sprichwort)

In diesen Künsten sind die Mollusken häufig sogar die Hauptfiguren. Es gibt unzählige Beispiele. GODAN (im Druck) nennt Maler und Graphiker, auf deren Bildern Schnecken, Muscheln und Kopffüßer im Vordergrund stehen oder eine Perle als Symbol. Die Mollusken sind auch in der Literatur Akteure. Die weniger beliebten Kraken sind Leitfiguren in der Satire und im humoristischen Sprichwort.

7. Forschung

7.1 Objekte zum Studium der Lebensfunktionen des Menschen (Physiologie, Immunität u.a.)

Es gibt viele Gemeinsamkeiten zwischen Mollusken und Säugetieren, wie die umfangreiche Liste der Publikationen zeigt. So sind die Mollusken in vieler Beziehung als Forschungsobjekte zum Studium der Lebensabläufe des Menschen geeignet und werden jetzt immer häufiger herangezogen. Das trifft zu für Stoffwechselvorgänge, Biochemie des Nervensystems, Herzfunktion, Blutkreislauf, hormonale Steuerung der Fortpflanzung, Immunität, Karzinom-Entwicklung u.a.

Eine umfassende Übersicht findet sich bei GODAN (1983; und im Druck). WILBUR & YOUNGE (1966) bringen Details der Physiologie der Mollusken in den Kapiteln: 1. Feeding, 2. Digestion, 3. Feeding and Digestion in Cephalopods, 4. Heart, Circulation and Blood Cells, 5. Respiration, 6. Molluscan Hemoglobin

and Myoglobin, 7. Molluscan Hemocyanins, 8. Pigmentation of Molluscs, 9. Carbohydrate Metabolism, 10. Nitrogen-Metabolism, 11. Excretion, 12. Physiology of the Nervous System, 13. Sense Organs (less Cephalopods), 14. Cephalopod Sense Organs, 15. The Brain and Behavior of Cephalopods.

RUSSEL-HUNTER (1979) gibt folgende für die Forschung nützliche Informationen:
19. General Characteristics of Molluscs
20. The Evolution of Gastropods
21. The Trials of Nonmarine Molluscs
22. The Evolution of Filter-feeding Bivalves
23. Functional Aspects in Snails and Bivalves
24. Invertebrate Zenith: The Cephalopods
25. Toward Perception: Memory and Learning
26. Minor Molluscan Group and Phylogeny.

Die Larven der Miesmuscheln werden für Bioassay-Tests verwendet. Austern dienen als Versuchstiere zur Erforschung der Kalzifikation des Wirbeltierknochens; zum Studium des Reparaturverlaufs nach Beschädigung. Wie bei den Vertebraten und damit dem Menschen umfaßt der Stoffwechsel der Mollusken den Kohlenhydrat-, Protein- und Lipid-Metabolismus. Kohlenhydrate und Glukose sind ebenfalls Nahrungsreserven für eine längere Hungerperiode. Glukose ist ein normaler Bestandteil des Schneckenblutes und seine Konzentration steigt bei Nahrungsaufnahme. Die Mollusken produzieren Dopamin, Serotonin, Lipide, Triglyzeride, Phosphorlipide, Cholesterin, Enzyme und Hormone, sogar Östrogen. Sie sind daher Studienobjekte für die entsprechenden Bereiche des Menschen. Ihre Enzyme haben biochemische und bakterizide Eigenschaften. So wurde in *Mercenaria* eine Substanz entdeckt, die bei Mäusen eine tumor- und leukämiehemmende Wirkung aufwies. *Mytilus canaliculus* besitzt einen Stoff mit antirheumatischem Effekt.

Im Darmtrakt kommen proteolytische Enzyme vor. So spaltet der aus dem Magensaft der Weinbergschnecke hergestellte Extrakt Cellulose, Hemicellulose und Pektin und kann zur Mazeration von Pflanzenmaterial verwendet werden. Die Mitteldarmdrüse von *Ostrea edulis* produziert neben Enzymen auch Substanzen von insulinartiger Wirkung.

Gastropoda und Bivalvia besitzen ein offenes Kreislaufsystem, aber Cephalopoda ein geschlossenes mit Arterien, Venen und Kapillaren wie der Mensch. Ihre Blutzellen sind amöboid beweglich und können agglutinieren. Die Herzschlagfrequenz unterliegt ebenfalls der hormonalen Steuerung.

Die Nervenzellen ähneln in Eigenschaften und Wechselwirkungen den Neuronen der Vertebraten, und so erfährt die Neurophysiologie der Mollusken wachsendes Interesse. Bei den am höchsten entwickelten Mollusken, den Cephalopoden, und Säugetieren gibt es Analogien im Bereich des Gehirns. Es bestehen ferner Gemeinsamkeiten im Bau und in der Funktion der Sinnesorgane. So besitzt das Auge der Kopffüßer Cornea, Linse und Retina und ermöglicht ein scharfes Bild der Umgebung, sogar ein räumliches Sehen und wahrscheinlich auch für Farben. Cephalopoden besitzen ein Kurzzeit- und Langzeitgedächtnis, wie der Mensch. Schnecken (*Limax flavus* L. u.a.) können lernen und eine Situation bis zu drei Tagen in Erinnerung behalten.

Das **Immunsystem** der Mollusken ähnelt dem der Säugetiere und des Menschen. Es gibt amöbiod-bewegliche Zellen (Amöbozyten) im Blut, die den Lymphozyten des Menschen entsprechen. Sie sind wie diese zuständig für die Erkennung eines Fremdkörpers im Blut und Gewebe, das Einfangen und Auffressen eingedrungener Viren und Bakterien, für die Wundreaktion und Reparatur zerstörten Gewebes. Die Amöbozyten können wie die weißen Blutkörperchen des Menschen die Wand der Gefäße durchdringen. Auch werden Antikörper (Haemagglutinine) gebildet, wenn artfremdes Eiweiß in Blut und Gewebe gelangt ist. Die Mollusken sind daher für die Immunhaematologie-Forschung zur Klärung der entsprechenden Funktionen des Menschen sehr nützlich.

Maligne Tumore als Folge von Störungen im endokrinen und nervösen System oder von Parasiten gibt es bei den Mollusken häufig. Ihre Widerstandskraft ist in diesem Falle erheblich geschwächt, wie beim Menschen, mit dem Resultat erhöhter Krankheitsbereitschaft und Sterblichkeit. Karzinome können bei Schnecken sogar experimentell ausgelöst werden, wie Versuche mit 0,2%igem Crotonöl bei *Ampullaria australis* (Orbigny) erwiesen haben. Die nach 95 bis 100 Tagen entstandenen Epitheltumore in der Nähe des Gehäusedeckels ließen sich sogar in das Tumor-Schema der höheren Wirbeltiere einordnen.

7.2 Indikatoren für Belastungen der Umwelt und tektonische Veränderungen

Auf Beeinträchtigungen ihres Biotops reagieren die Mollusken äußerst empfindlich, so daß sie als **Indikatoren** für den Verschmutzungsgrad der Flüsse, Seen, Küstengewässer und Landgebiete eingesetzt werden. Sie speichern die Umweltchemikalien im Körper und akkumulieren sie in Werten, die wesentlich höher als im Wohngebiet sind. Bei *Physa* wurde ein DDT-Rückstand gemessen, der 15.000 mal größer war. In *Mytilus edulis* fanden sich 7.000 mal höhere Werte als im kontaminierten Wasser. Muscheln eignen sich als Indikatoren für Chlorkohlenwasserstoffe und Phosphorsäureester in den Küstengewässern. Auch Schwermetalle werden aufgenommen und akkumuliert. Das Speichervermögen ist in den Organen verschieden, am größten ist es in Leber und Gonade, wie sich bei *Cepaea hortensis* gezeigt hat.

Land- und Meeresschnecken sowie Süßwasser- und Meeresmuscheln haben sich als gute Indikatoren sogar für kleinste Rückstandsmengen erwiesen. Forschungen über Umweltbelastung im Ökosystem werden daher außer mit Wasserpflanzen, Krabben, Fischen und Insekten heute auch mit Mollusken durchgeführt. In Frage kommen bisher: *Arion rufus* (L.), *Arianta arbustorum* L., *Physa acuta* Draparnaud, *Viviparus ater* (Christopheri & Jan), *Biomphalaria glabrata*, *Unio*-Arten, *Anodonta cygnea* (L.), *Crassostrea virginica* Gmelin, *Mytilus edulis* L., *Venus japonica* (Gmelin), *Chlamys opercularis* (L.), *Pecten maximus* L., *Mercenaria mercenaria* L. *Rangia cuneata* (Gray), *Perna perna* (L.) und *Marisa cornuarietis* (L.) (hauptsächlich für TBT).

Relativ viele dieser Arten spielen eine Rolle in der Phyto-, Human- und Veterinärmedizin, wie auch in der Aquakultur. Eine Übersicht der Einzelheiten bringt GODAN (im Druck).

Als Indikatoren für tektonische Veränderungen der Erdkruste könnten Löcher von Bohrmuscheln dienen. Zum Beispiel: An den Säulen des Serapeion zu Pozzoli nahe Neapel bilden sie in zwei Meter Höhe ein breites Band, möglicherweise der Beweis dafür, daß die dortige Küste in der Antike unter Wasser gelegen hat und der Säulenfuß vom Meerwasser umspült war. Inzwischen hat sich die Küste gehoben mit der Folge, daß die Säulen jetzt auf dem Land stehen. Gegenwärtig senkt sich die Küste.

III. Der Mensch als "Geschädigter", die Mollusken als "Feind"

1. Phytomedizin

1.1 Pflanzenschutz
1.2 Vorratsschutz
1.3 Schadwirkung durch nicht-heimische vom Menschen verschleppte Schneckenarten
Quarantäne

Die "Phytomedizin"-Review wird in einem der nächsten Hefte der "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem" erscheinen.

2. Human- und Veterinärmedizin
Übertragung von Krankheiten

Die Mollusken bedrängen auch die Gesundheit von Mensch und Tier. Mit diesem Problem befassen sich die 1985 gegründete "International Society for Medical and Applied Malacology" und die folgenden Zeitschriften:

Acta Tropica
Amer. J. Hyg.
Ann. Trop. Med. Parasitol.
Bull. Appl. Parasitology
Bull. Soc. Pathol. Exot.
Bull Wld. Hlth. Org. (WHO)
Haliotis
Helminthol. Abstr.
Int. J. Parasitol.
J. Invert. Pathol.
J. Medical and Applied Malacol.
J. Trop. Med. Hyg.
Malacologia
Parasitologie
Parasitology

Revista di Parasitologia
Z. Parasitologie
Z. Parasitenkunde.

Schnecken und Muscheln können dem Menschen beim Waten und Baden gefährlich werden. Beispiele: Die Fechterschnecke *Strombus* sp. im Flachwasser der warmen Meere kann mit ihrem hornigen sichelförmigen Gehäusedeckel blutende Wunden zufügen. *Conus*-Arten der Südsee setzen als "Waffe" ihre stilett- oder pfeilförmige Radula ein, deren Stich tödlich sein kann. *Tridacna gigas*, die größte Muschel der Welt, schlägt bei Berührung des Mantelrandes die sonst weit geöffneten Schalenklappen schnell und kräftig zusammen und verletzt den Fuß des unachtsamen Menschen.

Von großer Bedeutung sind vor allem die Schnecken als Überträger von Wurmkrankheiten. Sie sind Transport- oder Zwischenwirte für parasitische Würmer bei Mensch und Haus- sowie Nutztier.

2.1 Transportwirte

Schnecken verschleppen Pilzsporen, Viren, Bakterien, Salmonellen und Wurmeier mit ihrem Körperschleim oder über ihren Darmtrakt. Beim Freßvorgang der Schnecke gelangen die Krankheitserreger auf Gemüse, Kopfsalat, Erdbeeren, Fallobst, Kresse u.a. Die Infektion des Menschen mit Enteroviren (Erreger der Hepatitis A) ist möglich, wenn Austern und Clammuscheln verzehrt werden, die aus einem Areal im Meere nahe von Abwassereinleitungen stammen. Am Körper der Ackerschnecke (*Deroceras reticulatum*) können Eier des Spulwurms (*Ascaris lumbricoides* L.) und des Peitschenwurms (*Trichuris trichiura* L.) haften und auf Gemüse, Erdbeeren u.a. abgestreift werden.

2.2 Zwischenwirte im Entwicklungsverlauf von Wurmparasiten bei Mensch und Tier

2.2.1 Badedermatitis

Hautreizungen oder Hautausschlag mit Quaddeln, Pusteln und Juckreiz treten im Hochsommer bei längerer Schönwetterperiode auf, wenn in Tümpeln, Bagger- und natürlichen Seen gebadet oder auch nur gewatet wird. Verursacher sind u.a. Zerkarien von Wildenten-Trematoden mit Schlammschnecken als Zwischenwirte.

2.2.2 Parasitische Würmer: Trematoden, Nematoden, Zestoden

Für die meisten Wurmkrankheiten in der Human- und Veterinärmedizin sind Zwischenwirte (Süßwasser- oder Landschnecken) notwendig. Ohne sie kann die Entwicklung des Wurms vom Ei bis zum adulten Tier im Endwirt nicht vollendet werden. Es besteht sogar eine enge Beziehung zwischen dem Überleben der Wurmlarve in der Schnecke und der Dichte deren Körpergewebes. Denn nur in einem lockeren Gewebe mit Kollagen- und Muskelfasern kann sich die eingedrungene Wurmlarve bis zum infektiösen Stadium entwickeln. Ein weiterer Vorteil für das Überleben der Larve ist die Möglichkeit der Schnecke, sich vor nachfolgenden Eindringlingen zu schützen und damit die Anzahl der in ihrem Körper parasitierenden Wurmlarven zu begrenzen. Die bereits eingedrungenen relativ wenigen Larven haben somit gute Entwicklungschancen. Das Überleben der Wurm-Species wird auch dadurch gesichert, daß Zwischenwirt und Endwirt im selben Gebiet ständig oder zeitweise leben.

Den Menschen befällt die infektionsbereite Wurmlarve entweder passiv, wenn dieser kontaminiertes Gemüse, Fallobst, Kresse u.a. verzehrt, oder aktiv, indem sie in die Haut des Menschen eindringt, wenn er in kontaminiertem Wasser badet oder watet.

Die in der Human- und Veterinärmedizin bedeutenden Wurmarten mit Schnecken als Zwischenwirte, deren Infektionsorte und -weise, ihr Vorkommen weltweit hat GODAN (im Druck) aufgelistet. KILIAS & FRICK (1963) haben die wichtigsten Haus- und Nutztier-Helminthen in Mitteleuropa beschrieben. Weitere Informationen liefern die anfangs genannten Zeitschriften und die Bibliographie zu diesem Kapitel.

Die wichtigste Wurmkrankheit des Menschen heutzutage ist die **Bilharziose** (Schistosomiasis) in Afrika, Asien, Südamerika bis Japan. Sie war bereits eingedämmt, kehrt jetzt aber zurück und ist in Afrika (Ägypten, Sudan, Westafrika) im Vormarsch, eine Folge der umfangreichen Bewässerungen zum Wohle der Produktion in der Landwirtschaft vor mehreren Jahren, aber für die Gesundheit des Menschen von Nachteil. Denn jetzt finden die Zwischenwirte der Wurmparasiten optimale Lebensbedingungen in den nun feuchten Gebieten, die früher trocken und für Süßwasserschnecken feindlich gewesen sind.

Wurmarten, die Schnecken als Zwischenwirte für ihre Entwicklung benötigen, haben den Menschen entweder als einzigen Endwirt oder als gelegentlichen bei Dominanz der Tiere, während bei anderen Wurmarten die Haus- und Nutztiere den einzigen Endwirt darstellen.

Trematoden (Saugwürmer) von humanmedizinischer Bedeutung:
Der Mensch - einziger Endwirt:
Schistosoma haematobium (Bilharz): Venen der Harnblase
Zwischenwirt: *Bulinus*-Arten
Mittelmeerländer, Afrika, Europa, Vorderer Orient
Schistosoma mansoni Sambon: Venen der Darmwand, des Bauchfells
Zwischenwirt: *Biomphalaria*-Arten
Ägypten, Sudan, Kongo, Südamerika
Schistosoma japonicum Katsurada: Venen der Darmwand, des Bauchfells
Zwischenwirt: *Oncomelania*-Arten
Japan, China, Taiwan, Philippinen u.a.

Der Mensch - gelegentlicher Endwirt:
Fasciola hepatica L. (Großer Leberegel): Leber, Gallengänge
Zwischenwirt: Süßwasserschnecken, etwa 14 Arten, u.a. *Galba truncatula* ("Leberegelschnecke"), auch in Kresse-Kulturen; *Lymnaea tomentosa* in Australien u.a.
Weite Verbreitung in Europa, Nordamerika, Mexiko, Südamerika, Australien.

Nematoden (Rundwürmer) von humanmedizinischer Bedeutung:
Der Mensch - einziger Endwirt:
Angiostrongylus cantonensis Chen (Lungenwurm): Lungenarterie, Ödeme, wahrscheinlich Meningoenzephalitis
Zwischenwirt: Landgastropoden: Nacktschnecken *Limax* sp. (auch *Deroceras reticulatum*), *Arion* sp.; Gehäuseschnecken: *Achatina* sp., *Bradybaena* sp., *Pomacea paludosa*, *Veronicella* sp. u.a.; Auster: gelegentlich?: Fund in Kuba: *Crassostrea rizophora*
Transportwirt: Süßwassergarnelen, Krabben, Krebse, Planarien u.a.
Infektion des Menschen durch Verzehr von rohen Garnelen, Schnecken u.a. in Salaten u.a.
Südostasien, Pazifische Inseln, Hawaii, Kuba, Tahiti, Taiwan, China u.a.

Zestoden (Bandwürmer) von veterinärmedizinischer Bedeutung:
Geflügel-Farmen (Hühner, Gänse, Enten, Fasane)
Davainea proglottina Davaine: Darm (sehr pathogen)
Zwischenwirt: terrestrische Nacktschnecken: *Arion* sp., *Limax* sp., *Milax* sp.
Europa

2.2.3 Bekämpfung der Schnecken-Zwischenwirte
Unabhängig von der guten Toxizität für den Schnecken-Zwischenwirt kann ein Molluskizid bei der Bekämpfungsaktion dennoch versagen, aus folgenden Gründen:
1) Hinaufkriechen der Schnecken aus dem behandelten Wasser auf das wirkstoffreie Ufer, herausragende Reis- und Krautbüschel u.ä.
2) Eingraben der Schnecke in den Bodenschlamm, dessen Wirkstoffkonzentration geringer ist als im Wasser darüber.
3) Wiederbesiedlung des behandelten Gewässers aus der unbehandelten Umgebung.
4) Konzentrationsabfall des Wirkstoffes im Gewässer bei starker Zirkulation und Turbulenz im Wasser.
5) Dichter Pflanzenbewuchs am Ufer oder Gewässerboden, ungünstiger Säuregehalt des Wassers u.a.
6) Wirkstoff-Ausfällung.
7) Einfluß der Sinkgeschwindigkeit des Molluskizids von der Oberfläche zum Boden des Gewässers.

Die in Frage kommenden Landschnecken gehören vorwiegend zu den in der Phytomedizin wichtigen Arten, so daß die verschiedenen Bekämpfungsmethoden dort besprochen werden. Für sie treffen die bei Süßwasserschnecken angeführten Gründe nicht zu.

Gegen die Süßwasserschnecken-Zwischenwirte können chemische und nicht-chemische Mittel eingesetzt werden.

Von pflanzlichen Molluskiziden kommen Saponine in Frage. Sie werden gewonnen aus *Zygophyllaceae*, *Sapindaceae* ("Damsissa"-Präparat), *Leguminosae* und *Phytolaccaceae* ("Endod"-Beeren). Speziell gegen *Biomphalaria alexandrina* (Ehrenberg) sollen "Damsin" aus der ägyptischen *Ambrosia maritima (Compositae)* und Aceton-Extrakt aus *Euphorbia lactea* (Haw). (*Euphorbiaceae*) helfen. Extrakte aus *Polygonum*

senegalense Meissner (*Polygonaceae*) sind starke Mittel gegen *Lymnaea natalensis* (Krauss) und *Biomphalaria pfeifferi* (Krauss). Aridanin wird aus *Tetrapleura tetraptera* Taub. (*Mimosaceae*) gewonnen und hauptsächlich in Nigeria angewandt.

Das Insektizid Pyrethrum aus den getrockneten Blüten von *Chyrsanthemum*-Arten ist auch als Molluskizid anwendbar gegen *Radix auricularia* (L.), *Lymnaea stagnalis* (L.) und *Physa fontinalis* (L.). Das zunächst als Fungizid entwickelte Phebrol (sodium 2,5-dichloro-4-bromophenol) erwies sich toxisch für *Biomphalaria*, *Bulinus*, *Oncomelania* und sogar auch für deren Eier im Gewässer.

Von Predatoren spielt die Raubschnecke *Marisa cornuarietis* L. gegen *Biomphalaria glabrata* und *Bulinus* sp. eine Rolle, so daß sie in überfluteten und besonders feuchten landwirtschaftlich genutzten Flächen eingesetzt wird; sie wird sogar in Massen für diesen Zweck gezüchtet. Nur ist ihr Einsatz in Kressekulturen nicht möglich, zum Beispiel gegen *Lymnaeidae*, weil *Marisa* die Wasserkresse als Nahrung bevorzugt.
Pomacea-Arten helfen ebenfalls gegen *Biomphalaria glabrata*. Die Wasserwanze *Limnogeton fieberi* Mayr (*Hemiptera*, Fam. *Belostomatidae*) ist in Nordafrika auf Süßwasser- und amphibische Schnecken spezialisiert. *Sciomyzidae* ("marsh flies") (*Diptera*) sind in Europa nützlich (GODAN 1979, 1983). Zur biologischen Bekämpfung der Schistosomiasis ist ferner der Fisch *Astatoreochromis alluaudi* geeignet.

3. Beschädigung meerumspülter Bauten, Verstopfung der Kanalisationsrohre u.ä.

Bohrmuscheln richten Schäden an Holz- und Steinbauten im Küstenbereich an. Einsturzgefahr kann für Hafenanlagen, Pfeiler von Holzbrücken, Dämme u.a. bestehen. So war *Teredo navalis* L. die Ursache der großen Dammbrüche im Holland des 17. und 18. Jahrhunderts.

Zu den Bohrmuscheln mit reduzierter Schale und/oder "Bohrkopf" gehören: *Teredo navalis* L. (Bohrwurm, Schiffwurm, shipworm), *Pholas dactylus* L. (Common piddock), *Martesia striata* (L.), *Xylophaga atlantica* Richardson, *Petricola pholadiformis* Lamarck (American piddock) und *Lithophaga lithophaga* L. (Stein- oder Meerdattel). Die Schwert- und Scheidenmuscheln *Ensis ensis* (L.) (Atlantic, Jackknife Clam) und *Solen viridis* Say (Green Jackknife) sind durch parallele Schalenklappen charakterisiert.

Süßwassermollusken können bei Massenauftreten die Rohre in Kanalisationssystemen verstopfen, wie in den Niederlanden, wo die Muschel *Dreissena polymorpha* (Pallas) in Wasserwerken die Rohre der Speicherbecken verstopfte und die Schnecken *Physa acuta* Draparnaud, *Pseudosuccinea columella* Say und *Radix peregra* (Müller), die Reinigungsanlagen einer Kanalisation besetzten, so daß hier die Biofilter unbrauchbar wurden.

Petricola wurde um 1890 von Amerika nach England verschleppt und ist jetzt weit verbreitet in der Nordsee, im Atlantik bis Südnorwegen, Mittelmeer, Schwarzen Meer, Nordamerika u.a.

IV. Der Mensch als "Feind" der Mollusken

Belastung, Zerstörung der Biotope und des ökologischen Gleichgewichts

Eine intakte Umwelt ist für den Menschen notwendig. Er braucht sie für sein seelisches Gleichgewicht und damit seine Gesundheit. Doch er belastet seine Umwelt bis zur Zerstörung einzelner Areale. Viele Faktoren bedrohen die Biotope auch der Mollusken. Neben den chemischen sind es mechanische und physikalische. Der "Artenschutz" erfordert den "Biotopschutz". Mit der Umweltproblematik in bezug auf das Ökosystem beschäftigen sich eingehend BRAUNS (1985), der Pestizid-Report (1991) und die Zeitschriften Bull. Environmental Contamination and Toxicology (Verlag Springer international) und Fresenius Environmental Bull. (Verlag Birkhäuser, Basel). Einen Überblick der Belastungsfaktoren und ihrer Wirkungen bringt GODAN (im Druck). Es handelt sich um folgende:

1. Ausbreitung der Industrie, landwirtschaftlichen Nutzflächen, des Verkehrs u.a.

1.1 Nicht-chemische Veränderungen

Die Ausbreitung der Industrie, Landwirtschaft, Wohnsiedlungen, des Verkehrs u.ä. auf bisher "freie" Gebiete ist für alle Lebewesen ungünstig, auch ohne Belastung ihrer Biotope mit Umweltchemikalien. Mechanische und physikalische Veränderungen des Lebensraumes schädigen die Gesundheit der Mollusken. Das trifft zu für:

Landschnecken:

1. Starke Absenkung des Grundwasserspiegels infolge intensiver Bautätigkeit
2. Trockenlegung der Moore, Sümpfe, Feuchtwiesen
3. Starke Nitrat-Belastung der Äcker und Wiesen infolge übermäßiger Düngung mit Gülle aus Massentierhaltungen
4. Intensive Bodenbearbeitung der Äcker und Grünflächen

5. Vernichtung der "Unkräuter" in Feldrainen und Böschungen
6. Rodung, Abholzen, Beweiden; Verminderung der Wälder, Hecken, Brachflächen.

Süßwasserschnecken und -muscheln:
1. Begradigung der Flußläufe, deren Kanalisierung, Stauung, Verbauung der Ufer
2. Temperaturveränderungen im Gewässer infolge Einleitung von Warmwasser aus industriellen Kühleinrichtungen
3. Verschmutzung der Gewässer durch Einleiten von Abwasser aus Haushalten
4. Belastung durch stark phosphathaltige Haushaltsabwässer mit der Folge übermäßiger Eutrophierung der Algen und dadurch Sauerstoffmangel im Gewässer
5. Versalzung der Flüsse infolge zunehmender Salzfracht aus der Kali-Industrie
6. Zerstörung der Uferpflanzen.

Meeresmollusken:
1. Verschmutzung der Schelfmeere durch Einmündung der phosphatbelasteten großen Flüsse
2. Sauerstoffmangel und damit Atemnot infolge starker Eutrophierung des marinen Planktons
3. Anreicherung von Schwefelwasserstoff und Faulschlamm als Folge übermäßiger Eutrophierung des nicht mehr auf natürlichem Wege abbaubaren Planktons.

1.2 Belastung mit Schwermetallen, Pestiziden, Öl, organischen Stoffen

Zu den die Biomasse und das Ökosystem schädigenden Substanzen gehören Chlorkohlenwasserstoffe (DDT, Dieldrin, Endrin u.a.), Phosphorsäureester, Herbizide, Schwermetalle, Holzschutzmittel, Tributylzinn, Öl und auch der "Saure Regen", wie sich neuerdings erwiesen hat. Die Mollusken sind sehr empfindlich. Ihr Immunsystem wird außerordentlich geschwächt. Gehemmt werden Aktivität, Fortpflanzung, Koordinierung der Bewegungen, Kriechgeschwindigkeit, Herzschlagfrequenz u.a.; Krankheitsbereitschaft und Sterblichkeit sind erhöht. Carbamat-Rückstände blockieren die Cholinesterase-Aktivität mit der Folge zentraler Nervenlähmung und Muskelerschlaffung. Besonders empfindlich sind die Veliger-Larven.

1.2.1 Landgebiete

Äußerst negativ für Landschnecken wirkt sich die übermäßige Anwendung der Herbizide in der Landwirtschaft aus. Sie sind toxisch, wenn Schnecken kontaminierte Pflanzen fressen. Der Mensch selbst ist indirekt geschädigt: Durch die totale Vernichtung der Wildkräuter bei übermäßiger Herbizid-Ausbringung können die Schnecken nicht mehr auf die "Unkräuter" zurückgreifen, die sie möglicherweise den Pflanzen der landwirtschaftlichen Monokulturen vorziehen. Bei Massenvermehrung infolge günstiger feuchter Witterung sind daher die Schnecken ausschließlich auf die Kulturpflanzen angewiesen, um zu überleben. In diesem Falle bereitet also der Mensch selbst den Boden für deren Schadwirkung.

1.2.2 Flüsse, Seen, Meere und deren Küsten

Die Verschmutzung der Flüsse und Seen wird immer bedrohlicher, so daß Süßwassermollusken geringer werdende Chancen zum Überleben haben; ein Musterbeispiel ist die Flußperlmuschel *Margaritifera margaritifera* (L.) in Mitteleuropa.

Für die Mytili-, Ostréi- und Aquakulturen in den Küstenregionen hat die Belastung mit Umweltchemikalien verheerende Folgen, da der kommerzielle Gewinn in der Regel zunichte gemacht wird. Große Verschmutzer des Atlantik, insbesondere des Wattenmeeres, sind die Flüsse Elbe, Rhein und Rhône.

Herbizide belasten nicht nur Landschnecken, sondern auch Meeresmollusken, weil sie wie andere Pestizide, Schwermetalle und organische Stoffe aus den Flußmündungen in die Schelfmeere gespült werden. Beispiel: In der Baie d'Arcachon werden die Larven der *Crassostrea gigas* außerordentlich durch die Rückstände der Herbizide Atrazin und Simazin geschädigt und, was schwerwiegend ist, nicht nur die Austernlarven, sondern auch die zur Ernährung wichtigen marinen Algen *Chaetoceros calcitrans* und *Isochrysis galbana*.

In Europa trifft die Gefährdung sämtliche Meere: Nordsee mit dem Wattenmeer, Ostsee und Mittelmeer. Die Verschmutzung hat vor allem in der südlichen Nordsee zugenommen. Stichproben ergaben einen jährlichen Zuwachs an:

Quecksilber	-	110 Tonnen
Blei	-	21.800 Tonnen
Kupfer	-	19.500 Tonnen
Zink	-	107.100 Tonnen.

Pestizide wie Diazinon, Parathionmethyl, Herbizide u.a. wurden außer in Fischen auch in *Mytilus galloprovincialis* gefunden. Lindan, Heptachlor, Aldrin, Dieldrin, Endrin, DDT u.a. wurden in mehreren *Mytilus*-Arten festgestellt. Tributylzinn-Verbindungen, die als Schutz gegen Algenbesatz an Schiffsrümpfen eingesetzt werden, sind für *Mytilus edulis*, *Crassostrea virginica* und *Crassostrea gigas* sehr toxisch. In der Nordsee gibt es hohe TBT-Werte nicht nur infolge der Schiffsanstriche, sondern auch der Abwassereinleitungen aus Flüssen und Klärschlamm-Verklappungen (EBING & KIRCHHOF: Gas Chromatography of Pesticides, Tabular Literatur Abstracts, Series XVIII, Mitteil. Biolog. Bundesanstalt, Berlin-Dahlem, H. 275, 1992).

Die ständigen Ölbelastungen in Häfen durch küstennahe Industrieanlagen, Raffinerien, Schiffsverkehr, Tankerunglücke, Bohrinseln verursachen eine chronische Ölverschmutzung. Der Ölfilm auf der Meeresoberfläche behindert den Sauerstoff-Austausch zwischen Luft und Wasser. Auch die Mollusken auf dem Meeresgrund sind in Gefahr. Petroleum-Derivate und Kohlenwasserstoffe sind im Sediment und in *Mytilus edulis* gefunden worden.

Das in der Welt einzigartige Ökosystem "Wattenmeer" ist besonders gefährdet, zumal es mit der verschmutzten Nordsee weitläufig verbunden ist. Die Belastung mit Schadstoffen beruht ebenfalls auf dem Vorhandensein von Chlorkohlenwasserstoffen, Phosphaten, Schwermetallen, Ölresten u.a. In hoher Konzentration ist hier wie in der Nordsee das PCB (Polychlorbiphenyl) sogar im Sediment des Meeresbodens vorhanden. Das Wattenmeer enthält sämtliche Schadstoffe auch im Sediment, die dann von Schnecken und Muscheln im Körper gespeichert werden. So wurde Americium (^{242}Am) in *Pecten maximus* in hohen akkumulierten Werten ermittelt. Die Hauptverschmutzer sind Elbe und Rhein, die hochgradig mit Schwermetallen (Quecksilber, Cadmium, Chrom, Blei, Kupfer, Mangan, Nickel, Zink) verseucht sind. Dazu kommen die Folgen des Massentourismus, umfangreicher Eindeichungen, Entwässerungen und intensive Beweidung der angrenzenden Wiesen.

Für die Ostsee gilt das gleiche wie für die Nordsee. Ihre relativ geringe Tiefe von nur etwa 60 Metern (im Durchschnitt) macht sie für Belastungen besonders anfällig. Zur Ermittlung der Spuren von Schwermetallen und Radionukliden, zur Übersicht ihrer Ausbreitung und zur späteren Überwachung vorwiegend in Küstengebieten, doch auch im Meer, wurde um 1975 in Europa das "Mussel-Watch" - Projekt geschaffen ("Intercomparison of trace level constituent determination"). GOLDBERG (1975) nennt es "einen ersten Schritt zum globalen marinen Monitoring". Ihm haben sich u.a. auch Länder wie Taiwan angeschlossen. Als Indikatoren für "trace-metals" sind geeignet : *Mytilus edulis* L., *Mytilaster minimus* (Poli) und *Littorina littorea* (L.) u.a.. Außerhalb des "Mussel-Watch" - Projekts stehende Indikatoren sind in Kapitel II. 7.2 genannt.

2. Freizeitgestaltung

2.1 Massentourismus, Wandern, Camping, Surfen, Motorboote u.a.

Der Massentourismus zerstört die Biotope vieler Pflanzen und Tiere; er ist auch für Mollusken verhängnisvoll, weil sie in größerem Maße als die anderen Tiere standortgebunden sind. Die zunehmende Zahl der Campingplätze und des Wandertourismus u.ä. vergrößert die Müllhalden in Feld und Wald und die Einleitung der Abfälle in Flüsse, Seen und Küstengebiete. Dazu kommt die mechanische Zerstörung der Uferbereiche durch Vertritt, wachsende Anzahl von Uferwegen und Straßen u.ä. Bedrohlich ist die Vernichtung des Schilfgürtels durch den ständig hohen Wellenschlag bei starkem Schiffsverkehr und Motorbootrennen.

2.2 Nichtbeachtung der Naturschutzgebiete

Mit dem Massentourismus verbunden ist die häufig festgestellte Gleichgültigkeit vor den Grenzen der Naturreservate; doch auch Wirtschaft und Technik nehmen bei Neuplanungen kaum Rücksicht. Ein Musterbeispiel ist das Watt der Nordsee.

V.Der Mensch als "Beschützer"

Maßnahmen zum Schutz der Mollusken

PLARRE (1985) nennt materielle und ethische Gründe für die Erhaltung der Fauna und Flora und damit der genetischen Vielfalt in der Natur. Für die Mollusken kommen nach meiner Ansicht folgende in Betracht:

1) Wirtschaftliche Gesichtspunkte. Sie betreffen die Mytili-, Ostréi- und Aquakulturen sowie die Muttermuscheln der Kulturperlen. Infolge der chemischen und mechanischen Belastungen der Zuchtstätten sind viele wertvolle Muschel- und Schneckenarten zugrunde gegangen, zumindest stark gefährdet. Der Gewinn bleibt aus, die Kulturen wurden bzw. werden eingestellt.

2) Ökologische Gesichtspunkte. Im Ökosystem haben die Mollusken eine wichtige Aufgabe als Humusbilder; ferner sind sie bedeutende Glieder in der "Nahrungskette" zahlreicher Tiere. Auch der Mensch schätzt die Mollusken als Nahrung und sogar Delikatesse.
3) Ethische Gesichtspunkte. Die Mollusken sind ein großer Tierstamm, der einen wichtigen Platz in dem Ökosystem der Natur einnimmt. Eine für die Gesundheit des Menschen intakte Natur ist ohne Mollusken - auf dem Land und im Wasser - nicht möglich. Sie sind daher ein wichtiges Glied in der Umwelt des Menschen.

1. Bestandserhebung, Kartierung, "Rote Liste"

Vorbedingung für den Schutz der Mollusken ist die flächendeckende Bestandserhebung der einzelnen Arten im Rahmen der Erfassung europäischer Wirbellosen im "European Invertebrate Survey" (E.I.S.). Das Ziel der Kartierung der europäischen Land-, Süßwasser- und Meeresmollusken ist die Schaffung von Arten-Listen, "Check-Lists". JUNGBLUTH (Neckarsteinach) hat vor Jahren zum Schutz bedrohter Land- und Süßwassermollusken die "Projektgruppe Molluskenkartierung" ins Leben gerufen. Die Verbreitungskarten geben Einblick, welche Molluskenarten ausgestorben oder schutzbedürftig sind.

Notwendig für die Kartierung ist die Bestandserhebung in den Biotopen der betreffenden Species. Diese schwierige Aufgabe erfordert genaue Kenntnisse über Verhalten, Versteckmöglichkeiten, Lichtwechsel, Temperatur im Wohngebiet u.a. Die mitteleuropäischen Nacktschnecken sind sehr aktiv bei abnehmender Helligkeit, am Abend, und bei zunehmender Helligkeit, am Morgen. Dieser Aktivitätsrhythmus wird außerdem von der Jahreszeit beeinflußt. Süßwasserschnecken leben versteckt zwischen Wasserpflanzen und sind - häufig noch getarnt durch helle oder durchsichtige Gehäuse - nur schwer zu erkennen.

In vielen Ländern Europas gibt es bereits Kartierungskarten und Atlanten über die Verbreitung ihrer Malakofauna, wie in Deutschland, Frankreich, den Niederlanden, England, Dänemark, Norwegen, Schweden, Finnland, Schweiz, Österreich. Außerhalb Europas gibt es weltweit Ansätze zur Bestandserhebung der dort heimischen Mollusken.

Kernstück der Kartierung in der Bundesrepublik ist die "Ökologische Datenbank". Von 1972 - 1986 wurden 200.000 Einzeldaten und über 3.000 tiergeographische Titel von der "Projektgruppe Molluskenkartierung" zusammengetragen; heute ist die Zahl natürlich größer.

Entsprechend dem "Red Data Book" der "International Union for Conservation of Nature and Natural Resources" (IUCN) werden die Ergebnisse der Bestandserhebungen in den "Roten Listen" veröffentlicht. Je nach der im Freiland festgestellten Gefährdung werden die Funde in 5 Kategorien eingestuft:

0 = Ausgestorben oder verschollen
1 = Vom Aussterben bedroht
2 = Stark gefährdet
3 = Gefährdet
4 = Potentiell gefährdet, nur in kleinen, am Rande ihres Areals lebenden Populationen.

Die "Rote Liste" dient nach JUNGBLUTH (1987) als:

1) Entscheidungshilfe für Naturschutzbehörden u.a. bei der Verwirklichung praktischer Naturschutz-Maßnahmen
2) Grundlage der Rechtsvorschriften für den "Artenschutz"
3) Entscheidungshilfe für Kommunen und Behörden, die Eingriffe in die Landschaft planen, genehmigen oder vollziehen
4) Entscheidungshilfe für Gerichte, Verwaltungsbehörden u.ä. bei Verstößen gegen Naturschutzbestimmungen
5) Informationsgrundlage für die Öffentlichkeit
6) Zur Durchführung und Planung von Programmen für den Arten- und Biotopschutz
7) Zur Anregung ökologischer und faunistischer Forschung mit naturschutzorientierter Zielsetzung.

Die Verhältnisse im Raum Berlin haben GODAN (1982) und JUNGBLUTH (1991) bibliographisch erfaßt.

Von den 270 Schneckenarten in den alten Bundesländern Deutschlands sind 128 Arten ausgestorben bis stark gefärdet, also fast die Hälfte. Von den 31 einheimischen Muschelarten sind 11 ausgestorben bis stark gefährdet, wieder fast die Hälfte.

Sehr stark bedroht oder fast ausgerottet sind u.a. *Margaritifera margaritifera* (Flußperlmuschel, Freshwater Pearl Mussel), *Unio crassus* (Kleine Flußmuschel) u.a. *M. margaritifera* war im Mittelalter die Grundlage der in Europa, vorwiegend in Deutschland, florierenden Perlfischerei. Gefährdet wegen Überfischung sind *Strombus gigas* (Queen Conch) und *Tridacna gigas* (Giant Clam), ferner in USA die Gattungen *Epioblasma*, *Achatinella* (um Hawaii) und *Patella* (um Moorea). Von den bedrohten *Haliotis*-Arten ist *Haliotis tuberculata* an der Küste der Kanalinsel Guernsey (Europa) bereits ausgestorben.

Indien erwägt, den kommerziellen Raubbau der Meeresschnecken *Trochus niloticus* (Commercial Trochus), *Turbo marmoratus* (Green-Turbo) und *Turbinella pyrum* durch Schutzmaßnahmen zu stoppen.

2. Gesetze, Verordnungen, Reservate

Gesetzliche Maßnahmen sollen den Schutz der bedrohten Mollusken gewährleisten. Für die Bundesrepublik Deutschland gilt das "Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz)", Bekanntmachung der Neufassung vom 12. März 1987. Nach der Bundesartenschutz-Verordnung vom 19. Dezember 1986 gehören zu den besonders geschützten Arten: *Helix pomatia*, *Helix aspersa*, *Unio*- und *Anodonta*-Arten sowie *Pinna nobilis*. Direkt vom Aussterben bedroht sind außer *Margaritifera margaritifera* noch *Pseudanodonta complanata*, *Pseudanodonta elongata*, *Pseudanodonta middendorffi* (Donau-Teichmuschel), *Unio crassus* und die Europäische Auster *Ostrea edulis*.

In Frankreich besteht das Gesetz "La Loi sur la Protection de la Nature" mit mehreren Novellierungen. Es stellt mehr Molluskenarten unter Schutz als das deutsche. Totales Verbot des Sammelns "zu allen Zeiten" gilt für:

Helix melanostoma (Escargot terrassier)
Helix aperta (Escargot naticoïde)
Helix tristis (Helix de Corse)
Tacheocampylea raspaili (Escargot de Raspail)
Macularia niciensis (Escargot de Nice)
Otala apalolena (Otala de Catalogue)
Elona quimperiana (Escargot de Quimper)
Rumina decollata (Bulime tronqué)
Margaritifera margaritifera (Moule d'eau douce, Molette).

In Finnland gehört *Margaritifera margaritifera* seit 1955 zu den völlig geschützten Arten. Zu Beginn dieses Jahrhunderts war die Muschel in mehr als 200 Flüssen und Bächen vorhanden, jetzt nur noch in 60. Ihr Rückgang ist die Folge der Schadstoffbelastung, aber auch der Entwässerung der Torfmoore.

Zum Schutz der europäischen Meere (Nordsee, Ostsee, Mittelmeer) haben sich die angrenzenden Länder zusammengefunden mit dem Resultat "Réglement (CEE)" - Communauté économique européenne - "pour la Protection de l'environment des zones côtières et des eaux côtières de la mer d'Irlande, de la mer du Nord, de la Manche, de la mer Baltique et de la partie nord-est de l'océan Atlantique (Norspa)", speziell die "Action Norspa" (DANKERT 1991). Der Schutz für die Ostsee basiert auf der Convention von Helsinki 1974. 1979 fand die "Conférence pour la Protection de la Mer Baltique" statt (RICOU 1979).

Der "Schutz genetischer Ressourcen" ist durchaus "mit dem des allgemeinen Artenschutzes oder auch Landschaftsschutzes" zu verbinden (PLARRE 1991). Zur Erhaltung bestimmter Ökosysteme mit ihrer genetischen Vielfalt bedarf es streng geschützter Areale. Vom Schutz der Flora und Fauna profitieren auch Schnecken und Muscheln. Beispiele sind das Wattenmeer, soweit es vom Menschen noch nicht gestört wird, ferner in den Niederlanden die Naturreservate Rammekenshoek und in Nordholland das "Duinreservat" Wijk am See (BUTOT) und in Ungarn der "Kiskunság National Park" sowie "Tisza district und Pusztaszer Regional Conservation Area" (BABA 1988).

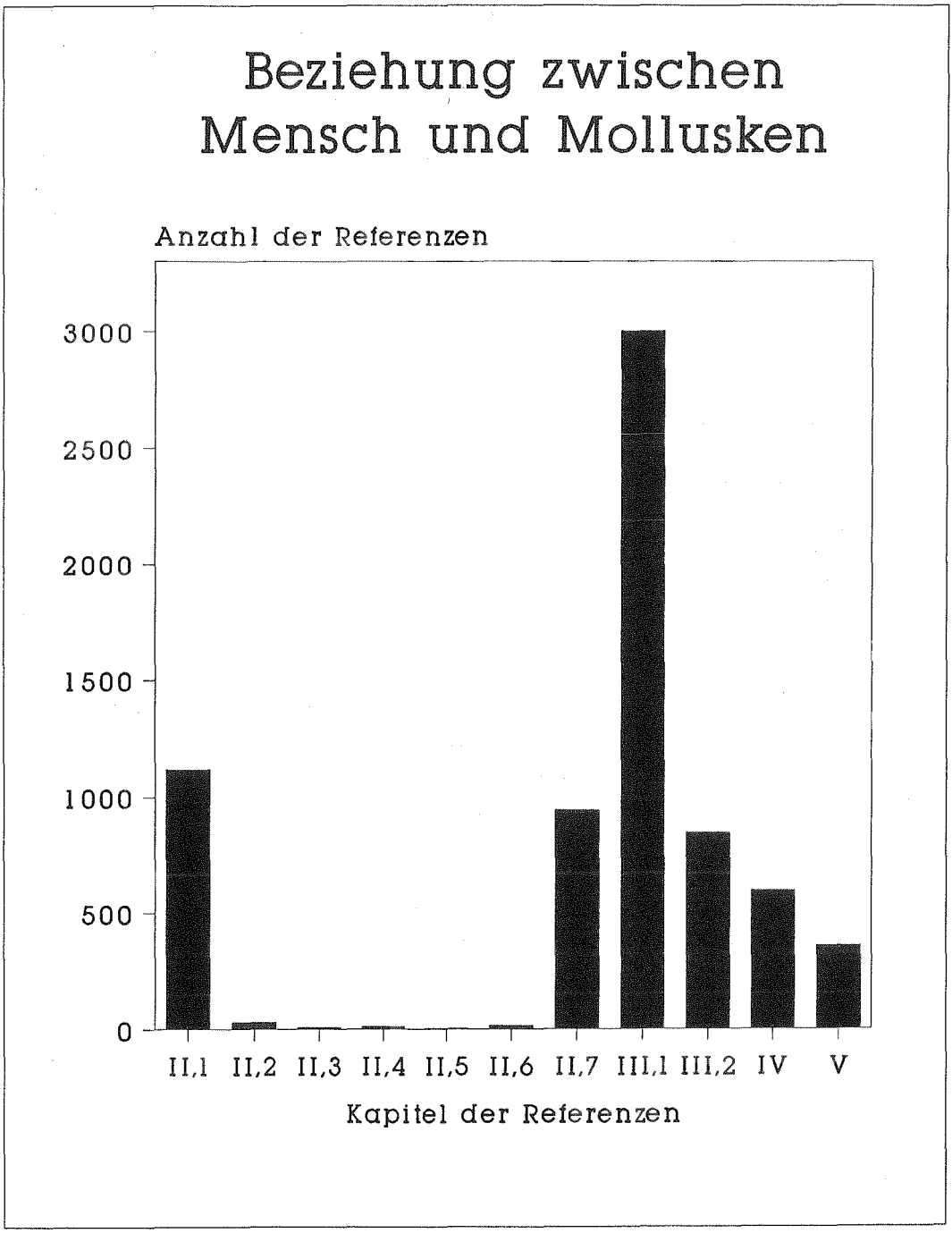
Erfreulicherweise gibt es bereits ein Naturschutzgebiet ausschließlich für Gastropoden: das "Schneckenreservat" in Bad Vöslau bei Wien. Auf Veranlassung von PAGET (ehemals Naturhistorisches Museum Wien) stehen hier einzigartige Eiszeitrelikte unter Schutz: *Fagotia acicularis audebartii* Prevost, *Bytinella parreissii* L. Pfeiffer und *Theodoxus prevostianus* C. Pfeiffer.

Abb./Fig. 1 : Anzahl der intern. Publikationen (1965-1992) in der "Angewandten Malakologie" als Indikator für das bisherige Interesse des Menschen in seiner Beziehung zu den Mollusken.

Number of the references in the intern. review (1965-1992) about "Applied Malacology" as indicator for the interest of man in his relationship to the molluscs.

Legende :

II.1	=	Nahrungsmittel Foodstuffs	1117	titles
II.2	=	Schmuck Jewellery	31	"
II.3	=	Bekleidung Dress	9	"
II.4	=	Schutz- und Heilmittel Protection, Objekt for Healing	12	"
II.5	=	Begleiter im Tagesverlauf Companion in Life of Man	4	"
II.6	=	Kunst Arts	16	"
II.7	=	Forschung Research	942	"
III.1	=	Phytomedizin (Titel im nächsten Heft der Mitteilungen ...) Phytomedicine (References in the next part of Mitteilungen ...)	3000	"
III.2	=	Human- und Veterinär-Medizin Human- and Veterinary-Medicine	845	"
IV.	=	Der Mensch : Zerstörer der Mollusken - Biotope The Man : Destruction of Molluscs-Biotopes	595	"
V.	=	Der Mensch : Beschützer der Mollusken The Man : Protector of the Molluscs	358	"


Beziehung zwischen
Mensch und Mollusken
Anzahl der Referenzen
3000
2500
2000
1500
1000
500
0
II,1
II,2
II,3
II,4
II,5
II,6
II,7
III,1
III,2
IV
V
Kapitel der Referenzen

II. Interpretation of the Review "Applied Malacology" - Relationship between Man and Molluscs (International References in the years 1965-1992)

With "Applied" or "Economic Malacology" generally the relationship between man and molluscs in Molluscs Culture, Medicine and Phytomedicine is understood. But as important like these fields are parts which GODAN (in press) has written in the book "Mollusca - Relationship between Men and Mollluscs" and also these parts which are given in the Journal "Zoological Record", Section "Molluscs", "Animal and Man".

The relationship between man and gastropods in the international plant protection and stored product protection is described by GODAN (1979, 1983) studying 1 500 publications. Meanwhile the literature on the relationship has grown very much. The trend is to create great collections of international bibliographies like the list "Recent Publications on Medical and Applied Malacology" (J. Med. Appl. Malacol. Vol 2, 1990). Further studies on foodstuffs and culture were published in the "Actes de Colloque" (Brest 1990) of the Société Française de Malacologie (Paris)/IFREMER in No. 13 (1991) "Aspects Récents de la Biologie des Mollusques" and in No. 14 (1992) "Les Mollusques Marins, Biologie et Aquaculture"; "Snail Farming Research" (Vol. 2, 1992) of the Associazione Nationale Elicicoltori" (A.N.E.), and also in the Abstracts and Proceedings of International Malacological Congresses: Proc. 10th Intern. Malacol. Congr. (Tübingen 1989) 1991 (Editor Cl. MEIER-BROOK) Part 1, 316 pp. and Part 2, 636 pp.; Abstr. 11th Intern. Malacol. Congr. (Siena, Italy 1992), also organizer is the Unitas Malacologica (Vienna) (Editors F. GIUSTI & G. MANGANELLI) 535 pp.; Intern. Congr. OILB (Organisation International de Lutte Biologique et Integrée contre les Animaux et les Plantes Nuisibles) in Tours (France) 1992. But there is always lacking a review of the enormous field "Pest Slugs and Snails in Agriculture".

The relationship between man and molluscs is very great today. It began at the time when man was collector and hunter; the molluscs were his foodstuffs, tools and object for jewellery. Later on the molluscs had become more important for example as symbol, talisman and object for healing, also as commercial medicament just today. Their use by man is very manysided. The molluscs have not everytime been the "friends" of man but also his "enemy". The man is always the "enemy"to gastropods, mussels and cephalopods. And when he is their "protector" in culturing them, it is only that he uses foodstuffs and pearl-jewellery. Finally the man is the destroyer of the molluscs-biotopes and their ecological community causative of environmental pollution.

The following disposition of the "International Bibliography of the "Applied Malacology" in the years 1965-1992" gives an image of the great relationship between man and molluscs. The diversity of parts are exhibited on the researches of more than 7 000 publications. The following review gives informations on some 4 000 titles. With regard to Phytomedicine the review, some 3 000 titles, is not yet finished; it would be published in one of the next numbers of the "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem."

In search for publications about molluscs-cultures and slugs- and snails-damage in agriculture serve bibliographies and data bases: "Mollusc Culture", "Quick Bibliography Series", United States Department of Agriculture; "PHYTOMED" (International databasis for literature on plant diseases and plant protection including storage protection) and "Bibliography of Plant Protection", edited by the "Documentation Centre for Phytomedicine" of the Federal Biological Research Centre for Agriculture and Forestry, Berlin-Dahlem.

The great diversity of topics on "Applied Malacology" is exhibited on the following disposition. The references have been recorded on datadiscs as there.
Disposition of "Applied Malacology" - Relationship between Man and Molluscs, alltogether more than 7 000 publications, ( )= number of titles.

I. Knowledge about the Molluscs (100)

Collecting, Making great malacological sections in the Museums of Natural History and others

II. Man as "Consumer"; the Molluscs as "Friend"

1. *Foodstuffs* (alltogether 1 117)
1.1 Catch of Terrestrial Snails in the Biotope, Feeding up in Snail-Gardens
1.2 Snail-Farming, Héliciculture, Elicicoltori, Ostréiculture, Mytiliculture, Conchyliculture, Mariculture, Aquaculture
1.2.1 Terrestrial and Marine Gastropoda (308)
1.2.2 Bivalvia (689)
1.2.3 Cephalopoda (121)

2. *Jewellery* (31)
Pearls (Nature- and Culture-Pearls)

3. *Dress* (9)
Purple Coloured Texture, "Silk de la Mer", Pearl Ornaments

4. *Protection from Inconvenience and Object for Healing* (12)
4.1 Symbol, Talisman, Mask
4.2 Object for Healing, Commercial Medicament

5. *Companion in the Life of Man* (4)
5.1 Use of the Shells, Ornaments, Music
5.2 Communication (Signal, Money, Stamps, Document and others)
5.3 Giving the name to Body-Organs of Man and Animal and to the Domain of Economy and Technology

6. *Arts* (16)
6.1 Architecture (Volute, Koncha, Rocaille, Shellwork, Intarsie)
6.2 Painting, Graph, Design; Literature (Romane, Novel, Fable, Satire, Proverb)

7. *Research* (alltogether 942)
7.1 Object for Studying the Life-Functions of Man (Physiology, Immunity, Blood, Carcinom and others)
7.1.1 Terrestrial Gastropods (437)
7.1.2 Freshwater- and Marine Molluscs (377)
7.1.3 Cephalopods (44)
7.2 Indicators for Environmental Pollution and Tectonic Changes on Coastal Regions (84)

III. Man in Danger; The Molluscs as "Enemy"

1. *Phytomedicine:* Destruction of the Plant-Foodstuffs Gastropods as Pests in Agriculture (alltogether some 3 000)
1.1 Damage on Cultivated Plants and their Fruits

1.1.1 Species of Pest Slugs and Snails
1.1.2 Control of Pest Gastropods
1.1.2.1 Chemical Control
1.1.2.2 Mechanical and Ecological Methods
1.1.2.3 Biological Control, Problems
1.1.2.3.1 Agents of Diseases (Viruses, Bacteria, Fungi)
1.1.2.3.2 Parasites
1.1.2.3.3 Predators (Molluscs, Arthropods, Vertebrates)
1.2 Damage on Stored Products (Food, Faeces, Body-Slime)
1.2.1 Species of Pest Gastropods
1.2.2 Control
1.3 Dispersal of Harmful Gastropods and Mussels by Man, Quarantine

2. *Human and Veterinary Medicine:* Transmission of Diseases
2.1 Carriers for Agents of Diseases (alltogether 845)
2.2 Freshwater or Terrestrial Snails as Intermediate Hosts for Larvae of Parasitic Worms in Man and Animal
2.2.1 Dermatitis
2.2.2 Parasitic Worms: Trematoda, Nematoda, Cestoda
2.2.2.1 Schistosoma sp. (Bilharziosis) (262)
2.2.2.2 Other Parasitic Worms (320)
2.2.3 Control of the Vector-Snails (261)

3. *Molluscs as Destroyer of Buildings* in Coastal Regions (13)
Stoppage in the Canalization

IV. Man as "Enemy" of the Molluscs (alltogether 595)

Environmental Pollution
Destruction of Molluscs-Biotopes and their Ecological Community

1. *Expansion of Industry, Agriculture, Mobility, Traffic and others*
1.1 Non-Chemical Destruction
1.2 Pollution by Heavy Metals, Pesticides, Oil, Toxic Organic Substances
1.2.1 Landregions
1.2.2 River, Lake, Ocean and the Coasts

2. *Environmental Destruction by Holiday Factors*
2.1 Masstourism, Camping, Jogging, Motorboats, Surfing, Ships and others
2.2 Non-Attention to Reservates

V. Man as "Protector" of the Molluscs (alltogether 358)

1. *Survey of Dispersal, Mapping of the Molluscs-Species, "Red List"*
2. *Rules, Legislation, Reservates*

The "Disposition" clearly shows the main emphasis in the relationship between man and molluscs (Fig. 1). It is the sector Foodstuffs: Culturing edible snails, mussels and cephalopods is of great significance today mainly the aquaculture of marine molluscs (II.1 = alltogether 1 117 titles). Just as important, perhaps much more, is the Phytomedicine, protecting the food-plants in agriculture and the stored products (III.1 = some 3 000 titles). Then follows the Research: the molluscs as object for studying as many factors in their physiology, immunity, blood, carcinom are similar to the physiological state and functions in mammals and also man. Furthermore important is the significance of molluscs as indicators for environmental pollution (II.7 = 943 titles). The next part is the Human- and Veterinary-Medicine: especially freshwater-snails as intermediate hosts for larvae of parasitic worms in man and animal (III.2 = 845 titles). By that time much less is the number of publications on the Environmental Pollution caused by man like the destruction of the biotopes and the ecological community of the molluscs, in which snails and mussels are important members in food- chains, which play a role also for man (IV. = 595 titles). The Protection of molluscs has got only little attention, but excepting the studies on population density in a specific area and the mapping as basis to protect snails and mussels; JUNGBLUTH is the initiator of the "Projektgruppe Molluskenkartierung" (V. = 358 titles).

I. Knowledge about the Molluscs

A very great literature, more than the titles in the review, contains characterizations of the molluscs as the Taxonomy, Classification, Key of identification, details of the biotopes and others. This main feature is important in the relationship between man and molluscs.

At the beginning of the 17th century there was a great interest on the shells of gastropods, mussels and cephalopods (*Nautilus* sp.). There were founded Shell-Cabinets, Molluscs- Collections and were produced many shell books with very good pictures about snails and mussels, for example the "Historia Conchyliorum" (LISTER) and the "Index Testarum Conchyliorum" (GUALTIERI). LINNAEUS, LAMARCK and other famous collectors give their name to sign new collected species. Well known is the book "A History of Shell Collecting" with plates of 22 famous molluscs-collectors from the 17th-20th century (DANCE 1986). DIAS-MERLANO (1985) brings 365 publications by this time. Museums of Natural History with great shell collections of scientific importance come in.

II. Man as "Consumer"; the Molluscs as "Friend"

1. *Foodstuffs*

The molluscs have become a commercial factor in the food-industry. The publications describe methods of culturing, diseases, parasites and predators. The phytoplancton is very important for an excellent nutrition and must also be cultured. There are plenty of studies on the environmental pollution by heavy metals, pesticides, oil, toxic organic substances and therefore the growing stress especially for marine molluscs.

These themes are significative of the journals "Haliotis" (Société Française de Malacologie" (Paris)), "Malacologia" (Unitas Malacologica (Vienna)) and "Snail Farming Research" (Associazione Nazionale Elicicoltori (A.N.E.), Italian Snail Farmers Association).

GODAN (in press) brings a review of the edible molluscs, culturing them and the problems. The growing importance of the molluscs as food-stuffs is shown up by the numberless congresses especially in France and Italy; for example: III. "Symp. Européen de Biologie Marine" in Arcachon, 1968; Intern. Meeting in La Rochelle, 1985; IFREMER (Shellfish Culture Development and Management); "I. Intern. AWARD for Research on Snail Farming" (A.N.E.) 1986; Symp. de Rochefort on Snail Farming", 1986; Symp. de Rennes, 1987"; "Sympos. International sur la seiche:

"La Seiche/The Cuttlefish", Cain, 1989; "Meeting Aspects Récents de la Biologie des Mollusques", VIII. Congr. National Brest, IFREMER, 1991; "Biologie appliquée à la Conchyliculture et à l'Héliciculture", Colloque Scientifique "Bordeaux Aquaculture", 1992; Bordeaux Convention Center with the characteristic themes: Intensive fishfarming and environment; Genetics and pathologie in shellfish-farming; water quality in shellfish-farming; tropical aquaculture.

In Europe, USA and Canada the following terrestrial and marine snails are preferred as food-stuffs: *Helix pomatia* L., *Helix aspersa* Müller, *Helix aperta* Born, *Helix lucorum* L., *Achatina*-species, *Haliotis lamellosa* Lamarck, *Haliotis tuberculata* L., *Haliotis gigantea* Gmelin, *Strombus gigas* L., *Buccinum undatum* L., *Murex brandaris* L. The amphibious species *Ampullaria* is very estimated in South America and introduced in the Asiatic countries: *Ampullaria canaliculata* Lamarck (*Pomacea canaliculata*) to Taiwan (1985) and Japan (1987), *Ampullaria glauca* (L.) to Western India (1988) and *Ampullaria gigas* Reeve to Hong Kong (at 1989), perhaps 1985 to China.

1.1 Catch of Terrestrial Snails in the Biotopes, Feeding up in Snail-Gardens

The edible Vineyard Snails have been preferred in Europe and North America up to present, above all *Helix aspera* Müller. But formerly it was *Helix pomatia* L., which was the famous food-stuff. It was transported by the Old Romans during their wars over Europe. Later on the snails became well-known and important as "Fastenspeise" for the monks and later for the other people. The catching of the snails in the biotopes would be very extreme, that by the time the population density was diminishing so much, and the protection of the Vineyard Snails is now necessary.

In Germany the collecting of *Helix*-Snails in the biotopes is permissible only at the time of 1. April - 15. June and again in the same areas only after three years. The shell-volume must not be under 32 mm in any case.

In France, Belgium and the Netherlands there are stronger reglements for protecting the snails than in Germany. So in France the protected species are very much and the collecting in the biotope is temporary permissible for:

Helix pomatia (Escargot de Bourgogne)
Helix aspersa (Escargot Petit-Gris)
Zonites algirus (Escargot péson)

at all time forbidden for:

Helix aperta (Escargot naticoides)
Helix tristis (Helix de Corse)
Helix melanostoma (Escargot terrassier).

In Belgium the rule "L'Executiv Régional Wallon" exists as of 1984. The Vineyard Snails would be collected in areas only at the time of 1. August - 30. September. The minimum of the shell-volume should be 30 mm for *Helix pomatia* and 25 mm for *Helix aspersa.*

In the Netherlands BUTOT has taken the basis for the rules in protecting the Vineyard Snails by his manyside researches in the areas.

But today the *Achatinidae* are on the market. Their commercial importance began with *Achatina fulica* Bowdich after the Second War by the Japanese to nourish the hungry people. The home of *Achatina fulica* was East-Africa, and many *Achtina*- species have displaced the Vineyard Snails.

1.2 Snail-Farming, Héliciculture, Elicicoltori, Conchyliculture, Ostréiculture, Mytiliculture, Aquaculture

The literature about the Snail-Farming and the other Molluscs-Cultures gives some titles in the Quick

Bibliography Series "Aquaculture Information Center" of the years 1979- 1986 (Shell-fish culture) (HANFMAN 1987) and of the years 1985-1990 (Molluscs-Culture) (MS VEY 1990).

1.2.1 Terrestrial and Marine Snails

Helix sp. and *Achatina* sp. were cultured in all the world. The Snail Farming of *Helix aspersa* Müller has a great dispersion in France; Besançon, Fusterouau (Riscles), Bretagne, Finistère, Normandie, Loire-Atlantique, and in Italy: Cherasco, Cuneo, Piedmont. *Helix aperta* Born would be cultured in Sizilia and *Helix lucorum* L. in Greece (Peleponnes, Thrakia, Mazedonia), *Achatina marginata* (Swainson) in England, Italy and by the time also in Ghana.

There are many problems in the Snail Farming, for example on *Helix aspersa*: The hibernation, its begin and duration, is very important for the young snails, while the egg production is stimulated in the adults. Desiccation, mistakes in feeding, parasites and predators are very distressing for eggs and young snails.

Important for culturing are the temperature, change between luminary and darkness, sufficiency of humidity and optimal feeding. These factors have great influence with the activity at the intensity of egg-laying and feeding-behaviour. They play a great role on the terrestrial *Helicidae* and *Achatinidae*, while the quality of seawater, the temperature in it and the engagement for culturing good food (marine plancton, algae, diatomeae) have the predominance on the marine snails. *Helix aspersa* would be attracted by nematodes as: *Alloionema appendiculatum* (Schneider), *Angiostoma aspersae*, *Nemhelix bakeri* Morand & Petter, and *Rhabditis gracilicaudata* de Man. The intermediate host of the protostrongylid *Muellerius capillaris* (Müller), the snail *Helix aspersa* plays a role in the farming of the Tourraine (France) in the springtime, whilst the slug *Deroceras reticulatum* (Müller) is the main final host in autumn. The young *Helix* are infected during their phase of hatching from the eggs in the earth. At a prophylactic method it shall be good to clean the eggs for 30 sec. under running water. At time *Rhabditis* sp. is also a remarkable parasite in the farming, and the washing method of the snail eggs is a good help against the worms.
A strong ectoparasite is the mite *Ricardoella limacum* (Schrank) today. Formerly the mite was only a parasite on *Limax* sp. also slugs in agriculture. In the last years it became important in the *Helix aspersa* Farming. The mite lives in the mantle cavity of the snail and is feeding the haemolymph of the host.

The first methods of research for farming were made on the Vineyard Snails. CHEVALLIER (1979, 1983 ect) has developed the Snail-Farming of *Helix aspersa* to a famous commercial factor. The literature is great and gives much information also about the influence of pollution, and of stressing population density.

There are Mariculture, Conchyliculture of marine snails also in all the world. The most edible species are *Haliotis* sp. (Abalone), *Buccinum undatum* L. (Whelk) and *Strombus gigas* L. (Queen Conch); they would be cultivated

Haliotis lamellosa Lmck	-	France, Spain
Haliotis discus (Reeve)	-	Spain (at 1983)
Haliotis gigantea Gmelin	-	Karibic
Haliotis sp.	-	Japan (first experiments 1962),Taiwan (at 1975)
Buccinum undatum L.	-	France (Golf Normano-Breton)
Strombus gigas L.	-	Turkey, Mexico, Karibik,Caicos-Islands, Puerto Rico, Bahamas.

In the farming of marine snails, for example *Haliotis* (Abalone), *Strombus gigas* (Queen Conch), the density of population has great influence on the mortality. So, the biomass of the phytoplancton decreased to such an extent when the density of *Strombus gigas* has become so very great, that the nutrition of the snails was not ensured any more.

1.2.2 Bivalvia

Important edible mussels are Oysters (*Ostrea*- and *Crassostrea* species) and Moules (*Mytilus edulis* L., *Mytilus galloprovincialis* Lamarck), *Pecten jacobaeus* L., *Pecten maximus* L., *Chlamys opercularis* L., *Chlamys varia* L., *Cerastoderma (Cardium) edule* L., *Tapes rhombiodes* (Pennant), *Venus-, Venerupis- and Ruditapes* - species.

The Mytili-, Ostréi- and Aquacultures lie in the coastal regions of the oceans as the Atlantic of Europa and America: France in Basse Normandie, la Baie de l'Aiguillon, l'Etang de Thau, Baie du Mont San Michèle, Bassin d'Arcachon, Bassin de Marennes Oléron, Baie de Somme, Baie de Seine (Calvados), Golf Normano-Breton, Station de Wimereux, Bretagne, in the Gironde River. *Mytilus galloprovincialis* has the home on the coast of the Mediterranean Sea. In England are cultured *Mytilus edulis* in the Morecambe Bay (Wales), *Ostrea edulis* and *Crassostrea gigas* in the Emsworth Harbour. Mytilicultures are also on the coast of Sweden and the sea around New Foundland. *Cardium edule* is cultivated in the Wadden Sea of the North Sea (Germany).

There are cultures of *Crassostrea gigas* (Thunberg) in the Lagune of Qualidia (Maroc) and the Golf Persique (Iran), *Crassostrea virginica* Gmelin, in the Chesapeake Bay (Maryland, USA), *Ostrea puelchana* (Orbigny) in the Lagune San Matias and the Golf San José (Argentina), the "Hanging Cultures" of *Crassostrea gigas* in the Hiroshima Bay (Japan) and the Jaozhon Bay (Shandong Province, China). Cultures of *Pecten maximus* are in the Bay of Brest and Bassin d'Arcachon (France). "Nursery Cultures" of *Ruditapes philippinarum* Adams & Reeve (Palourde japonica) and *Ruditapes decussatus* (L.) lie in the Lagune Qualidia (Maroc).

Oyster-Cultures are found in strong tidal flat areas. Formerly the North Sea was the home of *Ostrea edulis* L. Today the robust *Crassostrea angulata* (Lmck) from Spain and Portugal are in its place, and later on *Crassostrea gigas* from Japan. The cause was a great bacterial disease in 1920, which has destroyed the most populations of *Ostrea edulis,* and the ostréiculture was not making money anymore.

Mytilis edulis L. and other mussels will be commercial harvest from banks of other methods of mariculture, most in the Wadden Sea of the North Sea. They are also very much dangered by increasing environmental pollution.

The *Aquaculture* is the modern method today. In connection there is the culture of algae and diatomeae for feeding the larvae and adults necessary. The main species of the marine phytoplancton are *Calanus helgolandicus, Chaetoceros calcitrans* (Paulsen), *Chlamydomonas reinhardi, Chlamydomonas bullosa, Chladophora subriana, Delesseria sanguinea Lamouroux, Nannochloris atomus, Isochrysis galbana, Stichococcus bacillaris, Phaeodactylus tricornutum, Tetraselmis suecica, Tetraselmis tetrathele, and Thalassiosira pseudonana.* Also in the Conchyliculture is culturing of *Diatomeae* sp. necessary.

Much enemies, parasites and diseases by viruses, bacteria and fungi may disturb the molluscs-culture, also predators for example the marine snail *Crepidula fornicata* (L.) (Slipper Limpet), the edible, also cultivated mussel *Mercenaria mercenaria* L. (Quahog), *Macoma balthica* (L.), also *Urosalpinx cinerea* (Say) (Oyster Drill), *Haematopus ostralegus* (L.) (Austernfischer), the Mew Larus canus L. and the worms *Pygospio elegans* Clarapède and *Nereis diversicolor* Müller.

Sudden increase of water-temperature in summer months brings a high mortality of snails and mussels in the aquaculture. It is the consequence of water pollution today, which has diminished the resistance of the molluscs so much, that they cannot overcome the stress of the sudden great heat.
The rivers Elbe, Rhine and Rhône flowing in the Atlantic Ocean wash their environmental chemicals into the shelfs and bays along the coast, a further increasing problem for the molluscs-industry in

future, also the eutrophy of non-edible algae for the molluscs, caused by strong pollution with many organic substances.
Some important factors in the aquaculture with the result of diminishing the individuels are:
1. Temperature in the water: great heat or coldness
2. Uncontrollable overfishing, therefore insufficient capture of the mussel-larvae, necessary for a growing aquaculture
3. Destruction of the ecological community by man with the following increase of the predators for example *Macoma balthica, Pygospio elegans*
4. Great pollution in water, therefore
5. Great increase of diseases and mortality of mussels
6. Diminution of egg production
7. Destruction of the important species of marin phytoplancton and therefore no optimal nutrition for the cultured mussels.

There are also found radionuclides, thorium and uranium in the phytoplancton of the Tropic Seas, East-Pacific, Adriatic Sea and Balthic Sea.

1.2.3 Cephalopoda

The aquaculture of cephalopods has been successful only late comparable with snails and mussels. Of the 17 species cultured today most of them are used as study-object for physiological research. The first commercial aquaculture was gone with *Octopus vulgaris* Lamarck at the beginning of the eighties of the 20th century in Japan. Important commercial aquacultures of *Sepia officinals* L. today are situated in France (Ile d'Oléron, Port-en-Bessin, Calvados) and Japan.

The following species are cultivated:

Sepia latimanus Quoy & Gaimard	- Japan
Sepia lycidas Gray	- Japan
Sepia officinalis L.	- France (Normandie), Monaco
Sepiella japonica Sasaki	- Japan
Doryteuthis bleekeri (Keferstein)	- Japan
Eledone cirrhosa (Lamarck)	- Japan
Eledone moschata Leach	- Japan
Octopus briareus Robson	- Miami (USA)
Octopus joubini Robson	- Texas (USA)

Species as study-object are: *Doryteuthis bleekeri, Eledone cirrhosa, Illex illecebrosus* (Lesueur), *Loligo pealeii* (Lesueur), *Loligo opalescens* Berry, *Loligo vulgaris* Lamarck, *Octopus vulgaris* Lamarck, *Octopus dofleini* (Wülker), *Octopus bimaculatus* Verrill, *Todarodes pacificus* Steenstrup.

II.2 *Jewellery*

A great importance in the industry of jewellery the molluscs have as producer of pearls and mother-of-pearl. There are Nature- and Culture Pearls. The first woud be named also Orient-Pearls because they come on the market from the Orient to Europe. Since 2500 before Ch. Nature-Pearls were known from the mussel *Pinctada* sp. At this time Europe also has Nature- Pearls but from freshwater mussels; *Unio* sp. and *Anodonta* sp. Very famous were pearls from *Margaritifera margaritifera* (L.) (Freshwater Pearl-Mussel), living in the rivers of the "Fichtelgebirge", the river Main for example (Germany). At the Middle-Ages in Germany there was a large commercial "Pearl- Fishing" and a profitable market. But today it is no more.

By the time the main industry has become the Culture-Pearl especially in Japan, China, islands in the Pacific Ocean, Taiwan, Borneo and other regions in the East.

To get the Culture-Pearl a little piece of the shell from a fresh-water mussel must be taken between the mantle and the shell of the mother-mussel. After the operation the mother- mussel with the growing pearl in her body lives individually in the sea under the control of man. Perhaps after 1, 2 or 3 years special at the method and species a good commercial famous pearl is ready. GODAN (in press) has given many details of culturing the pearls and also something about imitation pearls.

The important producer of Culture-Pearls are the marine mussels *Pinctada* sp. and *Pteria penguin* Röding, living in the shelf sea on japanese coasts. Marine snails also give culture-pearls: *Haliotis* sp. (Abalone pearls) and *Strombus gigas* (Conch-Pearls), living at the coasts of Florida and in the Golf of California (USA), Mexico and East-Asia.

On the market are pearls from the operated fresh-water mussels *Hyriopsis schlegeli* (Martens) (Japan, Biwa-Lake) and *Cristaria plicata* (Leach) (China).

The Pearl-mussel-cultures would be damaged by many factors as water-pollution, parasites and predators like also members of the mytili-cultures.

II.3 *Dress*

Purple Coloured Texture, "Silk de la Mer",
Pearl Ornaments.

Since 1600 before Ch. there were known the marine mussel *Murex* sp. as producer of the Purple-Colour. At the Middle-Ages the Purple-Texture in the regions of the Phönician and Cretians were well-known and very estimable. In England the producer was *Nucella lapillus* L. (Dogwelk, pourpre pierre). Later on the production of the Purple-Texture was made in Japan, Malaysia and Central-America. Today also the "Sepia-Melanin" of *Sepia officinalis* L. plays a role.

"Silk de la Mer" is the name of the texture from the long byssusfiles of *Pinna nobilis* L. for having famous gloves and hosiery for the rich people in the Middle-Ages.

Mother-of-Pearl is known from the shells especially of *Pinctada* sp. and *Haliotis* sp.

II.4 *Protection from Inconvenience and Object for Healing*

GODAN (in press) brings much information about these themes in the relationship between man and molluscs.

4.1 Symbol, Talisman, Mask

Since the time man was a hunter the molluscs were also his tool and later on his symbol, talisman and mask to protect him from inconvenience and diseases. Shells imitate the eyes in the death skull. The snail, which can retire her body into the shell and coming out soon was the symbol for the moon and the restauration (India). In some religions pearls and snails are symbols for regeneration also. The Nature-Pearl is it for the sun which is seen as the greatest precious object in the world (China). In Europe shells are estimated ornaments on masks and clothes in the "Fasnacht".

4.2 Object for Healing, Commercial Medicament

In the Middle-Ages the fossil cephalopods, the Belemnites, has got famous objects for healing the man from diseases: stones in kidney and bladder, also asthma etc. The slime of marine and terrestrial snails is bactericid. Today commercial medicines with healing effect from slugs (*Limax* sp., *Arion* sp.) are on the market. Mussels are good for diminishing the malady of rheumatism and arthritis. The marine mussel *Perna canaliculus* (Fam. *Mytilidae*) possesses a healing substance for an Anti-rheumatism medicament, and for being able to always have it the mussel is cultivated on the coasts of New Zealand.

II.5 *Companion in the Life of Man*

5.1 Use of the Shells, Ornaments, Music
5.2 Communication (Signal, Money, Stamps, Document etc.)
5.3 Giving the Name to Body-Organs of Man and Animal and to the Domain of Economy and Technology.

In these parts the molluscs play a great role today also. Well known is the "Triton Siren" (shell of *Charonia tritonis* L.) in the time of the Old Romans and the "Money" Shell (*Cypraea moneta* L.). The "Wampum" of the old inhabitants of South America should give great security to a contract between individuals. Also in these parts much information is in the book of GODAN (in press).

II.6 *Arts*

6.1 Architecture (Volute, Concha, Rocaille, Shellwork, Intarsie)
6.2 Painting, Graphics, Design
Literature (Romane, Novel, Fable, Satire, Proverb)

In the Antiquity the molluscs have been models for ornaments of the inside and outside architecture. The Volute ("snail", windings like the shell of a snail) was the ornament at the end of the ionic column from the temples of the Old Roman and Greece. Later on the Volute has become famous as ornament at the ridge on the roof of houses, especially in Holland. The Concha ("mussel" like the shell of the mussel *Pecten* sp.) was in the Middle-Ages the name to a niche in the roman temple and later on it was taken over to the Christian Churches. Rocaille ("mussel") was characteristic to the Rococco, so the french name "Style Rocaille" for this epoque. There were famous ornaments outside and inside of the official buildings and the houses of rich people. The ornaments imitate the shell of snails and mussels, they are seen in the rooms on mur, ceiling and pieces of furniture.
At the beginning of the Middle-Ages the Shellwork with real shells in famous ornaments was first made in Italy. The main material of the Intarsie is the mother-of-pearl on music- instruments, peaces of furniture, household goods and fancy objects.
The molluscs are often the main models in pictures and main action-agents in romane, novel, fable etc. The pearl is similar as a very good thing. But the cephalopod, as *Octopus vulgaris* L., with his many and long arms is the guide of badness in the satire and humourous novels, proverbs etc. Much information can be found at GODAN (in press).

II.7 *Research*

7.1 Object for Studying the Life-Functions of Man (Physiology, Immunity, Blood, Carcinom and others)
Terrestrial Gastropods
Freshwater and Marine Molluscs
Cephalopods

Many processes in life functions of molluscs are similar to or based on the same principle as the corresponding functions of mammals and man. The molluscs serve as object for researches in physiology, for example biochemistry of the nervous system, immunity, heart function, blood circulation, development of carcinom.

A massive review has given GODAN (1983 and in press), WILBUR and YOUNGE (1966) published details of the physiology in the chapters:

1. Feeding; 2. Digestion; 3. Feeding and Digestion in the Cephalopods; 4. Heart, Circulation and Blood Cells; 5. Respiration; 6. Molluscan Hemoglobin and Myoglobin; 7. Molluscan Hemcyanine; 8. Pigmentation of Molluscs; 9. Carbohydrate Metabolism; 10. Nitrogen-Metabolism; 11. Excretion; 12. Pyhsiology of the Nervous System; 13. Sense Organs (less Cephalopods); 14. Cephalopod Sense Organs; 15. The Brain and Behavior of Cephalopods.

Then there is also important information by RUSSEL-HUNTER (1979) about:
19) General Characteristic of Molluscs
20) The Evolution of Gastropods
21) The Trials of Nonmarine Molluscs
22) The Evolution of Filter-Feeding Bivalves
23) Functional Aspects in Snails and Bivalves
24) Invertebrate Zenith: The Cephalopods
25) Toward Perception: Memory and Learning
26) Minor Molluscan Group and Phylogeny

The larvae of the molluscs are object to bioassay tests. Oysters are study-objects for the calcification in bones of the vertebrates. The assimilation in the molluscs contains the carbohydrate-, protein-, and lipid-metabolism. Carbohydrate and glucose are reserves of food for a long period of hunger. Glucose is a normal part in the blood of the snail and his concentration grows very much after feeding like to vertebrates and man. The molluscs are producer of dopamin, serotonin, lipids, triglycerids, phosphorlipids, enzymes and hormones like to the man. The enzymes have also biochemical and bactericidal effects.

Malign tumors caused by disturbances in the endocrinal and nervous system or by parasites or fish eggs occur very often in molluscs. Carcinoms can be provoked by experiment and they even rang with the tumor-scheme of the higher vertebrates, including man, studying in *Ampullaria australis* (Orbigny) with 0,2% Crotonoil. In *Mercenaria mercenaria* a substance with inhibitory effect to tumors has been identified.

Cephalopods have a blood-circulation system with arteries, veins and capillaries like man. The heart of *Helix aspersa* is taken for the effect of drugs on the heart muscle of man. The frequency of heart rate is subject to neurohormonal control and there are "neurohemalorgans" for storage of neurohormones. The neurophysiology of molluscs is of great interest for studies of corresponding functions in man.

Also sense organs are comparable with these of man. So the eye of cephalopods has cornea, lens and retina and give the octopuses a sharp image of their surrounding. A formal and spatial vision even exists.

The immunity of molluscs has a similar function as mans. There are amoebocytes corresponding to the lymphocytes in the blood of man. There even exist hemagglutinins and antibodies, for the immune-effect. The phagocytosis play a role so that the molluscs are useful in the immune-hematology research.

7.2 Indicators for Environmental Pollution and Tectonic Changes on Coastal Regions

GODAN (1979, 1983, and in press) brings in the chapters "Molluscs as Indicators of Environmental Pollution with Chemicals" much information. There already exists a relevant literature on this subject.

Snails and mussels serve as indicator for the pollution in lakes, rivers, sea water and land regions with environmental chemicals. They react very sensitive to the residues and accumulate them in their body. The chemicals were stored up in quantities which lie much higher than in the affected biotope. For example in the fresh-water snail *Physa* a DDT-residue was measured which was 15 000 higher than in the habitation of the snail. The marine mussel *Mytilus edulis* has accumulated in her body residues of chlorinated hydrocarbons which were 7 000 times higher than in the contaminated water-body.

Terrestrial and marine snails, also freshwater and marine mussels are of use as indicators already for very little residues (Heavy Metals, Pesticides etc.). Therefore tests of the pollution in the ecological systems were made today also with molluscs as the species: *Arion rufus* (L.), *Arianta arbustorum* L., *Physa acuta* Draparnaud, *Viviparus ater* (Cristofori & Jan), *Biomphalaria glabrata* (Say), *Unio* sp., *Anodonta cygnea* L., *Crassostrea virginica* Gmelin, *Mytilus edulis* L., *Venus japonica* (Gmelin), *Chlamys opercularis* L., *Pecten maximus* L., *Mercenaria mercenaria* L., *Rangia cuneata* (Gray), *Perna perna* (L.), and *Marisa cornuarietis* (L.) (especially for TBT).

It is remarkable that these snails, slugs and mussels play a role in the Molluscs-Culture, Phyto-medicine and Human- and Veterinary-Medicine. As indicators for tectonic changes of the earth (coastal regions) are useful marine bivalves borers.

III Man in Danger; the Molluscs as "Enemy"

1. ***Phytomedicin:*** Destruction of the Plant-Foodstuffs, Pest Slugs and Snails in Agriculture
1.1 Damage on Cultivated Plants and their Fruits
1.2 Damage on Stored Products (Food, Faeces, Body-Slime)
1.3 Dispersal of Harmful Gastropods and Mussels by Man

The review about the studies (some 3 000 titles, perhaps much more) on Phytomedicine (plant protection and stored product protection) would be published in one of the next "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlen".

III.2. ***Human- and Veterinary-Medicine :*** Transmission of Diseases
2.1 Carriers of Disease (Viruses, Bacteria, Fungi)
2.2 Freshwater-Snails as Intermediate Host for Larvae of Parasitic Worms in Man and Animal

With the problem of the dangerous relationship between man and freshwater snails in the Human- and Veterinary-Medicine are occupied in many studies published in the following journals:

Acta Tropica
Amer. J. Hyg.
Ann. Trop. Med. Parasitol.
Bull. Appl. Parasitology
Bull. Soc. Pathol. Exot.
Bull. Wld. Hlth. Org. (WHO)

Haliotis
Helminthol. Abstr.
Int. J. Parasitol.
J. Invert. Pathol.
J. Medical and Applied Malacol.
J. Trop. Med. Hyg.
Malacologia
Parasitology
Parasitologie
Revista di Parasitologia
Z. Parasitologie
Z. Parasitenkunde.

GODAN (in press) brings details as to the methods for infestation by several worm species, there range in the world and others. KILIAS and FRICK (1963) nominate the important helminths of animals used by man in Middle-Europe.

2.1 Carriers for Disease (Viruses, Bacteria, Fungi)

Snails disperse spores of fungi, bacteria, salmonelles and eggs of parasitic worms with the body-slime or with their faeces in the areas. When snail is feeding, these agents would be deposit in fruits at the ground, lettuce leaves, vegetables, strawberries and cress. Before man eats it, they must be intensive washed in running water. Also possible is the infection with the agent of Hepatitis A, when man eats oysters and clam-mussels, which were living near or in seawater contaminated with chemicals or toxic organic substances. It is possible also that eggs of the ascaride worm *Ascaris lumbricoides* L. and of the whip-worm *Trichuris trichiura* L. are put on the body of *Deroceras reticulatum* (Müller) and would then be transported by the Field Slug on vegetables eaten by man.

2.2 Freshwater and Terrestrial Snails as Intermediate Hosts for Larvae of Parasitic Worms in Man and Animals

Freshwater and terrestrial snails are of great significance as intermediate hosts for the larvae of parasitic worms in man and animal. There is a good coexistence between the vector snail and the worm larva; for example the intermediate host-snail and the final host are living in the same biotope, advantageous to the worm larva, ready for infecting the final host. The larva infect man either passively, when he eats contaminated fruits, vegetables, lettuce, cress for example or actively by penetrating into the skin of man during his wate or bathing in water with mature worm larvae.

Parasitic worms in man and animal are members of *Trematoda, Nematoda* and *Cestoda.*

Today the most important diseases of man infected be parasitic worms is the Bilharziose (Schistosomiasis) in Africa, Asia, South America and Japan. Formerly this disease was going away by strong method of control but now at this time it has returned and plays a great role in Egypt, Sudan and West-Africa, following the enormous watering establishment in the agriculture for growing the production of food to man. But now in that great humidity on the land also with many canalizations the freshwater and amphibious snails got favourable biotopes, which was formerly in desiccation and therefore very disadvantagous to them.

Man is either the single final host or in other worm-species the secondary final host with animals being the main final host. There already exists a considerable literature.

Trematoda, important in Human-Medicine

Man as single final host

Schistosoma haematobium (Bilharz): blood vessels in the wall of the bladder.
Intermediate host - *Bulinus* sp.
Mediterranean countries, Africa, Europe, Near East
Schistosoma mansoni Sambon: blood vessels in the mesenterium and intestine wall
Intermediate host - *Biomphalaria* sp.
Egypt, Sudan, Congo, South America
Schistosoma japonicum Katsurada: blood vessels in the mesenterium and intestine wall
Intermediate host - *Oncomelania* sp.
Japan, China, Taiwan, Philippines and others

Man as secondary final host

Fasciola hepatica L. (Large Liver Fluke): liver, passage of gall
Intermediate host - freshwater snails (some 14 species also *Galba truncatula* in cress-culture)
Large distribution in Europe, North America, Mexico, South America, Australia

Nematoda, important in Human-Medicine

Man as single final host

Angiostrongylus cantonensis Chen (Lung-worm): arteries in the lung, Oedem, Meningoencephalitis (occasional)
Intermediate host - terrestrial slugs and snails: *Limax* sp.(also *Deroceras reticulatum*), *Arion* sp., *Achatina* sp., *Bradybaena* sp., *Pomacea paludosa*, *Veronicella* sp. and other snails. Oyster *Crassostrea rizophora* (occasional found in Cuba).
Transport host - freshwater shrimp, crab, cancer, planarie
South-East Asia, Pacific Islands, Hawaii, Cuba, Tahiti, Taiwan, China

Cestoda, important in Veterinary-Medicine

Animal as single final host
poultry farming and fattening (fowl, geese, duck), pheasantry

Davainea proglottina (Davaine) (Tapeworm): intestine, very pathogen

Intermediate host - terrestrial slugs: *Arion* sp., *Limax* sp., *Milax* sp.
Europe

2.3 Control of the Vector-Snails

A molluscicid with strong toxic effect in laboratory studies is possibly ineffective or no satisfactory in the biotope of the freshwater snails. There are many causes:

1. The snail goes out of the contanimated water crawling about stones or plants which rise over the water surface.
2. The snail goes to the water ground and into the mud which is diminishing the toxic effect of the molluscicid.
3. Many snails are coming from the untreated nearness into the applied area, which was formerly contaminated with the toxic substances but is now clean in the most parts.

4. Very much circulation and turbulence in the water body and therefore no sufficient toxic concentration in all parts of him. The snails are not really infested.
5. Compact plantation on the border or ground of rivers, lakes and canals.
6. Decomposition of the toxic compound in the water.
7. Rapidity of sinking of the toxic compound in the water body from the surface to the ground.

Chemical substances to control the vector-snails in freshwater areas found in the following plants: Saponine from *Zygophyllaceae, Sapindaceae* ("Damsissa"-Molluscicid), *Leguminosae, Phytolaccaceae* (Endod-Berries). Against *Biomphalaria alexandrina* (Ehrenberg) is effective "Damsin" from the Egyptian *Ambrosia maritima* (*Compositae*) and the Aceton-Extract from *Euphorbia lactea* (Haw.) (*Euphorbiaceae*). Extracts from *Polygonum senegalense* Meissner *(Polygonaceae)* are effective against *Lymnaea natalensis* (Krauss) and *Biomphalaria pfeifferi* (Krauss). "Aridanin" is the product from *Tetrapleura tetraptera* Taub. *(Mimosaceae)* especially applied in Nigeria.

The insecticid "Pyrethrum" from dried flowers of *Chrysanthemum* sp. is also a molluscicid against *Radix auricularia* (L.), *Lymnaea stagnalis* (L.) and *Physa fontinalis* (L.). The fungicid "Phebrol" (sodium 2,5-dichlor-4-bromophenol) is very toxic for *Biomphalaria, Bulinus, Oncomelania* and also their eggs in the water.

In the biological control of the vector-snails *Marisa cornuariatis* (L.) plays a role against *Biomphalaria* sp. and *Bulinus* sp. This predator-snail is introduced to flooded or very moist fields unter cultivation. Mass rearing methods have been developed. But nor can it be considered for control of *Lymnaea*-snails in cress cultivation because it feeds on watercress itself. *Pomacea*-species are also a help against *Biomphalaria glabrata*. The water bug *Limnogeton fieberi* Mayr (*Hemiptera*, fam. *Belostomatidae)* from North Africa is specialisted as a predator of freshwater and amphibious snails; *Sciomyzidae* ("marsh flies") (*Diptera*) are useful in Europe (GODAN 1979, 1983). Applicable to Biological Control of schistosomiasis is also the fish *Astatoreochromis alluaudi*.

III.3 *Molluscs as Destroyer of Buildings in Coastal Regions, Stoppage in the Canalization*

There are shallow-burrowers which make galleries into wood, limestone, rock, clay and wooden ships; they make damage in wooden and limestone buildings lying in sea water on coastal regions as harbour, also in pillars of wooden bridges and dams for example. Well known is *Teredo navalis* L. (Common Shipworm), making extraordinary destructions of dams in the Holland of the 17th and 18th century.

Some bivalves borers such as *Pholas dactylus* L. (Common Piddock) and *Xylophaga atlantica* Richardson in the wood show obvious structural modification of the foot including a suckerfoot or a gaping shell with tiny teeth like a rasp or file. *Lithophaga lithophaga* L. (Stone- or Sea-Date) bore chemically in limestone. The shell of *Teredo navalis* L. is reduced and is taken as "Augerblades" in boring. They therefore are named also *Martesia striata* (L.), *Petricola pholadiformis* Lamarck (American Piddock). *Ensis ensis* (L.), (Atlantic Jackknife Clam, Razor-Clam) and *Solen viridis* Say (Green Jackknife Clam) have parallel valves.

At a high population density some species of freshwater molluscs can make total stoppage in canalization like the mussel *Dreissena polymorpha* (Pallas), what it was in Holland, and the snails *Physa acuta Draparnaud, Pseudosuccinea columella* Say and *Radix peregra* (Müller).

Petricola pholadiformis was transported occasional from America to England and has become wide dispersion over the Atlantic (North Sea to South Norway), Mediterranean Sea, Black Sea, North America.

IV. Man as "Enemy" of the Molluscs

Environmental Pollution, Destruction of Molluscs-Biotopes and their Ecological Community

Gastropods and mussels are in danger by many activities of man. He destroys their biotopes on land and in water and their ecological community.

There are many causes like chemical, mechanical and physical. The protection of species has necessary the protection of the biotope and therefore the ecosystem. These problems, especially the protection of the ecosystem in the agriculture brings BRAUNS (1985). Information gives the Pesticide-Report (1991) and the journals "Bull. Environmental Contamination and Toxicology", "Environmental Bull" and the review of GODAN "Relationship between "Man and Molluscs""(in press).

1. *Expansion of Industry, Agriculture, Mobility, Traffic and others*

Fatal to molluscs is the expansion of industry, agriculture, roadways, motorroads, motorcars, camping, ships, mass tourism and the other activities of man to regions which have remained natural until now, also important the no-attention to the reservates sometimes.

The causalities of non-chemical damage are especially to:

Terrestrial and amphibious gastropods:
1. intensive activity in the architecture and therefore strong decrease of the underground water level
2. desiccation of swamps, marshland and humid meadows
3. pollution of fields and meadows with nitrogen by very much application of urine and faeces from animals for use in massfarming
4. intensive culturing the fields in agriculture
5. destruction of weed in the border of fields, in hedge and talus
6. damaging the wood and non-cultivated fields by rotting out and intensive pasture.

Freshwater snails and mussels:
1. intensive canalization and destruction of natural plantation on the border of rivers and lakes
2. change of the normal temperature in the waterbody by overheating from the water of cooling-institutions
3. pollution in the water with phosphoric compounds of contaminated household-water
4. Damage by strong phosphate contaminated water with the effect of strong eutrophying of the algae and therefore to come about a great lack of oxygen in the water body.
5. Destruction of the plantation on the border of river and lake.

Marine molluscs:
1. Pollution in the shelf sea by phosphate contaminated water from the great rivers for example Elbe, Rhine, Rhône.
2. Lack of oxygen in the water by strong eutrophy of marine algae.
3. Enrichment of sulphurhydrogen and rotting mud as result of the extraordinary eutrophy of plancton which cannot be going off on natural way now.

The pollution of the molluscs biotopes on land and in water with residues of chemicals as the pesticides (DDT, Dieldrin, Endrine), herbicides, phosphoric esters, heavy metals, products to protect timber wood, oil and toxic substances play today a role. The molluscs are very sensitive and accumulate the residue in their body so much that they are very helpful to man as indicators for pollution (see chapter II, 7.2).

In Europe all great seas are in danger: the North Sea and especially the Wadden Sea, the Baltic Sea as well as today the Mediterranean Sea. Heavy metals like anorganic compounds have increased extraordinary in the southern North Sea. Tributyltin-compounds against rotting algae at the ship-body are very toxic to *Mytilus edulis, Crassostrea virginica* and *Crassostrea gigas*. In the North Sea there are large TBT-effects by contaminated household-water and other sources (EBING and KIRCHHOFF: Gas Chromatography of Pesticides, Tabular Literature Abstracts, Series XVIII, Mitteil. Biolog. Bundesanstalt, Berlin-Dahlem, H. 275, 1992).

The situation in the Baltic Sea is similar to that in the North Sea. But much more by reason of is the relatively very little depth (only 60m in diameter) of the water body and in connection with them the great sensibility for pollution in the water of the Baltic Sea.

In 1975 was founded the project "Mussel-Watch" (Intercomparison of trace level constituent determination) to have a global monitoring about danger to marine coasts and the ocean by pollution with heavy metals and radionuclides: "The "Mussel-Watch" - a first step in global marine monitoring" (GOLDBERG 1975). As indicators for trace metals and radionuclides are applicable: *Mytilus edulis* (L.), *Mytilus minimus* (Poli) and *Littorina littorea* (L.). *Mytilus edulis planulatus* (Lamarck) is an indicator for heavy metals especially cadmium.
More indicators are listed in chapter II, 7.2.

V. Man as "Protector" of the Molluscs

PLARRE (1985) names economical and ecological reasons for protecting vegetation and animals and therefore the genetic variability in the nature. The following causality in the relationship between man and molluscs may be principal, I think:

1. Economical point of view: Mytili-, Ostréi- and Aquaculture, Snail-Farming and also mother-mussels as producer for pearls play a role. But in consequence of the pollution by chemical substances and mechanical activity of man many valuable species of used mussels and snails are damaged or dying out. There is no more profit by culturing them.
2. Ecological point of view: In the ecosystem the molluscs have a role as producer of humus, necessary in the nature and agriculture, gardens for example. They are also valuable members in the food-chains of many animals, also man.
3. Ethical point of view: The molluscs are a great phylum in the world of animals and therefore they are important in the ecosystem.

An intact nature in land and water is the precondition for the health of man. Therefore the molluscs are a famous member in the relationship to man.

1. *Survey to dispersal, Mapping of Molluscs-Species, "Red-List"*

The mapping of terrestrial, freshwater and marine molluscs in their biotopes is necessary for the "European Invertebrate Survey" (E.I.S.) and the "Red List" ("Check-Lists"). This work is the main activity of the "Projektgruppe Molluskenkartierung" founded by JUNGBLUTH. In the years 1972-1986 there were collected dates of 200 000 publications and the database has more than 3 000 titles.

The search of gastropods and mussels in their biotopes is not facil everytime; it is difficult, for example, by the manysided behavior of the molluscs, possibility of disappearance into cracks of the ground or into bushes and strong plantation, change between illumination and darkness, temperature and others. The middle European slugs are fully active in the first night when the light is going away, in the evening, and then at increasing light in the morning. Furthermore this rhythm in the activity would be influenced by the special times of the year as spring, summer, autumn and winter.

In many countries of Europe exists a Survey-Atlas for special groups of molluscs as in Germany, France, England, Holland, Denmark, Norway, Sweden, Finland, Switzerland, Austria and some other areas.

The criteria of the "Red List" is named like in the "Red Data Book" of the "International Union for Conservation of Nature and Natural Resources" (IUCN). 5 categories characterize the damage in the single species:

0 = dying out or is not found
1 = damaged as much as dying out
2 = strongly damaged
3 = damaged
4 = potentiality of damage, only staying in little populations on the border of the area, in which was living the population when it was great.

Very strongly damaged or dying out are *Margaritifera margaritifera* (L.) (Freshwater Pearl Mussel) and *Unio crassus* Retzius. *Margaritifera margaritifera* was in the Middle-Ages the basis for the "Pearlfishing". Damaged by overfishing are *Strombus gigas* L. (Queen Conch) and *Tridacna gigas* Lamarck (Giant Clam), the genera *Epioblasma* (USA), *Achatinella* (Hawaii), *Patella* (Island Morea). Of the damaged *Haliotis*-species the marine snail *Haliotis tuberculata* L. on the coast of the island Guernsey (Europe) is dying out now. India would stop the commercial overfishing of *Trochus niloticus* (Commercial Trochus), *Turbo marmoratus* L. (Green Turbo) and *Turbinella pyrum* L.

2. *Rules, Legislation, Reservates*

In Germany exists the rule "Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz)", in the form of 12.3.1987. Analog the "Bundesartenschutz-Verordnung of 19.12.1986 the following species are especially protected: *Helix pomatia, Helix aspersa, Unio-,* and *Anodonta* - species, *Pinna nobilis.* Damaged by dying out are *Margaritifera margaritifera, Pseudanodonta complanata, Pseudanodonta elongata, Pseudanodonta middendorffi, Unio crassus* and the European Oyster *Ostrea edulis.*

In France exists the rule "La Loi sur la Protection de la Nature" with several novelettes and there are more species protected than in Germany. Totally forbidden for "Collecting at all times":

Helix melanostoma (Escargot terrassier)
Helix aperta (Escargot naticoide)
Helix tristis (Helix de Corse)
Tacheocampylaea raspaili (Escargot de Raspail)
Macularia niciensis (Escargot de Nice)
Otala apalolena (Otala de Catalogne)
Elona quimperiana (Escargot de Quimper)
Rumina decollata (Bulime tronqué)
Margaritifera margaritifera (Moule d'eau douce, Molette).

In Finland *M. margaritifera* is since 1955 one of the most protected species. At the beginning of this century the mussel was all over and habitated in more than 200 rivers and water courses, but today it lives only in 60 areas.

To protect the European Seas (North Sea, Baltic Sea, Mediterranean Sea) the frontiere countries have arranged the institution "Réglement (CES) - Communité économique européene" - "pour la protection de l'environment des zones côtières de la mer d'Irlande, de la mer du Nord, de la Manche, de la mer Baltique et de la partie nord-est de L'océan Atlantique (Norspa)" especially the "Action Norspa" (DANKERT 1991). The protection of the Baltic Sea is based on the Convention of Helsinki 1974. "The Conference pour la protection de la Mer Baltique" was 1979 (RICOU 1979).

The protection of genetic resources is absolutely compatible with the common protection of species (plants and animals) and that of landscape (PLARRE 1991). To have an ecosystem with his characteristic preciseness and in consequence with a great genetic variability there are necessary strongly protected areas, and also profitable to snails and mussels: For example the Wadden Sea in biotopes which are free from activities of man, and like in Holland the reservates Rammekenshoek and "Duin-reservat" (North-Holland) (BUTOT) and in Hungary the "Kiskunság National Park" and "Tisza district and Pusztaszer Regional Conservation Area" (BABA 1988).

At present exists a reservate especially for gastropods, founded by PAGET (former member of the Museum of Natural History, Vienna) in Bad Vöslau near Vienna (Austria), to protect fossil species of the Ice Age: *Fagotia acicularis audebartii* Prevost, *Bytinella parreissii* L. Pfeiffer and *Theodoxus prevostianus* C. Pfeiffer.

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Man as "Consumer"; the Molluscs as "Friend"

1. Nahrungsmittel - Foodstuffs

1.1 - 1.2.1 Gastropoda (terrestrische und marine/ terrestrial and marine)
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6 Kunst - Arts
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7. Forschung - Research

7.1 Objekte zum Studium der Lebensfunktionen des Menschen (Physiologie, Immunität, Blut, Carcinom u.a.)
Objects for Studying the Life-Functions of Man (Physiology, Immunity, Blood, Carcinom etc.)

7.1.1 Gastropoda (Terrestische, Terrestrial)

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III. Der Mensch als "Geschädigter"; die Mollusken als "Feind"
Man in Danger; the Molluscs as "Enemy"

1. Phytomedzin - Phytomedicine
- in einem späteren Heft der "Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem"-
will be published later in one of the next "Mitteilungen aus ..."

2. Human- und Veterinärmedizin
Human- and Veterinary-Medicine

2.1 - 2.2.2 Transportwirte
Zwischenwirte für parasitische Würmer bei Mensch und Tier
Carriers für Agents of Diseases Freshwater- or Land-Snails as Intermediate Hosts for Larvae of Parasitic Worms: Trematoda, Nematoda, Cestoda

2.2.2.1 Schistosoma sp. (Bilharziose)

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III.2.

2.2.2.2 Parasitische Würmer, außer Schistosoma
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III.2.

2.2.2.3 Bekämpfung der Zwischenwirte
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III.

3. Beschädigung meerumspülter Bauten
Molluscs as Destroyer of Buildings in Coastal Regions

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IV. Der Mensch als "Feind" der Mollusken
Umweltbelastung, Zerstörung der Biotope

Man as "Enemy" of the Molluscs
Environmental Pollution, Destruction of Molluscs-Biotopes

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V. Der Mensch als "Beschützer" der Mollusken
Bestandserhebung, Kartierung, "Rote Liste", Verordnungen

Man as "Protector" of the Molluscs
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