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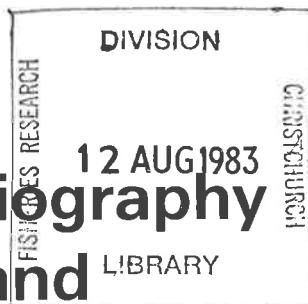
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An Annotated Bibliography of New Zealand Marine Mussels (Mytilidae) 1880-1982

by
R. W. Hickman

**Fisheries Research Division
Occasional Publication No. 40**

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of New Zealand
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Contents

	<i>Page</i>
Introduction	3
Nomenclature	5
Bibliography	7
Index	43

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Introduction

It may seem that the following list is a scanty one; but it is to be borne in mind, as accounting for this, that students at this end of the world labour under great disadvantages in the matter of reference libraries of scientific works.

Alex Purdie, 1887.

Purdie (No. 235), in the earliest publication devoted to New Zealand mussels, cited 12 references, only 1 of which, Hutton's "Manual of the New Zealand Mollusca" (No. 180), was a New Zealand publication.

Nearly a century later the problem is no longer the paucity of references, but rather, how to locate the appropriate references in the rapidly expanding volume of literature on New Zealand mussels.

The need for a bibliography exclusively on one family of New Zealand molluscs resulted from the advent of mussel farming, which began experimentally in the late 1960s. Most of the literature on mussels published since then is, directly or indirectly, about mussel farming or the biology of mussels in relation to farming. This literature includes scientific papers and many less formal publications, notably the fishing magazines *Catch* (and its quarterly supplement *Shellfisheries Newsletter*) and *Commercial Fishing*, and the *N.Z. Fishing Industry Board Bulletin*. These industry magazines contain much useful information that is not available elsewhere, and many of the anonymous citations in the bibliography refer to them. When 2 articles in different magazines cover the same topic (usually a meeting or a "news" item), only the earlier article is cited.

These anonymous references also give a valuable historical perspective to the development of the mussel farming industry in New Zealand. The detailed information they contain on the problems (biological and sociological) which have bedevilled the industry, and the solutions (by use of technology, science, and planning) which have allowed its development, has not previously been collated.

Several references have not been formally published, but have been included here because of the useful data or comment they contain.

Three earlier bibliographies included references to literature on New Zealand mussels. Fletcher (1973)* cited and annotated 28 references, 13 of which were derived from 1 seminar report. Paul (1979)† and Willan (1981)‡ included 40 and 36 mussel references respectively; neither of these publications was annotated. All appropriate references from these 3 bibliographies are included here.

Not cited here are the annual *Report on Fisheries* by the Ministry of Agriculture and Fisheries (the Marine Department from 1902 to 1972) and the annual *Report of the N.Z. Fishing Industry Board*. These reports contain data on the landings of the mussel fishery and much general information on mussel fishing and farming.

The legislation on mussel farming in New Zealand is contained in the Marine Farming Act 1971, and in its 1975, 1976, and 1977 amendments, published by the Government Printer.

A recent additional source of information and comment, specifically on

mussel farming, is the newsletter of the Marlborough Sounds Marine Farming Association. It is circulated regularly to all members.

Selected university theses and projects, though not readily available to the general public, are included because of the observations they contain on the biology of the New Zealand Mytilidae. The published literature has little information on this subject. Theses in which mussels have been studied as part of a much wider investigation of, for example, shoreline or plankton ecology are not included. The same applies to formal publications on such general topics; only a few are included and only when the observations they contain on mussel biology provide significant information. However, many of the books about the New Zealand sea-shore have useful information on mussels, and the classic volume, Morton and Miller (1968)§, probably has more data on population structure and distribution of mussels throughout the country than any other source.

No attempt has been made to include the increasing number of handbooks on New Zealand sea shells, though these invariably contain data on the form and function, distribution, and ecology of some or all of the mytilids, and they frequently include photographs of use in identification. "Shells of New Zealand" (No. 233) is included as a standard handbook and check-list, and the early manuals of Hutton (No. 180) and Suter (No. 249), with Powell's more recent authoritative tome (No. 234), give detailed taxonomic and reference information for all the New Zealand Mytilidae.

There are few references to the palaeontology of mussels in New Zealand because this specialist topic has been adequately covered by Fleming's paper on

Recent and Tertiary mytilids (No. 138) and in the extensive literature citations of Suter (No. 249) and Powell (No. 234).

The water quality and maritime planning aspects of mussel fishing and farming have occupied the attention of many persons recently, but there have been few publications on these subjects. References to the water resource investigations made by a catchment commission (No. 250 and 251) and the reports of 2 planning studies for mussel farming (No. 196 and 197) are included. No attempt has been made to abstract internal reports or data from the files of water boards, catchment commissions, harbour boards, government departments, and other planning authorities.

This bibliography will achieve at least one of its aims if it can be used as the basis to the answer to that question, asked of the author with increasing frequency, "Can you tell me all about mussels and mussel farming?"

°FLETCHER, W. S. 1973: Studies on commercially viable species of New Zealand Mollusca; a select annotated bibliography. Wellington Library School, National Library of N.Z., 43 p.

†PAUL, L. J. 1979: A bibliography of the literature about New Zealand's marine and freshwater commercial fisheries, 1840-1975. *Fisheries Research Bulletin, N.Z. Ministry of Agriculture and Fisheries, No. 16.* 43 p.

‡WILLAN, R. C. 1981: Bibliography of publications on New Zealand Mollusca (1973-1980). *Miscellaneous Publication, N.Z. Oceanographic Institute, No. 9-4.* 50 p.

§MORTON, J., and MILLER, M. 1968: "The New Zealand Sea Shore." Collins, Auckland. 638 p.

Nomenclature

The 12 New Zealand species of bivalve molluscs in the family Mytilidae have had many name changes. None of the species names used by Purdie (1887) (No. 235), in the first authoritative paper on New Zealand mussels, were thought to be correct by Powell (1979) (No. 234), in the definitive publication on New Zealand Mollusca. The nomenclature used in the source publications has been maintained throughout the citations in this biblio-

graphy, but the common names, currently accepted scientific names, and some synonyms are given below.

Atrina zelandica (the horse mussel or fan mussel), which is commonly found in estuarine sand flats and is of increasing economic importance, is not a member of the Mytilidae, but is the sole New Zealand representative of the closely related family, the Pinnidae. It is not included in this bibliography.

New Zealand marine mussels (Mytilioda, Mytilidae)

Common name	Scientific name	Synonyms
Blue mussel	<i>Mytilus edulis aoteanus</i>	<i>M. edulis</i> , <i>M. planulatus</i>
Green-lipped mussel	<i>Perna canaliculus</i>	<i>M. canaliculus</i> , <i>M. latus</i>
Small black mussel	<i>Xenostrobus pulex</i>	<i>Modiolus neozelanicus</i>
Brown mussel	<i>Xenostrobus securis</i>	<i>Modiolus fluviatilis</i> , <i>Volsella fluviatilis</i>
Ribbed mussel	<i>Aulacomya maoriana</i>	<i>Mytilus magellanicus</i>
Nestling mussel	<i>Modiolarca impacta</i>	<i>Musculus impactus</i> , <i>Ryenella impacta</i>
Hairy mussel	<i>Modiolus areolatus</i>	<i>Modiolus australis</i>
Boring mussel	<i>Lithophaga truncata</i>	<i>Zelithophaga truncata</i>
Deepwater species	<i>Gregariella barbata</i>	<i>Trichomusculus barbatus</i>
	<i>Crenella radians</i>	<i>Dacrydium radians</i>
	<i>Dacrydium pelseneeri</i>	<i>Quendreda pelseneeri</i>
	<i>Septifer bilocularis</i>	



Xenostrobus pulex



Modiolarca impacta



Modiolus areolatus



Aulacomya maoriana



Mytilus edulis aoteanus (wild)



Mytilus edulis aoteanus (cultivated)



Perna canaliculus (wild)



Perna canaliculus (cultivated)

The 6 mytilid species most commonly found around New Zealand, with the modified shell form which results from cultivation of the blue and green-lipped species.

Bibliography

1. ANON. 1963: Mussel shortage raises Auckland prices. *Commercial Fishing 1 (9)*: 8.

A mussel shortage has caused the sole supplier to the Auckland market to increase the price to 5d per cooked mussel, with a wholesale price of 2/- per pound (9c per kilogram) and a retail price of 2/11 to 3/1 per pound.

2. ANON. 1968: F.I.B. will subsidise mussel research in Sounds. *Commercial Fishing 7 (11)*: 40.

The Fishing Industry Board is supporting experiments by Victoria University of Wellington into the suitability of certain areas for the cultivation of mussels.

3. ANON. 1968: Fishery men meet to discuss mussel farming prospects. *Commercial Fishing 7 (12)*: 13.

A meeting of members of the Auckland fishing industry heard the views of the director of the Fisheries Research Division, Marine Department on the potential of mussel farming and in particular the suggestion, supported by the industry, that the department should not become involved in the development work.

4. ANON. 1968: Closed mussel season—by request? *Commercial Fishing 7 (12)*: 31.

A 4-month closed season for the fishery between Cape Farewell and Cape Campbell is said to have resulted from fishermen's requests. Limits on Nelson and Marlborough mussel fisheries may be reviewed.

5. ANON. 1969: High hopes for mussel farming in Pelorus Sound. *Commercial Fishing 8 (5)*: 32.

In a discussion on a proposal to make part of Pelorus Sound a maritime park, it was suggested that if half the 50 000 acres (20 250 ha) was devoted to mussel farming it could be expected to yield 130 000 tons (132 080 t) of mussels worth NZ\$6 million at the (then) current Australian price of \$2.15 per hundredweight (A\$0.04 per kilogram).

6. ANON. 1969: Minister optimistic over mussel farming. *Commercial Fishing 8 (6)*: 36.

A better future for mussel farming than for oyster farming was suggested by the Minister of Marine during a discussion on shellfish farming on Maori reserves. The Hokianga Harbour area was thought to be well suited to mussel farming.

7. ANON. 1969: Mussel dredging starts in Sounds. *Commercial Fishing 8 (8)*: 17.

Mussel dredging is opposed by locals who fear it will be detrimental to snapper fishing. There are 27 boats working the area.

8. ANON. 1969: Fisheries inspector stresses importance of Tauranga as mussel spat area. *Commercial Fishing 8 (9)*: 34.

The settlement of mussel spat on moored buoys in the entrance to the harbour suggests it could be a suitable area for the collection of spat to supply mussel farms throughout the Bay of Plenty.

9. ANON. 1969: Big plans for mussel farming in Marlborough Sounds. *Commercial Fishing 8 (10)*: 38.

Development plans for, and potential production from, mussel farming in the Sounds are discussed, and the requirement for fundamental biological research is noted.

10. ANON. 1969: Bright prospects for mussel farming in M'borough Sounds. *Commercial Fishing 8 (11)*: 37.

A meeting of local farmers, the Marine Department, the Fishing Industry Board, and intending mussel farmers heard one company's plans to establish mussel rafts in Kenepuru Sound and an assessment of the potential size of the industry.

11. ANON. 1969: Lease applications for Tauranga sites are opposed by harbour board. *Commercial Fishing 8 (12)*: 13.

Mussel and oyster farm applications were opposed on the grounds of conflict with public usage of the areas.

12. ANON. 1969: Committee visits Whangamata to look at mussel farm prospects. *Commercial Fishing 8 (12)*: 30.

A local bodies committee visited the area after an objection by the Whangamata local authority to a mussel farm application. The grounds of the objection were that the farm would be detrimental to recreation and dangerous to navigation.

13. ANON. 1970: OK given for M'boro Sounds farming. *Commercial Fishing 9 (1)*: 20.

Verbal permission from the Marine Department for Associated Fishermen (Nelson) Limited to start mussel farming is reported. Three 60 by 25 ft (18 by 8 m) rafts, each carrying 400 specially made

25-ft-long ropes, would be moored in Kenepuru Sound. A turnover of \$80,000 is expected during the first 5 years.

14. ANON. 1970: Green light from Govt. on Tauranga mussel farming. *Commercial Fishing 9 (2)*: 9.

Difficulties in drafting acceptable lease agreements under the Marine Farming Act 1968 are delaying the establishment of mussel farming in Tauranga Harbour, but the Marine Department has given the go ahead provided that intended mussel farms are acceptable to the harbour board.

15. ANON. 1970: First mussel rafts now moored in Marlborough Sounds. *Commercial Fishing 9 (4)*: 17.

The establishment of the first 3 mussel rafts in Kenepuru Sound is reported. The construction of the rafts and the mooring operation are described.

16. ANON. 1970: Mussel experiment in the Sounds. *Commercial Fishing 9 (7)*: 10.

The first spatfall on the mussel rafts in Kenepuru Sound was below expectations. The mussel farming company has suggested certain provisions related to raft design, mooring, and navigation that should be included in a marine farming act.

17. ANON. 1971: F.I.B. seminar predicts . . . bright future for N.Z. mussels. *Bulletin, [N.Z.] Fishing Industry Board, 6 (4)*: 1-2.

This report gives details of the participants, the papers presented, and the discussion generated at the mussel cultivation seminar.

18. ANON. 1971: Future of mussel cultivation linked with pollution control. *Commercial Fishing 10 (11)*: 4-5.

This report of the Fishing Industry Board sponsored seminar concludes that commercial success will depend on further research and assistance from the Marine Department, Victoria University of Wellington, and the Fishing Industry Board and on the maintenance of pollution-free growing areas.

19. ANON. 1972: Latest news from the mussel farming front. *Bulletin, [N.Z.] Fishing Industry Board*, 7 (4): 10.

Despite the lack of spat in the autumn of 1972, mussel rafts of various designs are being established in the Sounds. The seeding of ropes with small wild mussels is proposed. A Victoria University of Wellington research programme, a meeting between the harbour board and parties interested in mussel farming, the Waiheke Island experiments, and a Fisheries Research Division, Marine Department survey are briefly mentioned.

20. ANON. 1972: Thieves set back shellfish farming experiments. *Commercial Fishing* 11 (10): 4.

Losses of equipment and mussels through pilfering, despite the remote siting of the experimental rafts, have affected research into mussel farming.

21. ANON. 1972: Mussel growing programme in Bay of Plenty. *Commercial Fishing* 11 (10): 15.

The Ministry of Agriculture and Fisheries and the Tauranga Harbour Board are co-operating in a research programme to determine how effectively mussels can be caught and grown in the harbour and to ensure that commercial mussel farming is compatible with other harbour uses.

22. ANON. 1973: Mussel farmers meet in Blenheim. *Bulletin, [N.Z.] Fishing Industry Board*, No. 27: 3.

A Fishing Industry Board workshop discussed matters of interest to mussel farmers and the regulatory bodies concerned with the development of this new industry. The topics included current studies on growth and settlement and problems in licensing and mooring.

23. ANON. 1973: Mussel survey this month. *Commercial Fishing* 12 (8): 5.

A survey of suitable farming areas around Coromandel Peninsula and Waiheke Island will be undertaken in response to applications for leases. One company has applied for 84 acres (34 ha) to grow mussels on frames on the sea bed.

24. ANON. 1973: Mussel process not on. *Commercial Fishing* 12 (12): 14.

Processing green-lipped mussels to obtain the substance needed for a drug to relieve arthritis is thought to be impractical, because the 20 000 t required need to be harvested within 2 months and the mussels have to be opened raw without damage.

25. ANON. 1974: Mussel farming break through. *Bulletin, [N.Z.] Fishing Industry Board*, No. 28: 12.

Spatfall monitoring by plankton and spat settlement sampling at 20 sites in the inner Sounds is discussed.

26. ANON. 1974: Fouling problems beset mussel rafts. *Bulletin, [N.Z.] Fishing Industry Board*, No. 29: 6.

The fouling of ropes and smothering of young mussels by colonial ascidians can be combated by dipping the ropes in 23% saline solution for 15 minutes. Autumn mussel settlement is less prone to fouling.

27. ANON. 1974: Mussel workshop at Blenheim. *Bulletin, [N.Z.] Fishing Industry Board*, No. 31: 7.

The second Fishing Industry Board mussel workshop, with 35 participants, discussed farming technology, research, licensing, and the marketing potential of farmed mussels.

28. ANON. 1974: Experimental shellfish work holds forth promise. *Catch '74* 1 (2): 16.

Good meat growth during the first year green-lipped mussels were grown on a raft in Kenepuru Sound is reported in this article on scallop dredging.

29. ANON. 1974: Dredging has killed tons of mussels. *Commercial Fishing* 13 (10): 25.

Mussel beds have been smothered by silt from dredging operations in Tauranga Harbour.

30. ANON. 1974: Mussels cause health concern. *Commercial Fishing* 13 (11): 27.

Mussels purchased from an itinerant hawker were suspected of causing a typhoid outbreak. Sales of shellfish subsequently dropped dramatically.

31. ANON. 1974: Fish farm prospects in New Zealand. *Fish Farming International* 2: 79-82.

The recent development of mussel farming is mentioned in a superficial discussion of aquaculture prospects. Mention is made of 4 commercial rafts, the Fishing Industry Board spat prediction service, and the Ministry of Agriculture and Fisheries hatchery rearing work.

32. ANON. 1975: Board's mussel workshop. *Bulletin, [N.Z.] Fishing Industry Board, No. 35*: 9.

The third mussel workshop, attended by 50-60 people, discussed mussel farming and the problems involved, research,

processing, and marketing. The discussion led to the constitution of the Marlborough Sounds Marine Farming Association.

33. ANON. 1975: Long-line mussel farming shows promise. *Catch '75* 2 (4): 6-7.

The introduction of longlines could revolutionise mussel farming in the Marlborough Sounds and permit full development of the 84 ha of water in the inner Sounds that are suitable for marine farms. The advantages of longlines over rafts are that they are less of an eyesore, less of a navigational hazard, cheaper, and more versatile and they provide more uniform growing conditions. Licensing and spat catching are discussed.

34. ANON. 1975: Mussels are being well developed at New Zealand's only shellfish hatchery. *Commercial Fishing* 14 (5): 8-9.

An Auckland mussel company claims to have patented a method of rearing shellfish in a hatchery. The company suggests that green-lipped mussels being held live in San Francisco threaten the future of mussel farming in New Zealand.

35. ANON. 1975: Mussels from Marlborough. *Commercial Fishing* 14 (7): 11.

The longline system should be beneficial in terms of costs, aesthetics, and production in comparison with the use of rafts. Mussel production from Pelorus and Kenepuru Sounds could be worth \$500,000 at \$300 per tonne.

36. ANON. 1975: Farming licence for Marlborough Sounds. *Commercial Fishing* 14 (11): 7.

The granting of the first mussel farming licence to the NZ Marine Culture Company for its farm in Ruakaka Bay, Queen Charlotte Sound is reported.

37. ANON. 1975: Mussel farming restricted. *Commercial Fishing* 14 (12): 3.

Forty-two applications for mussel farms have been deferred by the Marlborough Sounds Maritime Park Board until a common policy has been formulated by all local authorities. The board believes licences are preferable to leases.

38. ANON. 1976: Blenheim mussel workshop. *Bulletin, [N.Z.] Fishing Industry Board, No. 39*: 11.

The annual workshop concentrated on harvesting, processing, and marketing, but also included reports on Ministry of Agriculture and Fisheries and university mus-

sel investigations and comments on financial aspects of mussel farming.

39. ANON. 1976: Good news for mussel farmers. *Commercial Fishing* 15 (1): 12.

The Ministry of Agriculture and Fisheries and the Ministry of Transport have resolved conflicts over mariculture and navigation and processed 4 mussel farm applications. A further 57 lodged to date should be processed by June.

40. ANON. 1976: Mussel farmers allowed loans. *Commercial Fishing* 15 (9): 3.

Mussel farms are eligible for development loans of up to \$13,000 for a longline



Mussels are, perhaps, the most characteristic zone-forming organisms of the intertidal rocky shore. They often occupy a broad band between the barnacles of the upper shore and the large brown seaweeds at extreme low water.

farm and \$20,000 for a raft farm at 7½% interest over a 5-year period.

41. ANON. 1977: Mussel farmers form co-operative. *Catch '77 4 (5): 7.*

A mussel farmers' co-operative, with an initial membership of 32 growers, is to be formed to distribute the expected crop of 300 t and to develop co-operative harvesting, processing, distribution, and marketing.

42. ANON. 1977: Mussel farming comes of age. *Catch '77 4 (6): 3-4.*

With a crop of 300 t from the 20 established farms, mussel farming has become New Zealand's second aquaculture industry. A synopsis of mussel farming techniques includes observations on the role of the mussel farmers' co-operative in the future expansion of the industry.

43. ANON. 1977: Assistance and incentives for fishermen. *Catch '77, October Supplement. 13 p.*

Information is given about mussel farm development loans of up to 50% of initial costs, sales and income tax concessions on development expenditure, and incentives for mussel farmers.

44. ANON. 1977: Moratorium placed on mussel farming. *Commercial Fishing 16 (1): 11.*

A 2-year moratorium on mussel farming in Tolaga Bay was imposed to permit Ministry of Agriculture and Fisheries trials of spat catching and growing techniques.

45. ANON. 1977: Mussel farming operation a big success story. *Commercial Fishing 16 (10): 17, 19.*

McFarlane Laboratories Limited's mussel farming and processing operation is described, with particular emphasis on the export potential of "Seatone" mussel extract.

46. ANON. 1977: Mussel marketing committee set up. *Commercial Fishing 16 (11): 9.*

A 12-man committee of mussel farmers has been formed to organise the harvesting and marketing of mussels through the Nelson Packhouse Co-operative Limited.

47. ANON. 1977: Pacific oyster invades the South Island. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 1: 2.*

The discovery of Pacific oyster settlement on mussel ropes in the Marlborough Sounds is reported. (A 5-line note.)

48. ANON. 1978: Mussel workshop draws large attendance. *Bulletin, [N.Z.] Fishing Industry Board, No. 47: 11.*

More than 130 people attended the sixth annual workshop and heard of the success of the first year of operation of the Nelson Packhouse Co-operative Limited in mussel marketing. Discussion sessions covered biology, equipment, economics, and processing, and there was a proposal to form a national aquaculture federation of mussel and oyster farmers.

49. ANON. 1978: Hatchery's work may lift oyster egg survival rate 50-80%. *Catch '78 5 (2): 21-2.*

Hatchery work with the green-lipped mussel has shown that it is difficult to rear the larvae through to settlement. Blue mussels are relatively easy to rear.

50. ANON. 1978: Mussel farms in demand. *Catch '78 5 (4): 5.*

From a total of 109 applications (since 1970), 42 licences have been issued, with 22 to be offered over the next 3 months. The cost of setting up a farm, the market value of mussels, and the involvement of the mussel farmers' co-operative in the industry are discussed.

51. ANON. 1978: Assistance and incentives for fishermen. *Catch '78, July Supplement*. 11 p.

Information is given about loans and tax deductions available to encourage development of mussel farming. This reference updates Anon. 1977 (No. 43).

52. ANON. 1978: Successful mussel season in the Sounds. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 2*: 3.

Late spatfall, but dense settlement, is reported. (A 4-line note.)

53. ANON. 1979: Mussel export factory planned for Havelock. *Bulletin, N.Z. Fishing Industry Board, No. 48*: 12.

The factory, with a staff of 10, will process farmed mussels for export at a rate of 10–20 t per day.

54. ANON. 1979: Pesticides no problem. *Catch '79 6 (1)*: 20.

Three-monthly analyses of cultivated green-lipped mussels from 6 sites in the Marlborough Sounds showed no residues of DDT, lindane, or PCBs.

55. ANON. 1979: [No title.] *Catch '79 6 (5)*: 21.

The results of a 4-year test by a Glasgow hospital on New Zealand mussel extract are claimed to be “extremely encouraging”. The manufacturer hopes to have the extract accepted as an ethical drug.

56. ANON. 1979: Mussel processing should mechanise slowly. *Catch '79 6 (8)*: 8.

The engineer of the Nelson Packhouse Co-operative Limited suggests that the mechanisation of the processing of cultivated mussels should be a gradual process

and concentrate initially on bulk handling from the point of harvest to the factory.

57. ANON. 1979: Growing demand for licences. *Catch '79 6 (10)*: 21.

Applications for mussel farm licences have increased from 7 in 1977, to 107 in 1978, and 92 in the first 9 months of 1979. At the time this article was written, the Ministry of Agriculture and Fisheries was processing 257 applications with 63 of them “under offer”.

58. ANON. 1979: More muscle needed in education. *Catch '79 6 (10)*: 31.

The president of the Marlborough Sounds Marine Farming Association suggests the cultivated mussel needs its own distinctive name.

59. ANON. 1979: Cost added to shellfish. *Commercial Fishing 18 (2)*: 31.

The Marlborough Harbour Board has imposed a wharfage charge of 17c per 18-kg sack of mussels (8c per sack for other shellfish).

60. ANON. 1979: About face on licences. *Commercial Fishing 18 (11)*: 25.

Pressure from objectors led the Northland Harbour Board to reverse an earlier decision and object to all 3 applications for mussel farms in Whangaroa Harbour on the grounds of undue interference with recreational fishing and boating. The board will request the Ministry of Agriculture and Fisheries to designate possible mussel and oyster farming areas in all Northland harbours.

61. ANON. 1979: Sounds amused. *Commercial Fishing 18 (12)*: 36.

The number of Ministry of Agriculture and Fisheries staff with interests in mussel licences is questioned in a brief report that 117 licences have been approved, 194 applications are being considered, and 6 farms have been sold.

62. ANON. 1979: Declaring areas in the Marlborough Sounds not available for marine farming licences or leases (Notice No. 2211, Ag. 54/7/1). *N.Z. Gazette*, 16 August 1979, No. 76: 2435.

A series of 60 maps which constitute the Marlborough Sounds Marine Farming Plan No. M.A.F. 147 are gazetted. The maps define the areas not available for marine farming for 5 years.

63. ANON. 1979: Mussel spatfall, Marlborough Sounds. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 4: 4.*

Southerly weather conditions are a prerequisite for successful spat catching in the Crail Bay-Beatrix Bay region. St Omer is suggested as an alternative commercial catching site. (A 9-line note.)

64. ANON. 1980: Genetic aspects of aquaculture. *Catch '80 7 (9): 20.*

The genetic implications of seed transfer in shellfish farming are briefly mentioned, and a current study into possible genetic differences between Marlborough Sounds and Kaitaia seed mussels grown on the same longline is reported.

65. ANON. 1980: Marine farming. [Letter.] *Catch '80 7 (9): 25.*

This brief letter from a "genuine mussel farmer" draws attention to the need for a high quality product for export and suggests controls on the resale of mussel farming licences.

66. ANON. 1980: Poor spatfall reason for ending experiment. *Commercial Fishing 19 (5): 23.*

Unreliable spatfall, poor spat maintenance, siltation, and unfavourable sea conditions were given as reasons for stopping

mussel farming experiments at Tolaga Bay.

67. ANON. 1980: Opposition to mussel licence. *Commercial Fishing 19 (5): 29.*

An application for five 3-ha mussel farms in Whangaroa Harbour is likely to meet opposition from the Northland Harbour Board on the grounds of interference with boating, fishing, navigation, and the natural scenic beauty of the area.

68. ANON. 1980: Mussel harvest finds ready Auckland market. *Commercial Fishing 19 (9): 7.*

One-third of the Marlborough Sounds annual crop of 500-800 t of mussels will be sold for preparation into mussel extract. The Nelson Packhouse Co-operative Limited expects to handle 10 000 t by 1985 and predicts an export industry worth more than \$10 million.

69. ANON. 1980: Further orders. *Commercial Fishing 19 (9): 17.*

A \$500,000 order for 100 t of mussels for freeze drying is reported by Wairau Fisheries, who currently handle 300 t per year, but have the capacity to process 2500 t. Growers are paid \$12-18 per 25-kg sack.

70. ANON. 1980: Use sought for shells. *Commercial Fishing 19 (10): 7.*

A proposal to use crushed mussel shell as road fill, instead of dumping tonnes of it at the tip, was discussed by the Richmond Borough Council.

71. ANON. 1980: Mussels ready. *Commercial Fishing 19 (12): 23.*

The Nelson Packhouse Co-operative Limited expects to begin processing mussels at its new Havelock factory in January. The \$250,000 plant will initially process 25 t per day, and later 50 t per

day, in two 15-man shifts. Half of the production is for the health food market, the rest for export.

72. ANON. 1980: Seatone in \$5 m lawsuit. *Pharmacy Digest, July*: 40.

A \$5 million lawsuit brought by a United States company against a New Zealand manufacturer of mussel extract claims breach of confidentiality. The New Zealand company's 1979 export earnings were about \$5 million. Another local company sells about 3.5 million tablets and capsules in New Zealand and overseas each year.

73. ANON. 1980: NZMJ paper due on mussel extract trial. *Pharmacy Digest, July*: 40.

The testing of mussel extract at 3 institutions is mentioned, with the results from 1 about to be published.

74. ANON. 1980: Price-cuts: right or wrong? *Pharmacy Digest, July*: 40.

Price cutting for the promotion of "Seatone" mussel extract would be against the medical code of ethics if the extract were regarded as a medicine.

75. ANON. 1980: "Marine farming: the role of the Ministry of Transport." Public Affairs Branch, N.Z. Ministry of Transport. 12 p.

This booklet outlines the legislation and policy concerned with marine farming and the Ministry of Transport's role in safeguarding navigation and public interest. Requirements and procedures for approval of mussel farming structures are described, and sample plans are provided.

76. ANON. 1980: Spatfall predictions and actual settlement. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 6*: 6.

Anomalies in mussel settlement recorded in the spatfall bulletins suggest additional factors may need to be considered in the assessment of spat catching and spat maintenance results. (A 10-line note.)

77. ANON. 1981: Mussel farming—a rapid growth industry with considerable potential. *Bulletin, N.Z. Fishing Industry Board, No. 60*: 5-6.

Actual and potential numbers of licences and production are included in this appraisal of the future development of the industry. Investment costs and labour requirements necessary to achieve the potential annual production of 30 000-50 000 t are assessed at \$30 million and 300 man-units.

78. ANON. 1981: Wellington mussel promotion. *Bulletin, N.Z. Fishing Industry Board, No. 62*: 12.

A 1-week promotion by extensive publicity and tasting opportunities throughout Wellington and the Hutt Valley is reported. (A 10-line note.)

79. ANON. 1981: New codes for mussels and chilled fish. *Bulletin, N.Z. Fishing Industry Board, No. 62*: 19.

A code of practice for handling mussels should be available in early 1982. It stresses the importance of control on pH during the marinating process and on temperature during distribution.

80. ANON. 1981: " 'An intermittent boost to the mussel industry' . . ." [and] "In a 1976 paper . . ." *Catch '81* 8 (2): 11.

Over 4.5 t of seaweed encrusted with seed mussels, stranded on Ninety Mile Beach during October-November, was gathered and consigned to mussel farmers. Seed from 1980 strandings should contribute some 500 t to the 1981-82 farmed mussel production.



The claimed therapeutic properties of an extract of the green-lipped mussel in the treatment of arthritis provided a strong impetus for the rapid development of mussel farming in the 1970s.

81. ANON. 1981: Recent fisheries regulations. *Catch '81* 8 (7): 5-6.

A 3-month closure of the mussel beds in Ohiwa Harbour is reported. The closure was necessary because of the reduction of the mussel population from 21 million in 1978 to 4.5 million in 1980. The amateur quota will be reduced from 50 to 25 when the season reopens.

82. ANON. 1981: Claim against N.Z. company. *Commercial Fishing* 20 (1): 13.

The suggestion that the promotion of mussel extract as a drug, and not just a health food, led to a United States import ban is made in this report of a \$2 million lawsuit being brought by a United States company against the New Zealand manufacturer of mussel extract.

83. ANON. 1981: Sounds. *Commercial Fishing* 20 (7): 5.

The Marlborough Sounds Maritime Planning Authority has begun a 1-year marine farming study. Submissions received by the authority have suggested local administration of marine farm licensing and clear delineation of areas for farming, and they have pointed to the dangers of log marshalling and spraying.

84. ANON. 1981: Mussel sites scarce in the Sounds. *Commercial Fishing* 20 (8): 8.

As new mussel farm sites in the Marlborough Sounds are now scarce, prospective farmers are showing interest in the more exposed waters of Tasman and Golden Bays.

85. ANON. 1981: Seatone's effectiveness doubted. *Commercial Fishing* 20 (8): 9.

Despite negative results from an 18-month trial of mussel extract at Auckland Hospital, a spokesman for the extract manufacturing company maintained that the extract had anti-inflammatory properties.

86. ANON. 1981: Mussel seminar. *Commercial Fishing* 20 (9): 18-9.

This report of the 1981 annual seminar gives details of all the presentations made at the meeting, and it outlines the main points raised during the concluding discussion sessions.

87. ANON. 1981: Tasman Bay choked. *Commercial Fishing* 20 (10): 7-8.

Disastrous consequences for mussel farmers are possible if the Tasman Bay slime becomes widespread in the Marlborough Sounds. Small quantities of slime have been recorded on mussel ropes in Beatrix Bay.

88. ANON. 1981: "Don't panic" over mussels. *Commercial Fishing* 20 (11): 7.

The manager of the biggest exporter of green-lipped mussels suggests that panic reaction will not help solve the expected oversupply of mussels which has resulted from rapid industry growth and haphazard production. There is general confidence in the long-term marketing prospects, but new markets in Japan and the United States are difficult to break into.

- 89. ANON. (1981): Marine farming: general information. *Fishdex, N.Z. Ministry of Agriculture and Fisheries, No. 10*. 3 p.

The difference between a lease and a licence, application procedures, site selection, planning, finance, mussel processing, and farm maintenance are briefly discussed.

- 90. ANON. (1981): Marine farming: applying for a lease or licence. *Fishdex, N.Z. Ministry of Agriculture and Fisheries, No. 12*. 4 p.

An application form is included in this explanatory leaflet which outlines the procedures to be followed when applying for a marine farming lease or licence.

91. ANON. 1982: NZ aims to increase mussel sales here. *Australian Fisheries* 41 (7): 48-9.

Optimism from the leader of a New Zealand mussel export opportunity team after a visit to Australia is reported, with

comments from a Tasmanian mussel producer on quality and price of the New Zealand product.

92. ANON. 1982: Wellington mussel sales increase after successful promotion. *Bulletin, N.Z. Fishing Industry Board, No. 63*: 22.

A 33% increase in sales during the month after a week-long mussel promotion in Wellington highlighted the advantages of concentrating marketing efforts on the local market before trying to develop exports.

93. ANON. 1982: Export Opportunity Team. *Bulletin, N.Z. Fishing Industry Board, No. 66*: 19.

This brief review of the report of the mussel Export Opportunity Team's visit to Australia concentrates on the forms of product for which there are export opportunities and the need to market New Zealand mussels as an alternative to the Australian oyster or scallop rather than in competition with the local mussel.

94. ANON. 1982: Trial export shipment of live mussels well received. *Bulletin, N.Z. Fishing Industry Board, No. 67*: 18.

An exemption from the ban on the export of live green-lipped mussels allowed a non-commercial trial consignment of 5 t of live mussels to be sent to the United States. Favourable response to the product, and estimates of a potential market of 2-4 t per week of live mussels in San Francisco alone, prompted an approach for an exemption for the export of a further 50 t.

95. ANON. 1982: Wellington restaurant competition. *Bulletin, N.Z. Fishing Industry Board, No. 68*: 13.

A competition among Wellington restaurants to find the best mussel or squid dish was so successful that it is likely to become an annual event.

96. ANON. 1982: "Mussels make a mighty meal." *Bulletin, N.Z. Fishing Industry Board, No. 68*: 16.

This catch-phrase was used in a 3-week national advertising campaign, in newspapers and on radio, to establish the farmed green-lipped mussel on the New Zealand market.

97. ANON. 1982: Shellfish exports earn \$72.5 m. *Catch '82 9 (5)*: 20.

Figures for the weight and value of 1981 mussel (and other shellfish) exports are given in 2 categories: fresh, chilled, or frozen, and canned or otherwise processed.

98. ANON. 1982: FRD gets approval for mussel longlines. *Catch '82 9 (8)*: 20.

Approval for the establishment of 4 mussel longlines in Wellington Harbour is reported. Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries will use the lines in the investigation of mussel biology and the capacity of a body of water to produce mussels.

99. ANON. 1982: Mussel sales rise. *Commercial Fishing 21 (3)*: 13.

Mussel sales increased by about 40% after a Fishing Industry Board promotion in December. The end of the regional development suspensory loan scheme for mussel farm establishment is reported.

100. ANON. 1982: Mussels unprofitable unless . . . ? *Commercial Fishing 21 (6)*: 8.

This brief review of a Ministry of Agriculture and Fisheries economic report (see No. 118) on the mussel farming industry

cites the need for the development of significant new markets and more effective marketing in New Zealand as the main conclusions.

101. ANON. 1982: Wharfage "spat". *Commercial Fishing 21 (6)*: 8.

Mussel farmers are becoming increasingly concerned about the charges for wharfage, berthage, inspection, and use of equipment being imposed by the Marlborough Harbour Board. However, the board claims that its revenue from mussels is far less than its expenditure on facilities for the mussel industry.

102. ANON. 1982: Marine farming limited to Golden Bay. *Commercial Fishing 21 (9)*: 7, 10.

An advisory group has recommended approval of 172 ha in Golden Bay for marine farming, but it ruled out farming in Tasman Bay. The recommended areas are more exposed than the water now used for mussel farming in the Marlborough Sounds. Although several of the 23 marine farming applications are for the recommended areas, it has yet to be proved whether mussel or scallop farming can be commercially viable there.

103. ANON. 1982: Mussel farmers decide to leave packhouse. *Commercial Fishing 21 (11)*: 16.

After 5 years of steady growth the marine division of the Nelson Packhouse Co-operative Limited, with 83 farmer members and a mussel processing factory at Havelock which handles 70% of the farmed mussel production, is soon to decide whether to remain part of the co-operative.

104. ARMITAGE, R. O., PAYNE, D. A., LOCKLEY, G. J., CURRIE, H. M., COLBAN, R. L., LAMB, B. G., and

PAUL, L. J. (Eds.) 1981: "Guide Book to New Zealand Commercial Fish Species." N.Z. Fishing Industry Board, Wellington. 216 p.

The shellfish section includes coloured photographs of external and internal features of both blue and green-lipped mussels, with brief notes on distribution and commercial significance.

105. ARNAUD, P. M. 1981: Evaluation of living resources of the southern ocean: the bivalves (Mollusca). In El-Sayed, S. Z. (Comp. and Ed.), "Biological investigations of marine Antarctic systems and stocks (biomass). Vol. 2: Selected contributions to the Woods Hole Conference on Living Resources of the Southern Ocean 1976", pp. 115-23. Scientific Committee on Antarctic Research (SCAR) and Scientific Committee on Oceanic Research (SCOR), Scott Polar Research Institute, Cambridge, England.

This survey of natural stocks of bivalves and the status of bivalve culture in Chilean, Argentinian, and New Zealand waters draws heavily on Watkinson and Smith (No. 267) for data on the fishery, landings, culture, and use of mussels, and it suggests the subantarctic islands have potential for mussel farming.

106. AVERY, M. 1982: Dream boat built like catamaran. *Commercial Fishing* 21 (11): 13.

A custom-built mussel farm work-boat, with good stability and handling qualities, a 6-t carrying capacity, and a capability of up to 60 km/h, is described.

107. BARTROM, A. 1980: Bivalve spat catching. *Catch '80* 7 (9): 18-9.

Results from the monitoring of scallop and mussel settlements in the Mahurangi and Coromandel Harbours showed commercial quantities of *Perna* spat in Coromandel Harbour in late spring, and growth to 73 mm in 11 months was recorded.

108. ——— 1981: Mussel spat monitoring. *Catch '81* 8 (5): 19.

Regular monitoring of settlement of green-lipped mussels in northern New Zealand has shown problems in determining the optimum catching time, maintaining the catch, and preventing fouling.

109. ——— 1982: The increasing importance of planning for mussel farming. *N.Z. Fishing and Processing* 1 (3): 81, 83.

The reasons for, and the sequence of events involved in, Ministry of Agriculture and Fisheries marine farm planning are briefly discussed.

*110. BERGQUIST, P. R., MILLER, M. C., BELLAMY, A. R., and BERGQUIST, P. L. 1982: Is the Hauraki Gulf the place for marine farming? *Commercial Fishing* 21 (3): 15, 17, 19-20.

Opposition to mussel farming in the Hauraki Gulf is expressed because of its possible adverse impact on tourism and the environment, its supposedly doubtful economic viability, and the suggested deficiencies in the quality and scope of the assessments used in marine farm planning.

111. BOOTH, J. D. 1972: Studies on New Zealand bivalve larvae, with observations on the adults and on the hydrology of Bay of Islands and Wellington Harbour. (Ph.D. thesis, lodged in Victoria University of Wellington library.)

The hydrology and the bivalve mollusc communities of the Bay of Islands and Wellington Harbour are compared, and observations are made on the occurrence and distribution of bivalve larvae in the plankton.

112. ——— 1977: Common bivalve larvae from New Zealand: Mytilacea. *N.Z. Journal of Marine and Freshwater Research* 11 (3): 407-40.

The late stage larvae of 5 common mytilid bivalves are described and identified. This study deals mainly with late stage veligers and early pediveligers (the stages at which the species are most readily distinguishable). Identification is important in determining the spawning periods of the different species for use in spatfall forecasting for the mussel farming industry.

113. BOYD, N. S., and WILSON, N. D. C. 1978: Handling and processing of raft-farmed mussels. *Indo-Pacific Fishery Commission Symposium on Fish Utilization Technology and Marketing in the IPFC Region, Manila, Philippines, 8-11 March 1978, IPFC/78/SYMP/52*. 7 p.

It is possible to increase the storage period for live mussels from 3 days at ambient temperatures to over 2 weeks with the use of ice and specially designed boxes. The shelf life of blanched, frozen, and glazed mussel meat is more than 9 months at -30°C , but only 3 months at -20°C .

114. BRETT, J. 1979: Mussel season will be critical. *Catch '79* 6 (10): 23.

The expected 1979-80 crop of 1200-1800 t of mussels from the Marlborough Sounds will necessitate a move into the export market. Expansion of the industry up to a production of 20 000 t has to be considered in the planning of

processing facilities, with processing at sea seen as perhaps the long-term solution.

115. BROOKS, J. D., and HARVIE, R. E. 1981: Quality changes during storage of the green-lipped mussel, *Perna canaliculus*. *Food Technology in Australia* 33 (10): 490-5.

The most effective storage condition was under melting ice, which retarded the development of undesirable flavours and gave a shelf life of 9 days, compared with only 2 days for mussels stored at ambient temperatures. The development of undesirable flavours was directly correlated with an increase in numbers of bacteria.

116. BROOKS, R. R., and RUMSBY, M. G. 1965: The biogeochemistry of trace element uptake by some New Zealand bivalves. *Limnology and Oceanography* 10 (4): 521-7.

Mytilus edulis aoteanus from Tasman Bay was 1 of 3 species for which analyses of silver, cadmium, chromium, copper, iron, manganese, molybdenum, nickel, lead, antimony, vanadium, and zinc were made on the meat, the shell, and individual organs. The concentrations of all elements were higher than those in sea water. Levels of most of the elements varied between the different organs and the 3 bivalves studied (mussel, oyster, and scallop).

117. CAMERON, M. 1981: Mussel industry needs tightening up. *Catch '81* 8 (10): 9.

The oversupply in the mussel industry is likely to worsen unless a co-ordinated strategy is implemented by the industry. The formation of the Mussel Promotion Council should help solve some of the marketing problems by the use of promotional campaigns and the development of new markets and products.

118. ——— 1981: The cultivated mussel industry in New Zealand: situation report 1981. Economics Division, N.Z. Ministry of Agriculture and Fisheries. 13 p. (Unpublished.)

This overview of the mussel farming industry is intended to identify problems in production, processing, and marketing and to recommend possible solutions. Uncertainty over markets, cash flow requirements, and the low condition of the mussels in 1981 are seen as the basic problems.

119. ——— 1982: Developments in the New Zealand cultivated mussel industry. Economics Division, N.Z. Ministry of Agriculture and Fisheries. 14 p. (Unpublished.)

Recent developments in mussel production, processing, and marketing are assessed in terms of profitability. It is concluded that some retrenchment among growers, particularly in the outer Sounds, is likely, with an increase in the integration of growing, processing, and marketing. Farming cost and profitability figures and product prices are appended.

120. CAMPBELL, J. S. 1972: Observations on Spanish mussel cultivation. In "Report on mussel cultivation seminar, October 1971", p. 4. [N.Z.] Fishing Industry Board, Wellington.

Aspects of the Spanish mussel industry, such as labour costs, farming techniques, marketing, and depuration, are discussed. There is speculation on whether New Zealand can evolve cultivation methods which will lead to mussels becoming a successful export product.

121. ——— 1978: Aquaculture in New Zealand. *Fish Farming International* 5 (4): 24-8.

This general article on aquaculture includes a description of mussel farming which outlines its history. There is an estimate of \$50,000 for the establishment cost of a farm with 4 longlines. A crop of 800-1000 t from 25 farms is suggested for the 1978 production.

122. CHAPMAN, L. P. J. 1972: Processing of mussels. In "Report on mussel cultivation seminar, October 1971", pp. 32-3. [N.Z.] Fishing Industry Board, Wellington.

The disadvantages of marketing mussels in the shell are listed. Cooked, shucked mussels are seen as the most suitable product for the home market, and there may be substantial scope for the export of frozen, shucked mussels. New products such as pastes, spreads, sauces, fritters, croquettes, or simply canned and/or smoked mussels will need market development and attractive packaging.

123. CHIANG, R. 1982: [No title.] *B.C. Shellfish Mariculture Newsletter* 2 (5): 4.

This brief note reports the bilateral trade agreement between Canada and New Zealand on molluscan shellfish and includes a list of 13 New Zealand seafood processors registered on the United States Food and Drugs Administration "Interstate Shellfish List".

124. CLARKE, G. 1977: Spherical floats for longline mussel farming. *Catch '77* 4 (1): 16.

New Zealand designed spherical floats of low density polythene are stronger and more buoyant and provide less resistance to wind and water movement than the Japanese capsule-shaped floats.

125. CROFT, J. E. 1979: "Relief from Arthritis. A Safe and Effective Treatment from the Ocean." Thorsons Publishers Limited,

Wellingborough, Northamptonshire. 128 p.

This book briefly describes the chemistry of the ocean and some of its organisms and discusses the forms of arthritis and the use of an extract of the green-lipped mussel in their treatment.

126. CULLEN, J. C., FLINT, M. H., and LEIDER, J. 1975: The effect of dried mussel extract on an induced polyarthritis in rats. *N.Z. Medical Journal* 81 (535): 260-1.

Powdered mussel ("Seatone"), added to the diet, had no beneficial effect on either the development or severity of an induced, rheumatoid-like arthritis in rats.

127. CUNNINGHAM, B. T. 1972: Management of mussel fisheries. In "Report on mussel cultivation seminar, October 1971", p. 31. [N.Z.] Fishing Industry Board, Wellington.

Fisheries legislation covers the harvesting of natural mussel stocks, and the Marine Farming Act 1971 controls mussel farming. Legislation will need to cover harvesting of farmed mussels, with respect to size and season, as the industry expands.

128. DELL, R. K. 1960: Chatham Island marine Mollusca based upon the collections of the Chatham Islands Expedition, 1954. *Bulletin, N.Z. Department of Scientific and Industrial Research, No. 139 (1-4):* 141-57.

Six mytilids are included in a checklist of 320 species of Chatham Island molluscs recorded from depths of less than 100 fathoms (183 m).

129. DEPARTMENT OF TRADE AND INDUSTRY. 1982: The market for New Zealand green-lipped mussels in Australia. Export Opportunity Team report, N.Z. Department of Trade and Industry. 37 p. (Unpublished.)

The report of the 7-man team includes an outline of the New Zealand marketing situation, an assessment of the Australian shellfish distribution and marketing organisation (including New Zealand's current involvement), and an identification of general and specific marketing opportunities for New Zealand mussels. Alternative marketing strategies are discussed. A common promotion, by licensed exporters, of a unique brand name is recommended to the mussel industry as the most suitable option.



The distributions of the mussel species often overlap to give mixed clumps of, for instance, blue (b), green-lipped (g), and ribbed (r) mussels.

130. DINAMANI, P. 1981: WESTPAC pollution monitoring. *Catch '81* 8 (2): 13.

The mussel is to be used as the main indicator organism in a pollution monitoring programme for the western Pacific Ocean. The presence of both *Perna* and *Mytilus* in New Zealand will help in understanding the differential ability of the 2 species to concentrate pollutants and regulate their internal pollutant levels.

131. ——— 1981: Mussel farming conference. *Catch '81* 8 (8): 15.

The continued expansion of the mussel farming industry was reflected in the buoyant mood of the annual workshop. An economic appraisal of the industry was presented. Concern was expressed about spat supplies, alternative seed sources, and the spatfall prediction service.

132. DUFF, M. F. 1967: The uptake of enteroviruses by the New Zealand marine blue mussel *Mytilus edulis aoteanus*. *American Journal of Epidemiology* 85 (3): 486-93.

A study of the uptake of Coxsackie A8 and Polio type 3 viruses showed that, though mussels are efficient at destroying viruses, they are potentially dangerous if eaten raw soon after becoming contaminated. Maximum infectivity occurs 18-36 hours after pollution, the polio virus being significantly more slowly inactivated by the mussel.

133. ELLIOT, B. 1982: When is a mussel not a mussel? When it's a kiwiclaim. *Fish Farming International* 9 (10): 5.

An enthusiastic reception from United States seafood buyers is claimed for the product, packaging, and name being used in a marketing promotion for green-lipped mussels throughout the United States.

Controversy over the use of the name "kiwiclams" for these mussels on the United States and Australian markets is mentioned.

134. FLAWS, D. E. 1968: Observations on the ecology of Mytilidae and Thaisidae in Wellington Harbour. (B.Sc. (Hons.) project, Zoology Department, Victoria University of Wellington.)

The distribution of 4 mytilids and 2 thaisids is related to physical and biological environmental factors. Colonisation depends on exposure to wave action. Hydroids and algae aid mussel settlement. Zonation is displayed by all species. There is evidence of protandric hermaphroditism in *Mytilus* and *Aulacomya* and a cercarian trematode in the gonad of *Perna*. The thaisids prey on smaller mussels.

135. ——— (n.d.): Preliminary report on prospects of mussel farming in the Marlborough Sounds. Report to the [N.Z.] Fishing Industry Board. 15 p. (Unpublished.)

Growth rate, spawning, and settlement at 5 sites, from inner to outer Marlborough Sounds, during 1968-69, are reported with observations on predation and suggestions on farming techniques.

136. ——— 1972: Observations on mussel biology, Cook Strait area. In "Report on mussel cultivation seminar, October 1971", pp. 14-9. [N.Z.] Fishing Industry Board, Wellington.

Data (derived from experimental suspended cultivation) on seasonal variation in growth rate and condition are used to determine optimum harvesting time and predict yields for mussels of a given size.

137. ——— 1975: Aspects of the biology of mussels in the Cook Strait area.

(Ph.D. thesis, lodged in Victoria University of Wellington library.)

The distribution of mussels in the inner Sounds is discussed. Growth is considered in relation to depth, light, salinity, temperature, predation, and size. The condition and reproductive cycles and their correlation are described.

138. FLEMING, C. A. 1959: Notes on New Zealand Recent and Tertiary mussels (Mytilidae). *Transactions of the Royal Society of N.Z.* 87 (1 & 2): 165-78.

Several changes are made in the taxonomy of the Mytilidae. These include the establishment of 2 new genera and the ranking of *M. aoteanus* as a subspecies of *M. edulis*. The fossil record for New Zealand mytilids is described.

139. GALBRAITH, G., and MEREDYTH-YOUNG, J. (1981): Marine farming: shellfish sanitation. *Fishdex, N.Z. Ministry of Agriculture and Fisheries, No. 14*: 2 p.

Materials which may be present in mussel-growing waters, and may be of public health concern, include trace metals, pesticides, biotoxins, bacteria, and viruses. New Zealand standards for growing-water quality and current harvesting restrictions for the Marlborough Sounds are discussed.

140. GARDNER, N. W. 1973: Mussels—Mytilidae in New Zealand. *Poirieria* 7 (2): 33-8.

Data on distribution and morphology are given for the 12 mytilid species, with drawings of 7 of the less common ones.

141. GIBSON, R. G., and GIBSON, S. L. M. 1981: Seatone in arthritis. [Letter.] *British Medical Journal* 282 (6278): 1795.

This letter comments on the methods and results of the study by Huskisson, Scott, and Bryans (No. 179) on the efficacy of "Seatone", presents additional data from an earlier study, and contends that Seatone is still the safest and most effective preparation for both rheumatoid arthritis and osteoarthritis.

142. GIBSON, R. G., GIBSON, S. L. M., CONWAY, V., and CHAPPELL, D. 1980: *Perna canaliculus* in the treatment of arthritis. *The Practitioner* 224 (1347): 955-60.

Positive results are given for a double-blind clinical trial to evaluate the administration of mussel extract in capsule form to sufferers of rheumatoid arthritis and osteoarthritis. A 4-year pilot scheme, followed by clinical trial therapy over two 3-month periods, showed a reduction of pain and stiffness. There was an improvement in the general health of the patients and a low incidence of side effects.

143. GILMORE, R. A. 1975: Letter from America. *Commercial Fishing* 14 (10): 9.

This letter, in response to an article on a New Zealand shellfish hatchery (No. 34), justifies, on the basis of research use, the presence of green-lipped mussels in San Francisco.

144. GOODING, B. 1982: Mussel men need marketing muscle and knowhow. *N.Z. Farmer* 103 (13): 30.

Current marketing problems in the mussel farming industry, compounded by rising costs and rapidly expanding production, are likened to the situation in the boysenberry industry and used to show the need for better planning of expanding rural industries.

145. GREENWAY, J. P. C. 1969: Settlement and growth of a colony of the

large green mussel (*Perna canaliculus*, Gmelin) from a pontoon in Te Kouma Harbour, Coromandel. *Fisheries Technical Report, N.Z. Marine Department, No. 43*, 14 p.

Settlement during 1967-69 was heaviest in the spring and concentrated near the surface; lighter during summer, but over a greater depth range; and minimal during autumn and winter. Some mussels reached 100 mm in 12 months. A tentative cultivation schedule is proposed.

146. ——— 1969: Surveys of mussels (Mollusca: Lamellibranchia) in the Firth of Thames, 1961-67. *N.Z. Journal of Marine and Freshwater Research* 3 (2): 304-17.

Dredging surveys were made to determine distribution and relative density of stocks of *P. canaliculus*. Intensive commercial dredging had severely depleted the beds, and natural regeneration appeared unlikely. There is a description of a small scale artificial cultivation experiment which has practical applications.

147. ——— 1972: Some observations on mussels in the Hauraki Gulf. In "Report on mussel cultivation seminar, October 1971", pp. 7-9. [N.Z.] Fishing Industry Board, Wellington.

A history of the Firth of Thames fishery prefaces comments on mussel farming experiments. Many problems are described and there are a few observations on growth and spatfall.

148. ——— 1975: Development of a colony of green mussels, *Perna canaliculus* in Coromandel Harbour, 1971-72. *Fisheries Technical Report, N.Z. Ministry of Agriculture and Fisheries, No. 141*. 22 p.

Settlement during 1971-72 occurred from September to March, being heaviest in September (near the surface) and Jan-

uary (throughout the water column). The mussels reached 80-90 mm in 12 months and 110-130 mm in 24 months. Movement of young mussels may cause problems during cultivation. Mussel condition is poor during January-May.

149. GUARD, C. 1972: Mussel farming project in the Marlborough Sounds. In "Report on mussel cultivation seminar, October 1971", pp. 21-3. [N.Z.] Fishing Industry Board, Wellington.

Commercial scale experiments on the use of large rafts, various types of rope, and different handling techniques are described, and a bright future is predicted for mussel farming in the Sounds.

150. HASWELL, W. A. 1902: On two remarkable sporocysts occurring in *Mytilus latus*, on the coast of New Zealand. *Proceedings of the Linnean Society of N.S.W.* 27 (108): 497-515.

Many sporocysts of the genus *Echinostomum* were found in 10% of a "large" sample of *M. latus*. Sporocysts up to 3 mm in size infected the mantle and gonad and produced a bright red coloration. Sporocyst and cercaria stages are described and figured.

151. HAYDEN, B. 1981: Mussel industry to return criteria. *Catch '81* 8 (11): 15, 17.

Mussel farming representatives favoured retaining the current harvesting restrictions despite suggestions from the Shellfish Sanitation Committee that the criteria could be relaxed a little and acceptable biological quality still maintained.

152. ——— 1982: NZ shellfish exports to U.S. and Canada. *Catch '82* 9 (11): 17.

A United States Food and Drugs Administration official, after visiting mussel and oyster growers and processors, concluded that the New Zealand "Shellfish Sanitation Programme" was meeting the requirements of the New Zealand-United States "Memorandum of Understanding" on shellfish exports. A recently signed agreement on the export of fresh and fresh-frozen shellfish from New Zealand to Canada is based on the same programme and memorandum.

153. HICKMAN, R. W. 1972: Survey of potential mussel farming areas around the North Island. Unpublished internal report, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries (held on File No. 64/6/-). 15 p.

This survey, based mainly on hydrographic and sociological information, identified 24 000 acres (9720 ha) potentially suitable for raft culture and a further 75 000 acres (30 375 ha) suitable for sea bed cultivation.

154. ——— 1975: New source of seed mussels. *Catch '75* 2 (7): 10-2.

Examination of seaweed washed up on Ninety Mile Beach revealed huge quantities of seed of the green-lipped mussel. The potential of this material as a seed supply for mussel farming is discussed, and the early growth rate of the seed is illustrated.

155. ——— 1976: Potential for the use of stranded seed mussels in mussel farming. *Aquaculture* 9 (3): 287-93.

Heavy settlement of seed mussels on stranded seaweed is described. Growth of the mussels is recorded and the possible use of this material for aquaculture is discussed.

156. ——— 1978: Incidence of a pea crab and a trematode in cultivated and natural green-lipped mussels. *N.Z. Journal of Marine and Freshwater Research* 12 (2): 211-5.

The incidence of infection was recorded at 7 sites in 4314 raft-grown and 2642 intertidal mussels. Infection was low (0.2%-3.6%) and the condition of the mussels was not significantly affected by the infection.

157. ——— 1979: Progress reported in efforts to get export approval. *Catch '79* 6 (1): 20.

Shellfish sanitation and controls (particularly for the Marlborough Sounds mussel industry) were discussed at a meeting sponsored by the Fishing Industry Board. Uncertainty over New Zealand's ability to meet overseas import regulations was said to be inhibiting full development of mussel farming.

158. ——— 1979: Second stranding of seed mussels. *Catch '79* 6 (2): 26-7.

A second stranding of seaweed encrusted with seed mussels on Ninety Mile Beach has renewed the interest of mussel farmers in this alternative seed supply. Experiments in which the seed is used are described, and there is a discussion of its possible source and potential.

159. ——— 1979: Mussel workshop was FIB's last. *Catch '79* 6 (8): 11.

The last of the annual workshops hosted by the Fishing Industry Board for the mussel farming industry indicated a healthy and optimistic outlook for the future, with the completion of the marine farming plan for the Sounds, encouraging analyses of overseas market potential, keen commercial interest from manufacturers of equipment, and the confidence of the board that the industry can stand on its own feet.



Seaweed, heavily encrusted with minute seed of the green-lipped mussel, irregularly washes up on beaches on the west coast of the North Island and is a valuable source of supply for the mussel industry. A handful may contain several thousand seeds.

160. ——— 1979: Allometry and growth of the green-lipped mussel *Perna canaliculus* in New Zealand. *Marine Biology* 51 (4): 311-27.

Allometry varies with environmental conditions, with the result that raft- and shore-grown mussels are morphologically distinct. Growth was recorded at 8 sites around New Zealand. Growth of intertidal mussels was less than half that of mussels grown in suspension. Average growth rates were 73 mm in length (32.5 g in weight) after 1 year and 113 mm (110 g) after 2 years. These figures are comparable to growth rates in other mussel farming countries.

161. ——— 1979: The future of aquaculture in the Australia and New Zealand region. *N.Z. Agricultural Science* 13 (4): 171-6.

This review emphasises the immediate possibilities for expansion or new development in aquaculture. The biological and socio-economic requirements are outlined and the current status and potential of species in this region are discussed. Co-operation in research, industry development, and legislation will be needed to achieve the potential.

162. ——— 1980: Marine Farming Seminar well attended. *Catch '80* 7 (7): 12.

This report on the first seminar run by the Marlborough Sounds Marine Farming Association notes a need for greater exchange of information and ideas. The emphasis of the seminar was on the practical aspects of mussel farming.

163. ——— 1980: Marine Farming Seminar wide ranging. *Catch '80* 7 (9): 20.

Areas needing further scientific research were identified during discussions at the annual seminar and included alternative spat catching sites, spat behaviour, alternative seed sources, and various aspects of condition in relation to harvesting, mussel size, and mussel origin.

164. ——— 1980: Management problems in mussel farming. *N.Z. Veterinary Journal* 28 (10): 226-30.

The reasons for farming mussels in New Zealand are suggested, and the requirements for a successful industry are identified under 3 headings: biological, hydrographic, and socio-economic. The practical problems include flotation, seed supply, predation, overcrowding, and

pollution. Mechanisation of harvesting is seen as a problem for the whole industry.

165. ——— 1980: The occurrence and possible use of stranded mussel seed. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 7*: 3-4.

Reports of strandings of seaweed encrusted with seed mussels, subsequent to those strandings first reported in 1976 (see No. 155), and the first evidence of an autumn stranding, have been well received by mussel farmers. The sequence of events necessary for a stranding is suggested.

166. ——— 1981: Mussel mesh versus mussel rope. *Catch '81 8 (11)*: 11.

Plastic mesh stocking is suggested as a possible alternative to the use of rope and "mussock", in combination, for reseeding.

167. ——— 1981: Mussel farming reports. *Catch '81 8 (11)*: 15.

Three recent reports on economic and marketing aspects of the Marlborough Sounds mussel farming industry are briefly reviewed.

168. ——— 1982: Mussel farming—open day at Te Kaha. *Catch '82 9 (2)*: 14-5.

The public meeting held to publicise the Te Kaha mussel research programme heard talks on research achievements and mussel farming procedures, and it also provided the opportunity for discussion and questions from an audience of about 70 people.

169. ——— 1982: Watch kept on mussel seed. *Catch '82 9 (8)*: 15.

The stranding of seed mussels on Ninety Mile Beach in June may be par-

ticularly valuable to the mussel farming industry because of the failure of spat catching in the Marlborough Sounds. Observations on differences between "Kaitaia seed" strandings are discussed.

170. ——— 1982: Seminar sparkles with interest. *Catch '82 9 (8)*: 18.

Workshops to complement the more formal sessions helped in the exchange of information at the 10th annual meeting of mussel farmers. Marketing, including the potential for export of live mussels and the activities of the Mussel Promotion Council, was of most interest at the seminar and at the annual general meeting of the Marlborough Sounds Marine Farming Association.

171. ——— 1982: Mussel marketing—a report. *Catch '82 9 (11)*: 18.

This review of the report of the mussel Export Opportunity Team mission to Australia (see No. 129) focuses on the problems in entry to the Australian market and the options available to New Zealand exporters.

172. HICKMAN, R. W., and ILLINGWORTH, J. 1980: Condition cycle of the green-lipped mussel *Perna canaliculus* in New Zealand. *Marine Biology* 60 (1): 27-38.

A study of condition of mussels, measured by 7 indices, at 7 sites around northern New Zealand showed a similar annual cycle at all sites, but different levels of condition at the northern, central, and intertidal sites. Two condition indices, both based on weight measurements, are recommended.

173. HICKMAN, R. W., and JOHNS, T. G. 1981: Mussel farming in the eastern Bay of Plenty—what prospects? [Abstract.] *N.Z. Marine Sciences Newsletter No. 24*: 13.

Mussel farming experiments in semi-exposed situations are described. The description includes the construction and cost of low profile rafts and mini-long-lines, results of spatfall monitoring, and indications of growth rate.

174. HIGHTON, T.C., and MCARTHUR, A. W. 1975: Pilot study on the effect of New Zealand green mussel on rheumatoid arthritis. *N.Z. Medical Journal* 81 (535): 261-2.

The mussel extract did not show any greater effect than a placebo in a double-blind crossover trial with 5 patients. The results of the pilot study did not warrant a larger trial of the extract.

175. HOGGINS, F. E., and BROOKS, R. R. 1973: Natural dispersion of mercury from Puhupuhi, Northland, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 7 (1 & 2): 125-32.

Perna canaliculus is 1 of 4 species of mollusc used in a study of the dispersion of mercury by river flow. There was no difference between mercury levels (0.02 ppm wet weight) in the flesh of mussels from the river estuary and from pollution-free control samples.

176. HOLDEN, D. C. 1980: Development of mussel farming and related problems. In Dinamani, P., and Hickman, R. W. (Comps.), Proceedings of the Aquaculture Conference, pp. 95-7. *Fisheries Research Division Occasional Publication*, N.Z. Ministry of Agriculture and Fisheries, No. 27.

Various problems for both the mussel farmer and the industry as a whole are categorised under 4 headings: water based, processing, marketing, and general.

177. HUGHES, J. T., CZOCHANSKA, Z., PICKSTON, L., and HOVE, E. L. 1980: The nutritional composition of some New Zealand marine fish and shellfish. *N.Z. Journal of Science* 23 (1): 43-51.

Perna canaliculus was 1 of 7 species of fish and shellfish used in a detailed proximate analysis (protein 14%, lipids 2%, moisture 78%, and ash 2%) and an amino acid, fatty acid, and vitamin content analysis.

178. HUM, J. 1971: Distribution of *Mytilus* in eastern Australia and New Zealand. (M.Sc. thesis, lodged in University of New South Wales library.)

The distribution of *M. edulis* in New Zealand is described, with observations on other mussels. The influences of salinity, substrate, and coastline, and the physiological characteristics (particularly growth) of the mussels, partly explain the distribution.

179. HUSKISSON, E. C., SCOTT, J., and BRYANS, R. 1981: Seatone is ineffective in rheumatoid arthritis. *British Medical Journal* 282 (6273): 1358-9.

A test of the anti-inflammatory efficacy of a single course of 4 weeks' treatment with "Seatone" on 30 patients showed that Seatone was not superior to a placebo (fish extract) in the treatment of rheumatoid arthritis.

180. HUTTON, F. W. 1880: "Manual of the New Zealand Mollusca. A Systematic and Descriptive Catalogue of the Marine and Land Shells, and of the Soft Mollusks and Polyzoa of New Zealand and the Adjacent Islands." Colonial Museum and Geological Survey Department, Wellington. 224 p.

Eleven species of the family Mytilidae are listed and described. One of these, *Mytilus polyodontes*, is thought to be based on an erroneous observation.

181. JENKINS, R. J. 1973: Mussel spatfall forecasting programme, January-June 1973. [N.Z.] Fishing Industry Board, Wellington. 20 p.

The development of a practical method to predict spatfall by monitoring larvae in the plankton and spat settlement on ropes is discussed. Problems included larval identification, sample size, and the correlation between larval numbers and subsequent settlement, but the potential of a spatfall forecasting system was confirmed.

182. ——— 1979: "Mussel Cultivation in the Marlborough Sounds (New Zealand)." N.Z. Fishing Industry Board, Wellington. 75 p.

This is the basic handbook for the New Zealand mussel farmer and it describes in detail most aspects of practical mussel farming in the Marlborough Sounds. Information on mussel biology and water quality is given and, in logical sequence, the culture operation from spatfall to harvest is discussed, with sections on fouling and disease problems, farm equipment, and production expectations. Although recent developments in the industry have dated some of the information, this is still the major reference for the intending mussel farmer.

183. JOHNS, T. 1980: Mussel farming in exposed coastal waters. *Shellfisheries Newsletter, Fisheries Research Division, N.Z. Ministry of Agriculture and Fisheries, No. 6:* 3-4.

The study of the feasibility of mussel farming in fully or partly exposed coastal areas in the eastern Bay of Plenty is briefly outlined.

184. JOHNS, T., and HICKMAN, R. W. 1982: Mussel farming methods for open coasts. *Catch '82* 9 (5): 14.

Several types of mussel farming equipment were evaluated during the 5-year research programme at Te Kaha. A mini-longline, with a single headline supported by small buoys, capable of carrying 50-60 culture ropes is described.

185. JOHNSTON, A., MACE, J., and LAF-FAN, M. 1981: The saw, the soil and the Sounds. *Soil and Water* 17 (3 & 4): 4-8.

The possible effects of large scale production forestry on the Sounds environment, and on mussel farming in particular, are discussed, mainly in terms of changes in turbidity.

186. JONES, J. B. 1975: *Nematopsis* n. sp. (Sporozoa: Gregarina) in *Perna canaliculus* (note). *N.Z. Journal of Marine and Freshwater Research* 9 (4): 567-8.

The first record of a sporozoan parasite of a New Zealand shellfish. Eighty percent infection was recorded in mussels from Ahipara, but there were only rare occurrences in Wellington Harbour and the Marlborough Sounds.

187. ——— 1975: Studies on animals closely associated with some New Zealand marine shellfish. (Ph.D. thesis, lodged in Victoria University of Wellington library.)

The examination of 858 *Perna* and 150 *Mytilus* (and 2 species of oysters) showed 2 sporozoan, 3 trematode, 2 copepod, and 1 pea crab species associated with the shellfish. None of the parasites were thought to be serious pathogens or to have a serious effect on shellfish farming.

188. ——— 1976: *Lichomolgus uncus* n. sp. (Copepoda: Cyclopoida): An

associate of the mussel *Perna canaliculus* Gmelin. *Journal of the Royal Society of N.Z.* 6 (3): 301-5.

A new species of copepod found on the gills of *Perna* is described. The copepod has no effect on the mussel.

189. ——— 1977: Natural history of the pea crab in Wellington Harbour, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 11 (4): 667-76.

Pea crabs were found in 188 of 486 *P. canaliculus* of 50-290 mm in length. Larger female crabs were found in larger mussels, but there was no correlation between the size of males and mussel size. Mussels above low water neap tide were rarely infected. Damage to the host is restricted to gill erosion and nodule formation on the mantle.

190. KENNEDY, P. 1982: Possible problems with IOC/WESTPAC monitoring programme. *Catch '82* 9 (2): 13-4.

The paucity of information on the biology of local mussel species is suggested as being one of several problems likely to face New Zealand during the setting up of a pollution monitoring programme. Sex-related differences in zinc concentrations in the ribbed mussel show the need for carefully planned sampling.

191. KENNEDY, V. S. 1976: Desiccation, higher temperatures and upper intertidal limits of three species of sea mussels (Mollusca: Bivalvia) in New Zealand. *Marine Biology* 35 (2): 127-37.

Distribution, abundance, and resistance adaptations were studied in the intertidal mussels *M. edulis aoteanus*, *P. canaliculus*, and *A. maoriana*. Desiccation rates varied inversely with mussel size. Colonisation of the more aerially exposed habitats is

related to the ability of small mussels to tolerate hot and windy conditions.

192. ——— 1977: Reproduction in *Mytilus edulis aoteanus* and *Aulacomya maoritana* (Mollusca: Bivalvia) from Taylors Mistake, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 11 (2): 255-67.

Maturation occurred during autumn and winter, and spawning began as temperatures increased in spring. Gametogenic activity continued throughout the year in *M. edulis aoteanus*, but *A. maoriana* had a resting period in mid summer. The coincidence of the spawning periods of 4 mussel species suggests there is inter-specific competition for settlement space.

193. KERR, R. N. 1969: Marine Department disagrees with our report on mussel farmers meeting. [Letter.] *Commercial Fishing* 8 (2): 32.

This letter from the Secretary for Marine suggests there is inaccurate reporting and unwarranted comment in the report (see No. 3) on a meeting held to discuss mussel farming prospects.

194. KILNER, A. R., and AKROYD, J. M. 1982: Ohiwa Harbour mussels over-exploited. *Catch '82* 9 (5): 13-4.

The dramatic decline in numbers of mussels (from 21 million in 1979 to 3 million in 1981) in Ohiwa Harbour forced the Ministry of Agriculture and Fisheries to close the harbour to mussel gathering. New quotas for amateur collectors will apply when the beds are reopened.

195. ——— 1982: Ohiwa Harbour mussel survey, summer 1978/79. *Fisheries Technical Report*, N.Z. Ministry of Agriculture and Fisheries, No. 158. 31 p.

The distribution, numbers, and weights of mussels in the 2 main beds were investigated by diving surveys in December 1978 and February 1979 to evaluate options for management. Most of the total population of about 21 million mussels were of edible size.

196. LANG, R. J. (Convener) 1979: Marine farming, Great Barrier Island, with particular regard to mussel cultivation. Department of Lands and Survey, Auckland. 33 p.

This paper reports a planning study for the integration of marine farming with other land and water activities on and around Great Barrier Island. Marine farming is described with reference to the island's resources, potential areas are surveyed and the likely impact considered, and recommendations are made for the establishment of mussel farming around the island.

→ 197. LANG, R. J., and MCQUOID, R. G. 1974: Planning for marine farming with particular reference to the west coast of Coromandel Peninsula. *Report to the Hauraki Gulf Maritime Park Board, Department of Lands and Survey, Auckland.* 35 p.

An interdepartmental team analysed the possible effects of mussel cultivation (and other forms of marine farming) and recommended a zoning system based on water use (both at the surface and below), water quality, and use of the adjoining land. Integrated planning was thought necessary to minimise conflicts and protect the marine farms and other existing uses.

198. LEHERON, J. 1981: "Marvellous Mussels." Te Kotuku Productions Ltd., Palmerston North. 128 p.

This specialist cookbook has 108 recipes and an introductory discussion on mussel farming.

199. LINZEY, M. C. 1971: The biology of *Cercaria haswelli* (Dollfus 1927) larval digenean parasite of the mussel *Perna canaliculus* (Gmelin 1791). (M.Sc. thesis, lodged in University of Canterbury library.)

The parasite occurs only in the gonad tissue of the mussel and frequently causes sterilisation by utilisation of the host's lipid reserves, which are required particularly for the production of ova. Infection is fairly constant within a mussel population, but differs in populations in different environments. There was strong correlation between numbers of parasites and mussel size.

200. LOOSANOFF, V. L., and MURRAY, T. Jr. 1974: Maintaining adult bivalves for long periods on artificially grown phytoplankton. *Veliger* 16 (1): 93-4.

Two samples of *P. canaliculus* were maintained under quarantine conditions for more than 17 months in California. The mussels were fed on phytoplankton (predominantly *Phaeodactylum*) which was cultured on a large scale by the enrichment of sea water with commercial fertilisers.

201. LUCKENS, P. A. 1975: Competition and intertidal zonation of barnacles at Leigh, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 9 (3): 379-94.

Xenostrobus pulex settled abundantly in areas of surface irregularities between and around barnacles, and by rapid growth the mussels soon smothered the barnacles. Large patches of the mussels were vulnerable to being ripped off the rocks by heavy seas.

202. ——— 1975: Settlement seasons of actual and potential fouling organisms at the New Plymouth power station. *Oceanographic Summary, N.Z. Oceanographic Institute, No. 7*. 7 p.

Observations on settlement and growth of *X. pulex* and *P. canaliculus* at and near the power station intake are discussed. Predation by the gastropod *Neothais scalaris* on *P. canaliculus* is recorded.

203. ——— 1976: Settlement and succession on rocky shores at Auckland, North Island, New Zealand. *Memoir, N.Z. Oceanographic Institute, No. 70*. 64 p.

Data were recorded on the settlement of more than 40 invertebrate species at 3 sites. Data on *P. canaliculus* and *X. pulex* include settlement season, area and density, growth rate, maximum size, size at sexual differentiation, age at death, cause of death, and associated predatory, encrusting, and boring species.

204. MCARTHUR, A. W., and HIGHTON, T. C. 1975: Green mussel and rheumatoid arthritis. [Letter.] *N.Z. Medical Journal* 82 (545): 97-8.

This letter dismisses the post-trial data provided by the manufacturer of the mussel extract (McFarlane Laboratories Limited) (see No. 207) as being irrelevant to the results of the clinical trial of the extract (see No. 174).

205. MACDONALD, I. H. 1963: Studies in the biology of *Mytilus edulis aoteanus* Powell, 1958 and *Perna canaliculus* Gmelin, two inter-tidal molluscs of the rocky shore. (M.Sc. thesis, lodged in University of Canterbury library.)

Taxonomy, anatomy, reproduction and settlement, and growth rate comparisons of the 2 species were included in the study.

206. MCFARLANE, S. J. 1972: New Zealand commercial mussel farming experiments in the Hauraki Gulf.



The typical mussel farm unit is the longline. It consists of a pair of 110-m horizontal headlines which are attached to large floats and support up to 440 vertical mussel ropes 4-5 m long.

In "Report on mussel cultivation seminar, October 1971", pp. 10-2. [N.Z.] Fishing Industry Board, Wellington.

A brief outline of commercial experiments with rafts records many problems in catching and maintaining spat and in growing mussels to a marketable size of 4.5-5 in (114-127 mm). A guaranteed supply of spat is seen as the main long-term problem.

207. ——— 1975: Green mussel and rheumatoid arthritis. [Letter.] *N.Z. Medical Journal* 81 (542): 569.

This letter comments on the small size of the clinical trial of mussel extract (see No. 174) and gives figures for post-trial condition thought to be necessary for interpretation of the results.

208. MARTIN, L. S. 1981: Mussel farming in the Marlborough Sounds. Small Business Development Research, Development Finance Corporation, Wellington. 22 p. (Unpublished.)

Many aspects of mussel farming in the Marlborough Sounds are discussed. These include the practicalities of cultivation, the problems involved, licences, production, processing methods, equipment, and trends and problems in processing. An economic appraisal is given. Markets, both local and export, are reviewed, with mention of the United States and Japan. Hygiene and quality control of the product and transport and storage are also discussed.

209. MEREDYTH-YOUNG, J. L. 1981: Mussel Spatfall Bulletin. *Catch '81* 8 (9): 8-9.

The Ministry of Agriculture and Fisheries collects data on mussel settlement and publishes them weekly in its "Mussel Spatfall Bulletin". Weekly settlement, maintenance of the catch, and larval

numbers in the plankton are included in the bulletin. A summary of the 1980-81 data is given.

210. ——— (1981): Marine farming: Mussel Spatfall Bulletin. *Fishdex*, N.Z. Ministry of Agriculture and Fisheries, No. 9. 4 p.

A description of the 3 sections of the "Mussel Spatfall Bulletin" is given, with a discussion of the interpretation of the bulletin and general observations on spat catching and spat maintenance. There are many factual and typographical errors, omissions, and inaccuracies in this publication; it is now being revised.

211. MEREDYTH-YOUNG, J. L., and JENKINS, R. J. 1978: Depth of settlement of two mussel species on suspended collectors in Marlborough Sounds, New Zealand (note). *N.Z. Journal of Marine and Freshwater Research* 12 (1): 83-6.

Settlement, at the surface and at depths of 2 m and 4 m, was monitored at 2 sites in the Marlborough Sounds from October 1975 to April 1976. Peak settlement of *M. edulis aoteanus* was in October-January, and settlement decreased with increasing depth. Peak settlement of *P. canaliculus* was in February-April, with no preferred depth of settlement.

212. ——— 1980: Problems of larvae and spat settlement and their relevance to mussel farming. In Dinamani, P., and Hickman, R. W. (Comps.), Proceedings of the Aquaculture Conference, pp. 34-8. *Fisheries Research Division Occasional Publication*, N.Z. Ministry of Agriculture and Fisheries, No. 27.

Identifying the commercial catching areas, forecasting the time and viability of

settlement, and avoiding the settlement of *Mytilus* are seen as the problems in farming *Perna*.

213. MICHAEL, P. R., and TERRENCE, J. 1975: 1974 Shellfish production. *Catch '75 2 (7)*: 20-1.

Mussel landings (2138 t) were slightly lower than in 1972 and 1973, with signs that the Tasman Bay-Golden Bay area is overfished.

214. MILLER, T. E., and ORMROD, D. 1980: The anti-inflammatory activity of *Perna canaliculus* (N.Z. green-lipped mussel). *N.Z. Medical Journal 92 (667)*: 187-93.

Experiments were conducted into the anti-inflammatory effect of a crude fraction of *P. canaliculus*. An induced inflammatory oedema of the rat hind foot pad was used as the experimental model. The extract of *P. canaliculus*, when injected into the peritoneal cavity, effectively reduced the oedema, whereas oral administration of the preparation was not effective.

215. MILNE, C. R. 1966: A study on the host-parasite relationships between a larval trematode, *Cercaria haswelli* Dollfus 1927, and its host, *Perna canaliculus* Gmelin. (B.Sc. (Hons.) project, Zoology Department, University of Canterbury.)

Sporocysts were found in 42%-45% of mussels (60-130 mm long) from a single intertidal site. The parasite causes sterilisation by its use of food reserves which the mussel normally needs for gametogenesis.

216. MORRISON, A. 1980: Green-lipped mussels clamped in controversy. *National Business Review 10 (20)*: 26.

The international legal, medical, and

commercial controversy over green-lipped mussel extract is reported.

217. MORTON, J., and MILLER, M. 1968: "The New Zealand Sea Shore." Collins, Auckland. 638 p.

This comprehensive guide includes extensive data and discussion on the distribution and ecology of mussels.

218. MUERS, P. E. 1972: Legal aspects of mussel farming under new Act. *Commercial Fishing 11 (July)*: 6.

The provisions of the Marine Farming Act 1971 are discussed in relation to mussel farming, with particular reference to the matters of concern to the Marine Department.

219. ——— 1972: Marine Farming Act 1971: requirements for mussel farming. In "Report on mussel cultivation seminar, October 1971", pp. 24-5. [N.Z.] Fishing Industry Board, Wellington.

The deficiencies of the 1968 Act are explained and the requirements of the 1971 Act are discussed in terms of navigation, raft design, and mooring arrangements.

220. N.Z. FISHING INDUSTRY BOARD. 1981: Farmed mussel industry in the Marlborough Sounds: an economic appraisal. *Economics and Marketing Division, N.Z. Fishing Industry Board, E.M. 28. 12 p.* (Unpublished.)

An economic overview of the mussel farming industry in the Marlborough Sounds is given with sections on landings and exports, capital establishment costs, annual operating costs, yields and earnings, profitability, and processing investment, costs, and earnings. The report gives a guideline for the assessment of the capital investment and viability of the industry.

221. NIELSEN, S. A. 1974: Vertical concentration gradients of heavy metals in cultured mussels. *N.Z. Journal of Marine and Freshwater Research* 8 (4): 631-6.
- Perna canaliculus* from Kenepuru Sound showed cadmium, lead, and iron levels which increased with depth and levels of zinc which decreased. At Waiheke Island, levels of all 4 metals remained fairly constant with depth. Variation between sites and with depth is ascribed to the differing availability of metals to the mussels which results from differences in the degree of mixing of the water column.
222. NIELSEN, S. A., and NATHAN, A. 1975: Heavy metal levels in New Zealand molluscs. *N.Z. Journal of Marine and Freshwater Research* 9 (4): 467-81.
- Cadmium, lead, copper, mercury, zinc, and iron levels were analysed in 13 species from 199 sites. Both *Mytilus* (wild) and *Perna* (wild and cultivated) were included, with *Perna* showing the highest levels of lead and *Mytilus* the highest levels of mercury. There were wide variations between the different sites.
223. OLIVER, W. R. B. 1923: Marine littoral plant and animal communities in New Zealand. *Transactions and Proceedings of the N.Z. Institute* 54: 496-545.
- Mytilus* and *Modiolus* associations are recognised as characteristic of rocky shores, the *Mytilus* association being best developed in southern New Zealand, and *Modiolus* being found near high water mark throughout the country. *Mytilus canaliculus* forms a belt around low tide mark, with *M. planulatus* being dominant above it. Typical members of the associations are described.
224. PAINE, R. T. 1971: A short-term experimental investigation of resource partitioning in a New Zealand rocky intertidal habitat. *Ecology* 52 (6): 1096-106.
- The removal of the starfish *Stichaster australis* from an area of rocky shore resulted in *P. canaliculus* extending its vertical distribution by 40% of the available range. The removal of both the starfish and the brown alga *Durvillea antarctica* resulted in 70%-80% of the available space being taken up by *Perna* within 15 months, to the almost total exclusion of other fauna and flora.
225. PATERSON, N. 1979: Prospects in the Sounds. *Catch '79* 6 (10): 24-5.
- In a brief review of the development of mussel farming in the Marlborough Sounds, anchorage systems, fish predation, pollution, licensing, spat catching, and marketing are identified as the problem areas.
226. ——— 1982: An association profiled. . . . *Catch '82* 9 (8): 20.
- The retiring secretary of the Marlborough Sounds Marine Farming Association comments on the attributes of the 3 association presidents he served under and the diversity of matters dealt with by the association during its 7-year existence.
227. PAUL, L. J. 1966: Observations on past and present distribution of mollusc beds in Ohiwa Harbour, Bay of Plenty. *N.Z. Journal of Science* 9 (1): 30-40.
- Green-lipped mussels (and rock oysters), beds of which had covered over 20 acres (8.1 ha) in 1930, have been virtually eliminated by a combination of over-exploitation and excessive siltation.
228. PIKE, R. B. 1969: Mussel farming in Tauranga Harbour and Ohiwa Harbour. Report to the [N.Z.] Fishing Industry Board. 3 p. (Unpublished.) (The text of the

report is in *Commercial Fishing* 8 (12): 11-3.)

Mussel farming would be restricted to shallow water areas between low tide level and the boating channels. It would probably be similar in style to oyster farming and would be limited by availability of spat. Suggestions for preliminary farming studies are made.

229. ——— 1971: 1970 report on mussel farming and mussel biology for the Fishing Industry Board. *Technical Report, [N.Z.] Fishing Industry Board, No. 71: 1. 7 p.*

The report concentrates on the sequence of settlement of organisms, including mussels, on artificial collectors in Kenepuru Sound. *Perna* and *Mytilus* have different spawning times and settlement behaviour. *Perna* grows 12-25 mm larger than *Mytilus* in 12-18 months. The highest condition (meat weight: total weight) is about 40%.

230. ——— 1972: Mussel biology. In "Report on mussel cultivation seminar, October 1971", p. 27. [N.Z.] Fishing Industry Board, Wellington.

Observations on the biology of mussels are made in relation to farming techniques.

231. POORE, G. C. B. 1968: Succession of a wharf-pile fauna at Lyttelton, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 2 (4): 577-90.

Intertidal regions of the wharf piles developed a climax community of *M. neozelanicus* within 2.5 years, after initial colonisation by barnacles. Storms and oil pollution can destroy the community.

232. POTTERTON, D. 1980: Arthritis medicine from the sea. *Bestways, January 1980*: 52-5.

The use of extract of *P. canaliculus* in the treatment of arthritis is reported through comments from patients, a physician, and the author of a book on the subject. It is stressed that the active principle in the mussel has not been identified and the extract is not claimed to be a "cure" for arthritis.

233. POWELL, A. W. B. 1976: "Shells of New Zealand. An Illustrated Handbook." 5th edition, Whitcoulls Limited, Christchurch. 154 p.

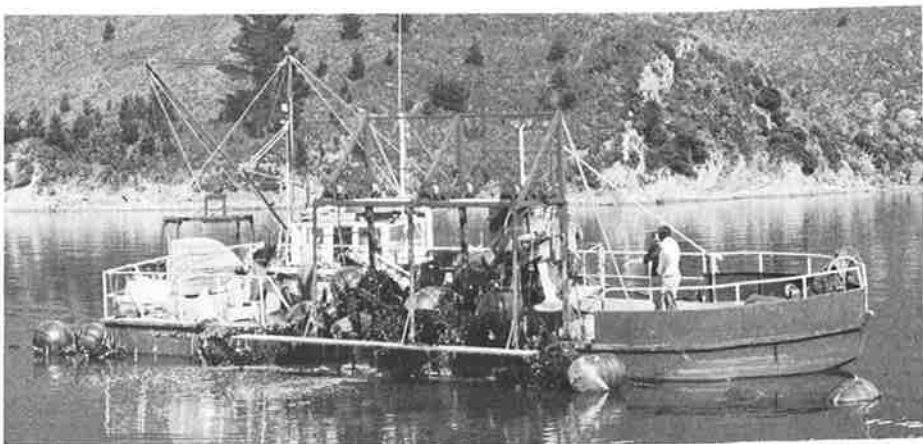
This check-list of the 2256 species and subspecies of living New Zealand molluscs includes 12 species in the family Mytilidae and has photographs of 7 of them.

234. ——— 1979: "New Zealand Mollusca: Marine, Land and Freshwater Shells." Collins, Auckland. 500 p.

This, the most comprehensive treatise on New Zealand molluscs, includes taxonomic descriptions of 12 species (11 are also figured) in the section on the Mytilidae (pp. 371-4).

235. PURDIE, A. 1887: The anatomy of the common mussels (*Mytilus latus*, *edulis*, and *magellanicus*). *Studies in Biology for New Zealand Students, Colonial Museum and Geological Survey Department, No. 3*, 55 p.

There are detailed descriptions (including 43 figures) of the anatomy of the 3 most common species of New Zealand mussel, the green-lipped, *M. latus*, the blue, *M. edulis*, and the ribbed, *M. magellanicus*, in this publication, which is intended for use as a student text. There is a table of features which distinguish the 3 species.



Mechanisation will be necessary to handle the increasing production of farmed mussels. Already most of the crop is harvested by a few contractors with specialised equipment.

236. RALPH, P. M., and HURLEY, D. E. 1952: The settling and growth of wharf-pile fauna in Port Nicholson, Wellington, New Zealand. *Zoology Publications from Victoria University College, Wellington, No. 19.* 22 p.

A 13-month period failed to give suitable conditions for growth and development of mussels, though settlement of *M. planulatus* was recorded throughout the year.

237. REDFEARN, P. 1981: Identifying mussel larvae. *Catch '81 8 (8):* 20.

The difficulty in distinguishing *Perna* and *Mytilus* larvae is illustrated, and the features used to separate the 2 species are explained.

238. REID, B. 1969: Mussel survey Hau-raki Gulf and Firth of Thames 1958. *Fisheries Technical Report, N.Z. Marine Department, No. 34.* 24 p.

This report described the mussel fishery in 1958, but was published more than 10 years later, after the fishery peaked and subsequently collapsed. Observations on

spawning, growth, distribution, and fishing methods suggested that hard substrate is necessary for the re-establishment of mussel beds and that the dredging process is detrimental to the beds.

239. ROADLEY, H. 1979: Good potential for future expansion. *Catch '79 6 (10):* 21.

The potential for expansion in rock oyster and mussel farming is discussed in relation to water purity and finance. The potential could be 10 times the current annual production, which is worth about \$1 million.

240. SCRIVEN, M. C. 1967: Host-parasite relationships between *Perna canaliculus* and *Cercaria haswelli*. (B.Sc. (Hons.) project, Zoology Department, University of Canterbury.)

The presence of the parasite in the gonad tissue of the mussel causes mechanical displacement, inhibits sexual development, and reduces fat accumulation.

241. SIDDALL, S. E. 1980: A clarification of the genus *Perna* (Mytilidae). *Bulletin of Marine Science* 30 (4): 858-70.

The historical development and geographical distribution of the 3 species in the genus *Perna* are reviewed. The presence of lateral hinge teeth, which develop after metamorphosis, is used to distinguish the species. The distinguishing features of the soft part of the anatomy and the adult shells are summarised. Possible trends in specialisation among *Perna*, *Choromytilus*, *Aulacomya*, and *Mytilus* are discussed.

242. SKERMAN, T. M. 1959: Marine fouling at the Port of Auckland. *N.Z. Journal of Science* 2 (1): 57-94.

Only 4 small *P. canaliculus* and 1 *M. impactus* were recorded during a 2-year study of the settlement of fouling organisms on black perspex panels.

243. ——— 1960. Ship-fouling in New Zealand waters: a survey of marine fouling organisms from vessels of the coastal and overseas trades. *N.Z. Journal of Science* 3 (4): 620-48.

Mytilus edulis aoteanus and *P. canaliculus* were frequent, but rarely dominant, fouling organisms, indicative of out-of-dock periods of 12 months or more. *Perna* was found more often on the lower plates and the keel; *Mytilus* was found on all submerged areas.

244. STACE, D. 1977: Mussel farmers and fruit growers get together. *Catch '77* 4 (9): 22-3.

The amalgamation of the mussel farmers' co-operative and the Nelson Packhouse Co-operative Limited should provide the mussel industry with existing management and administrative services and market outlets. The complementary

timing of fruit and mussel harvesting should benefit both co-operatives.

245. STEAD, D. H. 1971: A preliminary survey of mussel stocks in Pelorus Sound. *Fisheries Technical Report, N.Z. Marine Department, No. 61*. 39 p.

A dredge and shoreline survey of the distribution and population structure of green-lipped and blue mussels in inner Pelorus Sound showed signs of depletion in exploited stocks, but identified unexploited shallow water and intertidal beds capable of supporting a limited fishery. Recommendations for management of the fishery are given.

246. ——— 1971: Pelorus Sound mussel survey—December 1969. *Fisheries Technical Report, N.Z. Marine Department, No. 62*. 28 p.

A 2-week diving and dredging survey showed that stocks of *Perna* have been lowered to levels marginally economic for either dredging or hand gathering, though populations on rough substrates in the upper sublittoral zone are almost unexploited. Some revision of the regulations may be necessary to ensure a continuing fishery.

247. ——— 1973: Shellfish survey Nelson sewer outfall area April:June 1972. *Fisheries Technical Report, N.Z. Ministry of Agriculture and Fisheries, No. 123*. 15 p.

Size and distribution studies of mussels, oysters, and scallops showed average to marginal commercial quantities of mussels near the outfall. Bacteriological monitoring of commercial mussel grounds outside a proposed restricted area is recommended.

248. STRUIK, G. J., and BRAY, J. R. 1980: Sustainability of resource use in

Marlborough Sounds [Résumé].
N.Z. Journal of Ecology 3: 151.

Nine types of land and water use are compared in terms of their sustainability. Those which depend on maintaining the original land and water systems have a higher sustainability than monocultures such as mussel farming or *Pinus* forestry. A mix of the more sustainable systems is thought desirable.

249. SUTER, H. 1913: "Manual of the New Zealand Mollusca. With an Atlas of Quarto Plates." Government Printer, Wellington. 1120 p.
——— 1915: "Manual of the New Zealand Mollusca. Atlas of Plates." Government Printer, Wellington, 72 plates.

The section on the family Mytilidae (pp. 861-72) contains detailed descriptions and keys for the identification of 11 species, data on distribution, and figures of all the species.

250. TARANAKI CATCHMENT COMMISSION. 1981: Toxicology. Water resource investigations. Synthetic petrol plant—Motunui. Taranaki Catchment Commission, Stratford, New Zealand. 446 p. and 33 p. of references (unnumbered).

Perna canaliculus was 1 of 8 invertebrate species monitored during investigations into heavy metal pollution. Concentrations of zinc, which were sublethal in laboratory experiments, induced behaviour which would probably cause mortality in the wild. The behavioural changes included failure to secrete byssus threads or attach to the substrate, abnormal filtering, and general narcosis.

251. ——— 1981: Part I: Marine ecology. Part II: Bacteriology. Water resource investigations. Synthetic petrol plant—Motunui. Taranaki

Catchment Commission, Stratford, New Zealand. 116 p.

Perna canaliculus and *X. pulex* were included in an investigation into the dynamics of the ecosystem of the north Taranaki coastline. The results of bacteriological analyses of mussels and sea water were used as a basis for recommendations for the treatment of domestic wastes from the petrol plant.

252. THOMPSON, J. 1972: Marketing of mussels. In "Report on mussel cultivation seminar, October 1971", pp. 34-5. [N.Z.] Fishing Industry Board, Wellington.

Quality, packaging, distribution, continuity of supply, and careful costing are discussed in relation to success in marketing.

253. THOMPSON, W. 1979: Less muscle—more mussels. *Catch '79* 6 (2): 4-5.

The use of a 2-man pontoon-mounted, mechanical mussel harvester capable of gathering up to 10 t per day is described. There is a need for both small and large harvesting units and machinery for processing the mussels.

254. TORTELL, P. 1972: Investigation into settlement behaviour of mussels and the hydrology of a selected area with a view to farming the shellfish. First Report—October 1972, Mussel Research Programme, Victoria University of Wellington. 23 p. (Unpublished.)

A description of the study area, equipment, and research methods.

255. ——— 1973: Mussel research programme. *Commercial Fishing* 12 (11): 18-9, 24.

The programme is concentrating on settlement behaviour in relation to hydrology and climatology. Experimental techniques and equipment are discussed,

and some preliminary results are given. The construction and operation of a larval rearing unit is described.

256. ——— 1973: Investigation into settlement behaviour of mussels and the hydrology of a selected area with a view to farming the shellfish. Second Report—April 1973, Mussel Research Programme, Victoria University of Wellington. 32 p. (Unpublished.)

Preliminary observations on climatology, hydrology, and settlement.

257. ——— 1973: Investigation into settlement behaviour of mussels and the hydrology of a selected area with a view to farming the shellfish. Third Report—December 1973, Mussel Research Programme, Victoria University of Wellington. 28 p. (Unpublished.)

Observations on settlement, larval rearing, hydrology, and climatology.

258. ——— 1974: Investigation into settlement behaviour of mussels and the hydrology of a selected area with a view to farming the shellfish. Fourth Report—June 1974, Mussel Research Programme, Victoria University of Wellington. 32 p. (Unpublished.)

Observations on settlement, water movement, temperature and salinity, wind, rainfall, and bathymetry.

259. ——— 1975: Mussels. *New Zealand's Nature Heritage, Part 72*: 2000–2.

The biology of New Zealand mussels is discussed in relation to cultivation.

260. ——— 1976: A new rope for mussel farming. *Aquaculture* 8: 383–8.

The use of fibrillated polypropylene film, dyed with carbon black, for spat col-

lection is outlined, and its advantages are discussed.

261. ——— 1976: Investigation into settlement behaviour of mussels and the hydrology of a selected area with a view to farming the shellfish. (Ph.D. thesis, lodged in Victoria University of Wellington library.)

This thesis has much information on the hydrology and climatology of “Beatrix Basin”, Marlborough Sounds and on reproduction and settlement of mussels. There are observations on mussel farming potential, mussel food determination, and larval rearing.

262. ——— 1977: Mussel farming prospects in the Beatrix Basin. *Commercial Fishing* 16 (9): 27, 29.

Research into the hydrology of part of Pelorus Sound, and an assessment of conflicting interests, are used to estimate the potential production from longline mussel farming to be about 33 000 t, worth nearly \$10 million at the 1975 value of \$300 per tonne.

263. ——— 1980: Preliminary experimental rearing of mussel (*Mytilus edulis aoteanus*, *Aulacomya maoriana* and *Perna canaliculus*) larvae in the laboratory. *Mauri Ora* 8: 21–33.

Mytilus and *Aulacomya* were induced to spawn and the larvae reared for up to 90 days. *Perna* could not be induced to spawn even after conditioning. The facilities and methods used are described, and possible reasons for the failure of the larvae to metamorphose and settle are discussed.

264. ——— (Ed.) 1981: “New Zealand Atlas of Coastal Resources.” Government Printer, Wellington. 28 p. and 15 maps.

The maps indicate shoreline areas used for commercial gathering of mussels, traditional Maori shellfish gathering areas, and mussel farming sites. The text includes a section on marine farming which describes the collapse of mussel dredging and the development of mussel farming.

265. UNIVERSITY OF AUCKLAND. 1974: Maui development environmental study: report on phase one, 1974. Report prepared by the University of Auckland for Shell BP and Todd Oil Services Limited, Shell BP and Todd Oil Services Limited 1974, Auckland. 136 p.

Data on distribution and faunal associations of mussels are included in shore survey descriptions of 26 stations on the south-west coast of the North Island from Kawhia to Cook Strait. Brief mention is made of the fishery for and the farming of mussels, and figures are given for mussel landings for 1971-73 at 9 ports in the Taranaki-Marlborough-Nelson area.

266. WARWICK, J. 1982: A code of practice for mussel processing. N.Z. Fishing Industry Board. 25 p. (Unpublished draft.)

The code brings together recommended procedures for harvesting and handling live mussels, for grading, shucking, freezing, and storing mussels, and for preparing and handling marinated mussels. The code stresses the importance of keeping the mussels chilled from the time of harvest to ensure a high quality product.

267. WATKINSON, J. G., and SMITH, R. (Comps.) 1972: "New Zealand Fisheries." N.Z. Marine Department, Wellington. 91 p.

This general survey of New Zealand fisheries includes a section on mussels

which describes the resource, fishing method, catch composition, and current production.

268. WAUGH, G. D. 1972: Prospects for mussel cultivation in New Zealand and observations on the Spanish mussel cultivation industry. In "Report on mussel cultivation seminar, October 1971", pp. 1-3. [N.Z.] Fishing Industry Board, Wellington.

In a brief discussion of Spanish mussel farming techniques, similarities and differences between Spain and New Zealand are drawn. It is suggested that New Zealand adapt Spanish methods to suit the local situation.

269. ——— 1972: Future mussel research requirements. In "Report on mussel cultivation seminar, October 1971", p. 30. [N.Z.] Fishing Industry Board, Wellington.

Further research is needed on natural productivity and its relationship to mussel condition, the problems associated with the transfer of mussels, and the behaviour of mussel larvae and spat.

270. ——— 1980: Te Kaha aquaculture station. *Fisheries Research Division Information Leaflet, N.Z. Ministry of Agriculture and Fisheries, No. 10.* 14 p.

An outline of the research into the practicality of cultivating green-lipped mussels on a semi-exposed coastline is included in a description of the work of the station. Equipment design, spat collection, and growth studies are part of the research programme.

271. WILSON, B. R. 1967: A new generic name for three recent and one fossil species of Mytilidae (Mollusca: Bivalvia) in southern Australasia, with redescriptions of the

species. *Proceedings of the Malacological Society of London* 37 (4): 279-95.

The new genus *Xenostrobus* is proposed for the species previously classified as *Modiolus pulex* and *M. securis* on the basis of shell and anatomical features of type specimens, some of which came from New Zealand. Diagnostic features for species separation and habitat differences are discussed.

272. WILSON, N. D. C., and BOYD, N. S. 1976: Notes on the processing of farmed mussels. Report to the [N.Z.] Fishing Industry Board. 14 p. (Unpublished.)

Mussel texture is most susceptible to damage during processing and storage. Mussels held at ambient temperatures, or

in ice, are inedible after 5 days. If held at 4-6 °C in humid conditions they are inedible after 8 days. The time taken to steam open mussels is critical to weight loss and texture quality.

273. WOOD, P., and MEREDYTH YOUNG, J. (1981): Marine farming: mussel farming, economics and preparing a budget. *Fishdex, N.Z. Ministry of Agriculture and Fisheries, No. 15.* 4 p.

An economic overview of the establishment and operation of a mussel farm is given. Investment, annual operating costs, yields and earnings, budgeting, and production are discussed, and a sample 12-month cash flow statement is included. There are several typographical errors and omissions in this publication; it is now being revised.

Index

Anatomy

104, 140, 160, 180, 182, 205, 234, 235, 241, 249, 259, 271

Biochemistry

177

Condition

136, 137, 148, 156, 172, 229

Distribution

104, 105, 128, 134, 137, 140, 146, 178, 191, 194, 195, 201, 202, 203, 217, 223, 224, 227, 231, 236, 238, 242, 243, 245, 246, 247, 249, 251, 259, 264, 265, 271

Farming

Economics, 40, 43, 50, 51, 59, 77, 99, 101, 118, 119, 208, 220, 273

General, 2, 3, 5, 6, 9, 10, 17, 18, 19, 20, 21, 22, 27, 31, 32, 38, 48, 86, 98, 103, 105, 110, 120, 121, 131, 153, 159, 161, 162, 163, 164, 167, 168, 170, 176, 182, 193, 198, 208, 225, 226, 230, 239, 254, 261, 264, 269

Harvesting, 46, 59, 136, 151, 182, 244, 253

Licensing, 11, 12, 13, 14, 16, 23, 33, 36, 37, 39, 44, 50, 57, 60, 61, 62, 65, 67, 75, 77, 83, 84, 89, 90, 102, 109, 110, 127, 182, 196, 197, 218, 219

Marketing, 30, 41, 46, 58, 65, 68, 78, 88, 91, 92, 93, 94, 95, 96, 97, 99, 100, 114, 117, 118, 119, 123, 129, 133, 144, 152, 157, 171, 208, 244, 252

Processing, 24, 45, 53, 56, 69, 71, 79, 113, 114, 115, 118, 119, 122, 198, 208, 266, 272

Spat catching, 8, 16, 25, 26, 33, 52, 63, 66, 76, 80, 107, 108, 145, 147, 154, 155, 158, 165, 169, 173, 181, 182, 206, 209, 210, 211, 212, 229, 260

Technology, 13, 15, 19, 21, 23, 33, 34, 35, 42, 45, 70, 106, 120, 124, 135, 145, 146, 149, 164, 166, 173, 182, 183, 184, 206, 228, 253, 260, 262, 268, 270

Water quality, 139, 151, 152, 182, 185, 247, 248, 250, 251

Fishery

1, 4, 7, 81, 104, 105, 127, 146, 147, 194, 195, 213, 227, 238, 245, 246, 264, 265, 267

Genetics

64

Growth

28, 107, 135, 136, 137, 143, 145, 147, 148, 154, 155, 160, 173, 178, 182, 200, 202, 203, 205, 206, 229, 238

Larval biology

111, 112, 181, 182, 237

Larval rearing

49, 255, 257, 261, 263

Mortality

29, 37, 203, 250

Mussel extract

24, 45, 55, 68, 69, 72, 73, 74, 82, 85, 125, 126, 141, 142, 174, 179, 204, 207, 214, 216, 232

Palaeontology

138, 234, 249, 266, 271

Parasitism and other associations

134, 150, 156, 182, 186, 187, 188, 189, 199, 215, 240

Physiology

178, 190, 191, 200

Pollution

18, 30, 54, 116, 130, 132, 175, 190, 221, 222, 247, 250, 251

Predation

134, 135, 202, 203, 224

Reproduction

134, 137, 182, 192, 205, 238, 261, 263

Settlement

8, 26, 47, 80, 107, 108, 134, 135, 145, 147, 148, 154, 155, 158, 165, 169, 173, 181, 182, 201, 202, 205, 211, 229, 236, 242, 243, 255, 256, 258, 261

Taxonomy

128, 138, 140, 180, 182, 205, 233, 234, 237, 241, 249, 271

