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AUSTRALIAN MARINE SCIENCES ASSOCIATION

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BULLETIN CORRESPONDENTS

NEWS

Senior Queen's Fellowships for 1978 have been awarded to the following:

Professor R. Ginsburg from Comparative Sedimentology Laboratory, University of Miami. His expected duration of stay in Australia is one month and his program is being organised by Dr M. Gilmartin at the Australian Institute of Marine Science.

Professor P. Holmes from the Department of Civil Engineering, University of Liverpool. His expected duration of stay in Australia is three months and his program is being organised by Professor K. Stark, James Cook University of North Queensland.

Professor M. Langseth from Lamont Doherty Geological Observatory of Columbia University. His expcted duration of stay in Australia is three months and his program is being organised by Professor G. Philip, Geology Department of University of Sydney.

Professor R. Margalef from the University of Barcelona, Spain. His expected duration of stay in Australia is two months and his program is being organised by Dr M. Gilmartin at the Australian Institute of Marine Science.

Professor K. Mann from Department of Biology, Dalhousie University, Halifax, Canada. His expected duration of stay in Australia is three months and his program is being organised by Dr K. Radway Allen, Division of Fisheries and Oceanography, CSIRO.

Professor W. Munk from Institute of Geophysics and Planetary Sciences, Scripps Institute of Oceanography. His expected duration of stay in Australia is one month and his program is being organised by Professor J. Mahony, University of W.A.

The Ecological Society of Australia (Sydney Branch) is planning an Open Forum on Ecological Research, which will be held at Macquarie University, 15-16 May 1978. Papers are invited from anyone wishing to report on the progress or findings of current research in any field of ecology. Abstracts of not more than 300 words and a tentative short title should be submitted by the end of February 1978. All abstracts will be duplicated for distribution at the meeting. The program will be prepared when the abstracts have been received and will group papers in the same research area. A poster session will be held for those who wish to display work only or if there is an excess of papers. Registration fee, which includes morning and afternoon tea and sets of abstracts, will be $10 ($5 for full-time students). All enquiries to Ms M.D. Fox, School of Biological Sciences, Macquarie University, North Ryde, N.S.W., 2113.

The Oceans Society of Australia is arranging a forum on the philosophical basis of environmental protection; protection policies and policy planning; regulations; present trends and thinking in marine environmental research and pollution studies; and the role of Australian industry in pollution and preservation of the marine environment today. The forum, which is part of the Society's Annual Conference, will be held on Sunday 4 June 1978 in the Blackwood Hall, Monash University, Clayton, Victoria. All enquiries to Jeanette Watson, P.O. Box 4604, G.P.O., Spencer Street, Melbourne, Victoria, 3001.

The International Conference on Indian Ocean Studies will be held on the campus of the University of Western Australia, Perth, Western Australia, on 15-22 August 1979. The proceedings of the Conference will consist of plenary sessions of general interest and seminar sessions for each of the seven specialist sections: environment and resources; trade and development; history of commercial exchange and maritime transport; international politics; cultural exchanges and influences; archives and resources for study; and comparative education. The Conference will coincide with the 150th anniversary celebrations of the founding of Western Australia. Registration fee is $50. All enquiries to I.C.I.O.S. 1979, Centre for South and Southeast Asian Studies, University of W.A., Nedlands, Western Australia, 6009.

Coastal Zone '78, a symposium of technical, environmental, socio-economic and regulatory aspects of coastal planning will be held in San Francisco from 13-16 March 1978. All enquiries to Coastal Zone '78, P.O. Box 26062, San Francisco, California 94126, U.S.A.

A Coastal Management Workshop will be held in Melbourne, probably in February 1979. All enquiries to Dr E.C.F. Bird, Geology Department, University of Melbourne, Parkville, Victoria, 3052, or Mr P.W. Cullen, Canberra College of Advanced Education, P.O. Box 381, Canberra, A.C.T., 2601.

At the 9th International Sea-weed Symposium, Santa Barbara, California, papers covering various aspects of their research work were presented by members of the University of Melbourne: Mrs Sophie Ducker, Dr G. Kraft, Dr R. Wetherbee, Miss Sue Ramm and Mrs Roberta Townsend of the Botany Department and Dr K. Gaylor and Dr B. Grant of the Biochemistry Department. It was particularly pleasing to see that two of the persons attending and presenting papers were graduate students, since Australian Universities have to date not encouraged their students to travel abroad during their graduate work. Dr Gayler and Dr Grant also went on to the 4th International Conference on Photosynthesis at Reading, U.K., where they presented papers covering more basic aspects of their work on photosynthesis in marine algae.

At an International Workshop on Mangrove and Estuarine Area Development for the Indo-Pacific Region, Manila, Philippines, 14-19 November 1977, Graeme Wells of the Department of Environmental Physics, University of Sydney, presented a paper on current mangrove ecological studies in the Northern Territory and a status report on work being undertaken in Australia. The workshop was organised by the Philippine Government through the Philippine Council for Agricultural Research and Resources and several UN agencies, in particular UNEP (United Nations Environmental Program), SEAFDEC (South East Asian Fisheries Development Centre) and the Bureau of Fisheries and Aquatic Resources (Philippines).

The Royal Australian Institute of Parks and Recreation held its Fiftieth Annual Conference in Canberra in October. Working Groups on Coastal Management, which met several times, were attended mainly by local government parks and recreation staff concerned with shoreline vegetation and recreation. It is planned to devote an issue of the Institute's journal *Australian Parks and Recreation* to these topics in 1979.

The University of Melbourne has made further steps towards strengthening its graduate and research program in marine science. It has appointed Mr Mark Marsden of the Geology Department as co-ordinator of Marine Science Studies within the University. The co-ordinator's task will include the very important one of bringing together the various people with interests in specific areas of research, and in making co-ordinated submissions to the University and to outside granting agents for funds for group projects. While the University teaches a number of specific courses related to marine science, it has as a policy refused to set up an undergraduate degree in the subject, since it believes that a first degree in one area of basic science is desirable before specialising in marine sciences.

The University of Melbourne has purchased a new 22-foot Shark-Cat for use in inshore studies in marine sciences. This boat is well equipped to handle a wide variety of sampling tasks ranging from bottom sampling, water column monitoring, through to trawling. It will give the University a capability to handle estuarine studies in Western Port and Port Phillip Bay. Another important item of equipment purchased recently is a sub-bottom profiler and side-scan sonar, which is held by the Department of Surveying for the use of members of the Faculties of Engineering and Science.

The Marine Studies Group, a new separate research arm of the Ministry for Conservation, Victoria, has been formed by amalgamation of the Marine Pollution Studies Group and the Marine Chemistry Unit. The Marine Pollution Studies Group was established, as part of the Fisheries and Wildlife Department in 1968, to participate with the Melbourne and Metropolitan Board of Works in an environmental study of Port Phillip Bay. Between 1972 and 1974, the Group was enlarged to assist the State Electricity Commission with an evaluation of the likely effects of the discharge of heated effluents from the proposed Newport power station into Port Phillip Bay; and to assist the Environmental Studies Section of the Ministry for Conservation with the study of Westernport Bay and its catchment. The Marine Chemistry Unit was formed in 1972, as a branch of the Department of Agriculture, to participate in the Westernport Bay Environmental Study. The Officer-in-charge is Dr Allstair J. Gilmour, who is responsible to Dr Tom Linton, Director of Environmental Studies, Ministry for Conservation, Victoria.

Visitors to CSIRO, Cronulla, during the first two months of the year will be modelling experts Bill Holland from the National Modelling Center for Atmospheric Research, Boulder, U.S.A., and George Veronis, Chairman of the Department of Geophysics, Yale University.

Dr A.D. Albani has nearly completed his revision of AMSA Handbook Number 1, *Recent Foraminiferida of the Central Coast of New South Wales*. Copies should be available soon.

Dr Alan Carter, Department of Applied Geology, University of N.S.W., and **Dr Jean Carter** are leaving shortly to spend a year at the Sedgwick Museum, Cambridge University. Dr Alan Carter will work with Professor H.P. Whittington on various aspects of oceanography. Dr Jean Carter will be working on invertebrate structure and phylogeny.

Friends of **Gillian Kennedy** will be interested to learn that she is now Mrs (Dr) Scott and Acting Head of the Department of Biology, Capricornia Institute of Advanced Education, Rockhampton, following the resignation of Dr Andrew Osborn.

Dr John Kowarsky, an expert on catfish, has joined the staff of the Department of Biology, Capricornia Institute of Advanced Education, Rockhampton. Some interesting research on the Fitzroy River estuary is likely to start as a result of John's appointment.

Mr Greg. Maguire of the N.S.W. State Fisheries has toured Japan, Philippines and Thailand to inspect their prawn farming industries and research centres. In Japan he inspected prawn hatcheries, ponds and intensive culture units in the Seto Inland Sea area and in various parts of Kyushu Island. Whilst touring he also had the chance to see some aspects of the aquaculture of crabs, abalone, fin fish and seaweed. In the Philippines the most interesting project was the completion of the life cycle of *Penaeus monodon* by large-scale induction of farmed and wild female prawns. The work in Thailand was particularly relevant, because of the large-scale hatchery production of *Penaeus merguiensis,* the same species as the Australian banana prawn.

Dr Andrew Osborn has resigned as Head of the Department of Biology, Capricornia Institute of Advanced Education, Rockhampton, to take up the post of Scientific Advisory Officer with the Reserve Bank of Australia.

Mr David Tranter, CSIRO Division of Fisheries and Oceanography, Cronulla, is taking part in plankton studies aboard the research vessel *Walter Herwig,* which left Buenos Aires for Antarctic waters on 28 December 1977. The vessel will work in four areas: the Bellingshausen Sea west of the Antarctic peninsula; the Scotia Sea eastwards as far as the South Sandwich Islands; and an area north-east of South Georgia. The cruise ends at Ushuaia in Tierra del Fuego on 18 February 1978.

Mr Rob Williams of N.S.W. State Fisheries was able to arrange visits to a number of Japanese scientists during his recent holiday. His first visit was to Professor Emeritus Dr Tune Sakai, now retired from Yokohama National University, to discuss crab introductions. His second visit was to Professor Sigeru Matoda of Tokai University, Shimizu. The University has one of, if not the most magnificent marine aquariums in the world, and Rob went back for a second visit in as many days. Professor Matoda had previously been helpful during correspondence on identification of ballast water species. Shimizu is one terminal for woodchips exported from Eden, N.S.W., and the Professor, his staff and students have for some years conducted plankton surveys in the harbour. One staff member, Mr I. Uotani, positively identified some of the copepods obtained in Eden and taken to Japan. Professor Matoda recommended a visit to the research station and oyster farms of Mr Tadao Sato. The station is remarkable in two ways: it is one of the few privately financed oyster research laboratories in Japan, and Mr Sato continues in his role of director of the station at the venerable age of 92. Staff at the station are studying, among other things, parasites of edible and pearl oysters. A subsequent visit was made to the home of Dr and Mrs Izumi Nakamura, at the Fisheries Research Station of Kyoto University, Maizuru. Dr Nakamura had previously been at the Australian Museum during sabbatical when he worked on Gempylidae, Trichiuridae, Scombridae and Istiophoridae. His wife Reiko was also working in the Fish Department at that time. The last visit was to Professor Ryo Tatsukawa, Professor of Analytical and Environmental Chemistry, Ehime University at Matsuyama. The Professor and his staff are currently investigating a number of organic and inorganic environmental pollutants. Discussions centred on mercury in the environment.

Dr Baughan Wisely of the N.S.W. State Fisheries inspected various oyster farming areas in Japan during a two-month tour. In Hiroshima he studied the oyster raft industry which consists of 8000 rafts and also assisted with research into methods for predicting spatfall, a critical phase for the Japanese industry, as it only lasts 2-3 weeks. He also visited the Sado Island raft and longline oyster industry and the Mito area, where red sea bream *(Pagrus major)* and yellowtail *(Seriola grandis)* are farmed in floating pens. Finally, in Sendai Bay he investigated the longline oyster industry, oyster seed production for export, abalone and oyster hatchery methods and water treatment systems for laboratories e.g. u.v. sterilisation and sand filtration.

Mr Peter Wolf of the N.S.W. State Fisheries was overseas during August and September last year. While in America he attended a symposium on *Halosporida* in commercial shell fish (VIMS, Gloucester Point, Virginia, U.S.A.) and the Annual Meeting of the Society for Pathology. In France he studied oyster culture in Arcachon Bay, and he attended the 1st European Colloquium on Molluscan Diseases and Parasites at Centre Universitarie du Perpignan in southern France. The colloquium dealt mainly with schistosomes in tropical gastropods.

CSIRO's *Courageous* has been using the computerised echo integrating system during acoustic surveys of jack mackerel in waters off southern N.S.W., Bass Strait and eastern Tasmania. Biological data were collected by midwater and demersal trawling using an Engel 300x800 and a Frank and Bryce trawl respectively.

SCIENTIFIC INFORMATION SERVICES

The Australian National Scientific and Technological Library (ANSTEL), a branch of the National Library of Australia, has been established to improve the access of the Australian community to the world's scientific and technological literature. To this end, ANSTEL has developed a wide range of services based on computerised information retrieval systems.

One such service is the SCI (Science Citation Index) database. This multidisciplinary database is produced by the Institute for Scientific Information in the U.S.A. in the form of weekly magnetic tapes. These tapes contain details of articles from nearly 4000 of the world's most significant journals from over 100 disciplines in the following broad subject areas:

- Agricultural, biological and environmental sciences
- Engineering, technology and applied sciences
- Physical and chemical sciences
- Medical and life sciences
- Behavioural sciences

An SCI search tailored to individual requirements can retrieve:

- all works with titles containing specific key words or combinations of key words
- all papers citing a particular reference
- all papers citing works published by a particular author
- all works by scientists or technologists associated with a particular organisation
- all works published by a particular scientist

Both current awareness searches in the form of 52 bibliographies per annum, and retrospective literature searches are available. Until recently the maximum number of users who could subscribe to the SCI service was severely limited. These restrictions have now been lifted and there is no longer a waiting list for SCI services.

Charges for SCI services

1. Retrospective searches
   A search of the database from 1974 to date $50
   ,, May 1976 to date $20
   (More complex searches may cost more, and are undertaken only with the requester's agreement)
2. Current awareness searches
   (a) Information Bulletins (monthly)
   This service is designed to provide general coverage of a number of broad subject areas, e.g. air pollution, food engineering, lasers. Subscriptions cost $10 p.a. per title. A list of topics covered by these bulletins is available on request.
   (b) Individual profiles (52 bibliographies per annum)
   This service provides searches which have been tailored to the individual requirements of the subscribers. Subscriptions cost $75 p.a.

For further information on this and other ANSTEL services please contact the Chief Librarian, SCI Service, ANSTEL, P.O. Box E333, Canberra, A.C.T., 2600.

REPLIES TO OPEN LETTER

Three members (AMSA total membership nearly 600) have replied to the Open Letter of Collett, Holmes, Kudenov and Evans (Bulletin No. 60). The replies received are published below.

Sirs,

With reference to your open letter to AMSA members, of October 10, 1977, I have circularised this among our marine scientists and regret that I have received no comment or opinion from them. In short, they show no interest in the "Bulletin".

This is particularly disappointing to me, but with so many journals and papers to read one has to be sure that what goes into the "Bulletin" must attract readers. How to do this, I am not sure, because, being on Council one likes to keep close to the news and events that take place in the Marine sphere, and my opinion may not be shared by the majority.

I like the suggestion of an Editorial Committee to assist the Editor, but would direct attention to bias if the members are all in "close geographic proximity". If interested Branches had a correspondent — who almost automatically must be the local Secretary or a special Assistant Secretary — a more balanced approach may be achieved.

Additionally, now that Council is meeting four times per year, could the "Bulletin" come out in the Newsletter style immediately after each meeting of Council, with a report of each meeting and an outline of plans or projects the Council is working towards. Dates of meetings of Council should be publicised and also the dates of the National Meetings together with their themes should also be notified as soon as possible.

With the combined NZ-Australia meeting in 1979 there is already the need to inform people of a steering committee responsible for organisation, and of the major theme.

On top of the four Newsletter type publications, there must be some type of report on the papers and meetings of the AMSA National Conferences. Otherwise we will not build up our scientific image as an Association.

I hope that my comments are of some use to you.

J. T. BAKER
(Vice-President AMSA).

Roche Research Institute of Marine Pharmacology
Box 255, P.O., Dee Why, N.S.W., 2099.

The Secretary

I have just read the letter from Collett, Holmes, Kudenov and Evans on page 6 of the recent AMSA "Bulletin".

For what it is worth I would like to suggest that 2, 3 and 4 be combined in one annual report like that produced by our New Zealand colleagues.

I cannot see that suggestion 4 alone would solve the problems of *gathering* current information. As a former editor I am well aware of that problem.

BRIAN NEWELL

Ministry for Conservation
P.O. Box 41
East Melbourne 3002.

Sir,

Re: An Open letter to AMSA Members, Australian Marine Sciences Bulletin, No. 60, October 1977. Leon Collett, Nickolas J. Holmes, Jerry D. Kudenov, and Darwin Evans.

As requested by the authors, I have given their letter some thought and I have set out my comments below.

As a non institutionalized marine scientist (if you can call a dentist in private practice who is researching masticating structures of marine vertebrates and invertebrates a marine scientist) I look towards the "Bulletin" and the recently published Directory of Marine Scientists as a resource. Since coming to Australia from New Zealand, I have discovered a myriad of groups that cater for people in marine science research. AMSA's sister body in New Zealand seemed to cater for all those involved in marine research, and I was at a loss, initially, to sort out what society or organisation served the function of the New Zealand Marine Sciences Society.

On reviewing the New Zealand Marine Sciences Newsletter, 19 December 1976, I find that it does what the authors suggest the "Bulletin" should do, i.e., point 2. Having a yearly reference of institutions, their research, and the people involved is of enormous help to a new Australian or an itinerant researcher.

Because Australia has several states with quite separate attitudes and legislation regarding marine matters, I see that AMSA has a vital role to play in helping co-ordinate State and Federal policies (if that is at all possible).

No doubt the authors of the open letter have given a lot of thought to the peculiar problems of co-ordinating the communication of marine science in Australia, and I can only endorse their list of improvements.

Might I add that there is an urgent need to publish a description of marine research facilities available in Australia, e.g., Heron Island, with their requirements of use. Only recently did I become fully aware of the facilities and who could use them. Like the other state matters of who controls what, the various research stations have diverse and often conflicting requirements.

I hope the notes and comments are of some help and I would also like to thank you and your associates for the efforts to date in producing what is a valuable publication in spite of the comments above.

KEVIN B. SCALLY

Suite 5, First Floor
35 Ranelagh Drive
Mount Eliza, Victoria, 3930.

THE 200-MILE EXCLUSIVE ECONOMIC ZONE

Reprinted below is an article which appeared in 'The Herald', Melbourne, on 13 September 1977. The President wrote to The Honourable (the then) Mr Snedden about this article and received his permission to publish it in the Bulletin for the information of AMSA members.

WILL WE RULE THE WAVES?*

*by B. SNEDDEN, Speaker of the House of Representatives (*Reprinted from 'The Herald', Melbourne)*

Australia's top fishing expert estimates that there are up to 400 Japanese and Taiwanese catcher boats within 200 miles (322 km.) of Australia's coastline on any day.

And that is the area over which we will claim exclusive rights before 31 March 1978.

We've had a worrying and growing problem in policing our northern coastline for many years. Now we have a new and even more difficult policing operation.

But first, the old problem.

From Exmouth Gulf, about the centre of the West Australian coast, right around to Cairns, our coast is particularly exposed to anybody wishing to illegally enter for any reasons.

The north-west coast is particularly open to intrusion because the country inland is easily traversed and is covered by a network of roads and bush tracks.

Most of the areas of the Northern Territory and the Gulf are much tougher country with fewer tracks and no roads.

There are good reasons to suspect that the north-west is being used as an entry point for illegal migrants, smuggled contraband and drugs.

Equally alarming, it could be the entry point for exotic diseases, especially animal diseases which could ravage Australia's rural industries.

The surveillance of the coastline has been inadequate up to now and continues to be so without plans to upgrade it.

We must rely partly on sporadic aerial reconnaissance by the RAAF and partly on the chance of reported ship sightings. This can do no more than locate occasional fishing vessels.

There is no way by which an aerial reconnaissance can identify Australian from Taiwanese or Japanese fishing boats — except for the fact that we know we have none.

The aerial reconnaissance is supported by Navy patrol boats. The Navy's job is to intercept and arrest foreign fishing boats which are within 12 miles (19 km) of the coast.

This is the limit of the exclusive fishing zone which Australia now possesses. In the past year, 22 Taiwanese fishing boats have been arrested for illegal fishing.

Now to the second and newer problem.

Following United Nations discussions — as yet not finalised — country after country has gone it alone and reserved for its citizens an exclusive economic zone running out to 200 miles (322 km) from the coast.

Australia has played a leading role in the UN talks and has been unwilling to claim this advantage.

However, in Port Moresby two weeks ago at a meeting of the South Pacific Council, Australia joined with the other 11 nations of the Pacific in an agreement to legislate for this exclusive zone by 31 March 1978.

Taking this exclusive economic zone means Australians will have exclusive right to fish in that area.

Other countries' catchers cannot fish it unless we license them. This licensing process will involve a lot of trust and regulation by the fishers' own governments.

We have good relations with Japan. We have none with the Taiwanese Government whose fleet is by far the biggest. This gap must be overcome and there are ways to do it.

Unless we license foreign boats we will be facing the prospect of hundreds of arrests each year. If we can find and catch them!

Resource

We have added to Australia's wealth a vast economic resource. A sea surface half as much again as our land surface, it has a potential for national enrichment which cannot yet be estimated.

We have the technology but we do not have the industry. There is nowhere enough finance available to encourage Australians into the fishing industry.

I believe the Government will have to produce a program of special assistance for loans and equipment.

To utilise this vast resource we must quickly build a fishing industry comparable to a country with the biggest offshore area in the world.

Supervision of the area must rely principally on surface craft supported by aerial surveillance. Patrol boats of the right kind are not cheap, but they can be built in Australia competitively with other countries.

They are certainly cheaper than a fighting patrol boat. Armor, torpedoes and guns are not the need. A fast boat with wide radar scanning capacity, yet able to stand up straight in heavy seas when not under weigh, is a must to allow boarding or arrest. Without armor-plated heavy arms, it can have a long range.

Carefully positioned harbors along the coast will complete the mobility.

We are probably looking at 10 of them, at a cost of up to $750,000.

Australia has the seamen and fishing skills to compete with any other country, yet we have not even explored to find new major fishing grounds which we know to exist.

The Taiwanese and Japanese certainly know of them. We have in our control a vast supply of protein in a world continually multiplying the market for that essential substance.

There is no point in us possessing this exclusive economic zone if we do not use it. And there is no point in excluding the Japanese and the Taiwanese catcher boats or the Soviet prawn trawlers from the area if we don't use it ourselves.

We must develop a licensing system for foreign boats to fish our waters for two reasons.

First, as a revenue raising proposition, and second, to ensure that our resources are not fished out as we sit by and see the resource vanish.

MARINE SCIENCE POLICY FOR AUSTRALIA*

by D.J.G. GRIFFIN, Immediate Past President, AMSA
Australian Museum, Sydney

(* Paper presented at the Symposium on Science in The Oceans, ANZAAS, Melbourne, 1977.)

In the light of recent developments in politics in Australia we may well ask — will there ever be a marine science policy in Australia?

Before attempting to answer this question let me take you back some 2000 years. The century or so before the birth of Christ was a time when Aristotle's interest in marine science was stimulated by his wanderings along the shores of the Aegean Sea and Julius Caesar was about to die. Cassius, you will remember, was trying to con Brutus, the honest politician, into an alliance to remove Caesar. Almost as a last resort, Cassius tries to show Brutus his true 'face'. He says, 'The fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings'. I want to return to this quotation later.

I would like next to quote from a paper, delivered in Australia, which talks about marine science and policy in Australia. I wonder if we might be able to guess from what is said how long ago this paper was delivered.

'The observations involved in marine science are expensive'.

'Australia has no national program. Funding is piecemeal'.

'Machinery is now ready for a major development of marine science'.

'We must establish our communications'.

'Oceanography in Australia is still in its infancy and therefore can be trained into the right path for a fruitful life'.

I have deliberately chosen the title of this paper because I consider that there should, indeed must, be a defined national policy for marine science. Without a policy there is only the probability that marine science will continue to be fragmented and uncoordinated. There seems to be no ordering of priorities. The absence of a policy is only *one* of the problems, however. That there is no policy now would hardly be disputed: we continue a process of adhocery and waste. It should also be said that the need for a policy is not predicated on a program of a *particular* size.

Science policy has been defined as 'a deliberate and coherent basis for national decisions influencing the investment, institutional structures, creativity and utilisation of scientific research' (OECD Examiners Report 1975). Such a definition implies that the policy will allow for planning, implementation and review of science-based activities.

I could indicate that, in my view, whilst the planning stage — a framing of objectives — must be done carefully (and therefore consume a large amount of resources) the ongoing effort in coordinating should *not* be obsessively large: resources should be concentrated on implementation — conduct of the various programs — rather than diverted constantly to coordination. To have a science policy does not imply the development of a top-heavy bureaucracy.

Marine science, as we have seen, is an extremely diverse field including mathematical modelling of current patterns, geology of the sea floor, interactions at the air sea interface, effects of pollutants on animals and plants in the sea, culture of fish species and manufacture of various pharmaceutical products from marine organisms and so on. This enormous diversity of disciplines

has *possibly* contributed to the lack of a coordinated thrust in the development of marine science in Australia. Of course, there are those who reject the need for a marine science policy. As George Humphrey said in 1962, 'To many the idea of coordination is an anathema and many correctly oppose attempts to bring their work into a general scheme'. He noted, however, that few if any institutes which make facilities available do so simply at the asking. Despite his misgivings this latter observation highlights the need for coordination.

Aspects of marine science policy in Australia have been considered by others. Recent times have seen the creation of AIMS, introduction of fellowship schemes, international agreements and the funding of research on 'Crown of Thorns' starfish problem. The Great Barrier Reef Marine Park Authority and Consultative Committee have also been formed.

A number of points stand out from a review of past marine science in Australia:

- the low level of activity;
- delays in programs caused by conflict between the Commonwealth and the States; and
- lack of push by Government for establishment of a national policy.

The Day Report concluded (in 1971) 'Any impression that Australia is a hive of activity in marine science would be quite misleading'.

The major findings of the Review of Science in Australia conducted by the OECD Examiners in 1974 are well known. They stressed the need for a national policy. They stated, 'The need for a considerable increase in Australian research and development facilities in the basic and applied marine sciences is great . . .'

A subcommittee set up in late 1975 by ASTEC reviewed marine science. The resulting report had some difficulties in balance. But major areas of concern *have* been spelled out by a number of agencies and *are*, I contend, well known. These have been touched on by other speakers.

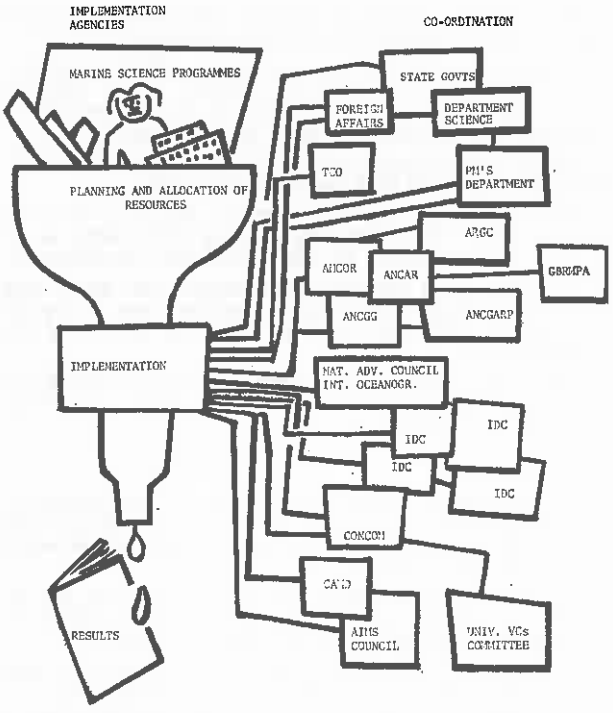
Categories in which support for marine science might be considered are:

- studies of direct consequence to man;
- studies yielding basic data for long-term research;
- studies of intrinsic interest in which Australia has a long-standing interest (or might have).

The major facility required is an ocean-going vessel. The structure required is a national council. The additional finance needed could be calculated for particular upgraded programs quite easily.

What has been spelled out also by Day and the OECD Examiners is the huge number of committees interested in (? coordinating) marine science: at least forty committees occupying the time of at least one hundred persons — academy, Government (Federal and State), university and lots of others, are in existence.

I set out previously in diagrammatic form the processes involved in science policy. Collett, the other day, indicated an appropriate structure: a council or management body reporting to a minister and controlling the implementing organisation (which might be looked at from time to time by a (small) audit group reporting to the council). In Australia I suggest another model is more accurate in describing, so far as marine science is concerned, how the system operates. With apologies to Bruce Petty I think it looks something like this (see Figure). The principle feature is that far too much is chasing far too little, the resources are going to planning (almost all inadequate) and expensive and ineffective coordination.



But, as I said, there are other problems. One, rather curiously perhaps, flows from what we understand as commonsense categories: what do we mean by Australia? If we are going to define *Australian* marine science as what is carried out in Australia *by* Australian agencies we are in some difficulty. Extending the definition by removing the requirement that Australian agencies be involved, makes it easier to see that something of value is going on: the benefits of international cooperation — use of other countries' ships — is considerable and so is work done in Australia *by* other countries. This should be encouraged! Having in mind the enormous attention paid to coordination, regulation and control, we can conclude that the inclusion of the 'consent regime' for research within the 'declared exclusive economic zone' as being proposed by the 'Law of the Sea Convention', will, in one stroke, wipe out a huge chunk of Australian marine science.

Next there is the linking of the diversity of disciplines. I can only say that there is nothing to stop separate policies being formulated for different disciplines — linked by the need to use common high-capital-cost facilities — marine stations and ships.

Then there is the co-operation of marine scientists. It was demonstrated dramatically yesterday. The question was, 'Would you give up a bit of what you have now to get a ship?' The response was 'No'!

Next, sociologists concerned about decision-making in science and allocation of resources, identify a group of persons whom they refer to as 'power brokers'. These are the people who influence decisions as to what is and what is not done. The quality of the work and the personal wishes of the researcher play a very small part in this process. It has been pointed out that during the development of a discipline there are stages when researchers need to negotiate about what constitutes acceptable and appropriate theories, methods and problems.

'The nature of the agreement will depend not only on the initial position of the negotiating parties, but also on the differential distribution of prestige and power' within the group (according to Mulcay *et al*). Members of the elite play a leading part in determining the pattern of scientific development. Support *by* the elite legitimises the science conducted by the majority. Can we see clearly among the existing 'power brokers' in Australia — the members of *many* committees, advisors to ministers, top bureaucrats (not ministers), any persons strongly dedicated to support for marine science — either policy formulation or programs? No!

The only hope is contained in the remarks of Jitts the other day. I think he said, 'Marine scientific research is now being carried out in the exclusive economic zone. This area is now controlled by coastal states through the consent regime. Governments will therefore have to take marine science much more seriously'.

I said earlier that science policy is not predicated on a program of a *particular* size. But I do contend that a program is dependent on a policy.

I started this address by quoting from a previous paper — it was delivered by Tony Cooper, then R.A.N. Hydrographer, in 1965 at an AMSA meeting. The remarks might have been made yesterday!

I return to Julius Caesar and his friends. Although Cassius had limited success, euphemistically speaking, in the long term, he did succeed in the short term. He knew his objectives and his policy and he worked hard at persuading the *right* people to his viewpoint, by showing them what was in it for *them*, not him.

The fault, dear colleagues, lies not in our governments but in ourselves that we have no marine science policy in Australia and no national marine science program.

THE FIRST ANNUAL VICTORIAN MARINE SCIENCE CONFERENCE

by M. MARSDEN, and J.D. KUDENOV†*
**Dept of Geology, University of Melbourne*
†Marine Studies Group, Ministry for Conservation, Victoria

The First Annual Victorian Marine Science Conference, held on 26 November 1977 at the University of Melbourne, was a success. About 45 people attended to hear a series of very good student papers. The interest generated by this conference was gratifying, and many people are looking forward to next year's conference which we intend to broaden to include both student and professional papers. We wish to acknowledge Dr Valda McRae (Chemistry Dept, Univ. Melbourne), Mr Robert Foster (BHP, Melbourne), Mrs Jan Watson (Treasurer, AMSA, Victoria) and Dr Nicholas Holmes (President, AMSA, Victoria) for their invaluable services and time spent in making this conference a success.

Abstracts of papers prepared for the conference are published below. Ms D.J. Hodden was unable to present her paper, but the abstract is published. No abstract of the paper by N. Birjak was available.

Distribution and production of *Australonereis ehlersi* (Augener) and *Ceratonereis eurythraeensis* **Fauval (Polychaeta: Neridae) at Werribee, Port Phillip Bay.**
by J.H. Dorsey, Zoology Dept, University of Melbourne.

Nereid polychaetes are conspicuous in the benthic community of Port Phillip Bay at Werribee, an area which receives secondarily treated sewage effluent from the Melbourne Metropolitan Board of Works Sewage Farm. Methods for investigating the distribution and production of the two dominant nereid species, *Australonereis ehlersi* and *Ceratonereis eurythraeensis*, are reviewed and initial results for February-April 1977 are considered.

Thirteen inshore and 11 offshore stations were located along a 2.74 km stretch of coastline having the 145 W drain as its midpoint. Inshore stations had an average depth of 0.5 m at mid-tide and offshore stations 1.5 m. Three samples and physical and chemical measurements were obtained monthly at each station. Sampling was started in February 1977 and will continue until July 1978. Samples were taken with a box corer (sample volume, 4.2 1, and area, 0.03 m^2, washed through a 1.0 mm mesh and preserved in a 10% formalin-seawater solution. Bottom temperature and salinity were measured in situ. Oxygen concentrations of bottom water were determined by the Winkler method. A sediment sample was frozen for organic carbon and nitrogen determinations. Additional sediment samples were taken quarterly for grain-size analysis; samples were divided into percentage shell, sand (fractions include very coarse, coarse, medium, fine and very fine sand) and mud.

Computer maps of distributional patterns and numerical abundance were generated by the program SYMAP on the CYBER 73 computer. Physical and chemical parameters will be correlated with these density patterns by means of factor analysis. Biomass was measured as ash free dry weight (mg AFDW). A sample of individuals from each month's sample was placed into age classes using probability paper analysis. Mean weight of each class was calculated from the regression relationship between biomass and neuroacicular length. Monthly production was measured by integrating the change of density and mean weight for each age class, then summing class production to yield total monthly production.

Individuals of *A. ehlersi* were up to 15 cm long and had a biomass of about 100 mg. In February their density (mean number of individuals/m^2) was low; 22.0 at inshore stations; 14.0 at offshore station, and nil in the drain area. High biomass per m^2 (984.6 and 624.9 offshore) tion (71.4%). March and April densities (inshore 313.8; offshore 116.5) were much higher because recruitment of young; AFDW/m^2, which decreased due to high adult mortality, was 550.3 inshore and 179.6 offshore. From February to April, overall production for the area was a gain of 248.8 mg/m^2.

Adult *C. eurythraeensis* are smaller than adult *A. ehlersi* and large individuals are about 5 cm long and have a biomass of nearly 5.0 mg AFDW. Highest densities, which occurred inshore primarily in the vicinity of the drain and Station 2 (located 975 m W of drain), ranged from 2087.5 in March to 3270.3 in February. Densities offshore were 27.0 in February and nil in April. Biomass/m^2 inshore averaged 2592 and offshore averaged 9.81. The population contained three age classes of which the oldest were reproductive individuals. Production during this period was estimated at 183.8 mg AFDW/m^2.

Both species were found together in various areas, but where there was a high density of nereid polychaetes, each species occurred alone. Centres of abundance for *C. eurythraeensis* were at the drain and Station 2: *A. ehlersi* predominated along inshore areas away from the drain. The population structure of *C. eurythraeensis* is more complex than that of the larger *A. ehlersi*, but appears to produce less tissue per m^2.

Relationship between fish grazing and bryozoan and ascidian communities at Portsea Pier, Victoria

by G. Russ, Zoology Dept, University of Melbourne

Grazing of ascidians by fish appears to have been a significant factor influencing the structure and composition of panel communities at the Portsea Pier, Victoria, Australia, during the summers of 1975-76 and, to a lesser extent, 1976-77. Experimental exclusion of a major predator, the juvenile tooth-brush leather-jacket *Penicipetta vittiger*, resulted in the dominance of colonial ascidians (mainly *Didemnum* c.f. *coriaceum*, and species of *Botrylloides* and *Distaplia)*. In the natural situation fish grazing on the potentially dominant competitors, the ascidians, appear to prevent severe competition between this group and a wide range of invertebrates, particularly arborescent and encrusting bryozoans, and a high community diversity is maintained. The effects of substrate complexity, a physical simulation of an arborescent bryozoan barnacle community, on ascidian settlement and survival are so far inconclusive. However, substrate complexity was shown to increase the settlement diversity and density of bryozoans.

Preliminary studies of Victorian non-articulated coralline algae

by R.A. Townsend, Botany Dept, University of Melbourne

Earlier records show that 13 genera of non-articulated corallines are found in Victoria. So far 15 genera of non-articulated members of the family Corallinaceae have been recorded in a study on the Victorian coast. The taxonomic position of two groups of organisms is as yet not definitely established, but evidently they represent new records for Australia.

Dioecious thalli are generally found in the coralline algae but on rare occasions monoecious genera have been recorded. Monoecious thalli are now found in Australian collections of the genus *Heteroderma*. Conceptacles containing both male and female reproductive structures are present in the Australian *Melobesia patena* Hoof f. & Harv. This type of conceptacle has only been recorded for one other species, *Phymatolithon lenormandi* (Areschoug) Adey. Other modifications of the thallus, such as 'spouts' on the male conceptacle were found for the first time in *Heteroderma* and other genera.

Ecologically the non-articulated corallines are important since in most cases they are the substrate for the establishment of phytobenthos and zoobenthos. My investigations show that non-articulated coralline distribution is governed by the overstorey at any location. Different genera have diverse requirements, which depend on their shade tolerance, ability to withstand grazing, etc. Likewise non-articulated corallines differ in their substrate preferences.

The fine structure of the vegetative cell and post-fertilisation development in Nemalion (Rhodophyta)

S. M. Ramm, School of Botany, University of Melbourne

The fine structure of the vegetative cell and post-fertilisation development was studied in *Nemalion helminthoides* collected from Queenscliff, Victoria, and *Nemalion multifidum* from Woods Hole, U.S.A.

Stages in development of the vegetative cell can be recognised on structural aspects of the cell wall and the chloroplast, particular to the location of the cell in the thallus. In the centre of the thallus, the medulla region is composed of irregular stellate cells arranged in filaments which are interwoven in their longitudinal axis. These cells are characterised by a very convoluted plasmalemma and a thick cell wall composed of two layers and a cuticle. In some cells a chloroplast was observed. Adjacent to the medulla is a transition region composed of large irregular cells which become smaller towards the outer region of the thallus. A large central vacuole is a feature of these cells as well as the occasional presence of a disorganised chloroplast. The outermost region known as the cortex is formed by dense dichotomous assimilative filaments. The most distinctive characteristics in these cells is a large stellate chloroplast containing a pyrenoid as well as a three-layered cell wall.

Postfertilisation development in *Nemalion* presents some unique aspects when compared to other red algae. The diploid reproductive spores have a functional chloroplast throughout development and do not depend on energy supplies from the breakdown of neighbouring cells. In the Australian material, proliferation was frequently observed whereby the spores are successively produced within the remains of old spore walls still attached to the mother cell.

The red algae, although typical eucaryotic cells, appear to rank among the most primitive higher life forms in terms of several biochemical and morphological features. The subcellular development of these plants is receiving a major emphasis in research at the present time in the hunt for clues to the phylogeny of all life forms. The southern Australian coastline, which is recognised as a centre of evolution and dispersal of red algae, offers many interesting species for pursuing these studies.

Lipid analysis of a prochlorophyte as a taxonomic tool

by G.J. Perry and R.B. Johns, Dept of Organic Chemistry, University of Melbourne

Prochlorophytes being procaryotic in cellular organisation but containing chlorophylls *a* and *b* characteristic of green algae are a unique group of algae. A prochlorophyte isolated from the ascidian *Lissoclinum patella* from Rodda Reef, Queensland, showed a pigment composition expected of a eucaryotic green algae. The prochlorophyte contained monogalactosyl diglyceride, digalactosyldiglyceride, sulphoquinovosyl diglyceride and phosphatidyl glycerol as its major lipids. These lipid data coupled with the limited range of hydrocarbons and fatty acid and sterol analyses are characteristic of the lipids of blue-green algae, and this study represents an unusual use of lipid chemistry in establishing the taxonomic position of this prochlorophyte.

Study of sulphides in marine sediments

by D.J. Hodder, School of Chemistry, University of Melbourne

Investigation of diagenesis of sulphur and interrelated geochemical reactions in marine sediments has previously been hindered by the lack of a sufficiently sensitive and selective method for the determination of available sulphide.

A new method for the direct determination of available sulphide in sediments is reported here. The method uses standard additions and direct potentiometric titration using a sulphide electrode. Incorporation of the sample into an anti-oxidant buffer allows determination of sulphide in solution at levels less than 1 ppm, with negligible (<5%) loss, either by volatilisation of hydrogen sulphide or by auto-oxidation of sulphate.

Studies on selected sediment cores showed marked stratification of sulphide in marine sediments with the maximum sulphide concentration at 6 cm below the sediment-water interface. Depth profiles for concentrations of copper, lead, zinc and iron were found to be consistent with metal sulphide formation.

For the sediments characterised it was concluded that of the sulphide formed by microbial action most was converted to hydrotroilite (FeS) and various other metal sulphides; further conversion to pyrite (FeS_2), at the horizons studied (0-24 cm), was insignificant.

Trace metal behaviour in sediments of the Yarra River estuary, Victoria

by P. Milne, Marine Chemistry Laboratory, School of Chemistry, University of Melbourne

Measurements of a number of trace metals (Cu, Zn, Pb, Cd and Fe, Mn, Ca) associated with the surficial sediments were made as part of a program to determine the chemical behaviour of river-transported material upon its transition from fresh water to sea water in an estuary. These chemical properties reflect reactions occurring over a time scale longer than that of the mixing processes between fresh and salt water in the water column.

Concentrations of extractable trace elements were found to correlate strongly with other chemical and physical properties of the sediments, notably the presence of hydrous ferric oxides which exist as surface coatings on much of the sediment. Consideration was given to other possible regulatory controls on trace metal concentrations found in natural systems.

A study of the fractionation of some selected heavy metals in sediments from the Yarra River, Victoria

by M. Ellaway, Water Studies Centre, Caulfield Institute of Technology

Samples of sediments were taken from a 150-km stretch of the Yarra River from Warburton through the estuary to Hobsons Bay.

Conc nitric acid-perchloric acid extracts of the $<63.0\mu>$ 20.0μ; $<20.0\mu>$ 2.0μ; $<2.0\mu$ fractions of the sediments were analysed by atomic absorption spectrophotometry for Fe, Mn, Pb, Cu, Zn and Cd. For all the metals the <20.0 $>2.0\mu$ and the $<2.0\mu$ fraction accounted for 90-100% of the total metal content; the $<2.0\mu$ fraction contained 60-80%. Concentrations of all metals, except Mn which remained fairly constant around 100μ g/g, increased with distance downstream.

Concentrations of Zn, Pb, Cu and Cd were highest in the estuarine samples (337 μg/g; 209 μg/g; 90 μg/g and 2.5 μg/g respectively), but fell to 132 μg/g; 72 μg/g; 40 μg/g; and 0.75 μg/g respectively in samples of the marine sediments. This decrease could be due to either desorption or 'dilution' effect caused by mixing of polluted river sediments with marine sediments.

A sequential selective chemical extraction procedure was then set up to investigate the 'phases' that these metals were associated with. The $<20.0\mu$ fraction of the sediments was thus divided into the following nominal fractions:

Nominal chemical phase	Extractant
(a) Adsorbed or exchangeable	1N ammonium acetate
(b) Humic and fulvic	0.1N sodium hydroxide
(c) Reducible	1M hydroxylamine hydrochloride-25% (v/v) acetic acid
(d) Residual	Digest with hydrofluoric acid, perchloric acid, nitric acid

The concentrations of Fe in the residual phase increased slightly downstream, whereas that of the humic + fulvic phase decreased. In samples from the estuarine sediments, the concentration of Fe in the reducible phase, which probably represents oxides and hydroxides, is almost double that in the freshwater sediments. This probably indicates the effect of flocculation and precipitation processes.

The concentrations of Pb, Zn, Cu and Cd in the residual fraction were nearly constant all the way downstream, whereas their concentrations in the deducible phase were much higher (500-1000%) than those in the river sediments. This supports the hypothesis that the oxides and hydroxides of Fe readily scavenge these metals which are then carried into the sediments.

Thus sedimentation and flocculation, together with adsorption and desorption, seem to be the main regulating mechanism involving trace metals when fresh and saline waters mix.

Relationship between zinc content and textural and mineralogical characteristics of the sediments of Lake Wellington, Victoria

by I.D. McKelvie, Water Studies Centre, Caulfield Institute of Technology

The ability of estuarine sediments to sorb heavy metals from the overlying waters is well established. This study considers the significance of textural and mineralogical characteristics in the uptake of zinc by estuarine sediments from Lake Wellington, Victoria.

Sediment samples were taken from 84 sites in Lake Wellington, the Latrobe, Avon and Perry Rivers, McLennan Strait and Lake Victoria. Size analysis of these samples showed that the centre of Lake Wellington is essentially clayey-silt and silty-clay, and that the highest concentration of sand occurred along the eastern shores of the lake.

Sieve analysis, at half phi intervals, of samples with a significant sand fraction (greater than 95%) showed the sands to be medium to fine-grained, moderately to very well sorted, and mesokurtic to very leptokurtic. Skewness varied from strongly fine to strongly coarse.

A representative subset of 20 samples was analysed for clay minerals by X-ray diffraction. Of the clay fraction (<2 μm), illite was the predominant mineral present (mean: 72%, range: 54-82%), with kaolinite, chlorite (an apparently poorly crystallised type), traces of montmorillonite and clay-size quartz being detected. X-ray diffraction was used to show that the sands were composed almost entirely of quartz.

Zinc, iron and manganese were extracted from the total sediment with nitric acid and analysed by atomic absorption spectrophotometry. Organic material, as percentage weight-loss on ignition, was also determined.

Regression analysis of the results showed that of these parameters, zinc content was most strongly correlated with the iron and clay contents of the sediments. Good correlation with the percentage organic matter was also found.

So that the adsorptive capacity of the sediments might be estimated, the surface areas of a number samples were determined. The sediments exhibited type II adsorption isotherms, and the surface area was computed using the B.E.T. approach. Surface areas varied from less than 1 m^2g^{-1} for a sandy sample to 21.5 m^2g^{-1} for one of high clay content. Statistical treatment of the results indicated that the clay fraction was responsible for most of the specific surface.

The statistical model reliably predicted the zinc content in terms of the amounts of iron and clay in the sediment. However, since the iron, clay and organic content (and to a lesser extent, the manganese content) display strong intercorrelation, some chemical means, such as a fractionation technique, should be used to determine the species responsible for the sorption of zinc in the sediments.

Transport, flux and deposition of suspended sediment in the intertidal zone, Hastings Bight, Western Port, Victoria

by R.W. Seedsman, Geology Dept, University of Melbourne

Hastings Bight, a small (about 11 km^2) tidal embayment on the western side of Western Port, is typical of other isolated intertidal flats and channel systems in Western Port. The morphology of Hastings Bight shows the typical zonation of salt marsh, mangrove, inshore sandy, and intertidal flat zones. The intertidal flats are covered with a mostly dense vegetation of *Zostera* and *Heterozostera*, have a complex topography, and show an apparently random sediment distribution pattern which set them apart from other intertidal areas studied elsewhere in the world. The bottom sediments are admixtures of a fine sand and a silty clay, and the movement of this silty clay subpopulation, which is transported as a suspended load, has been studied.

The concentration of suspended matter (turbidity) in Hastings Channel varies in a cyclic fashion according to the state of the tide. Maximum turbidity does not correspond to maximum tidal current in the channel, nor does minimum turbidity correspond to high- and low-water still stands. Maximum turbidity occurs late in the ebb tide, about one hour before low water, and results from turbulence created on the intertidal flats. Tide conditions (spring-neap) and wind speed control the levels of maximum turbidity (usually less than about 15 mg l^{-1}) which are low compared to other intertidal areas. Minimum turbidity occurs about two hours into the ebb tide following sediment deposition at slack water.

The amount of suspended material moved by Hastings Channel during ebb tides ranges from about 5 tonnes (neap tide, no wind) to 23 tonnes (spring tide, 6 km h^{-1} wind). The development of maximum turbidity late in the ebb tide, and the lack of any large scale exchange with North Arm water ensures that the flood tides return to Hastings Bight most of the material removed during ebb tides. Deposition of material at and near high-water still stand from water which has flooded across the intertidal flats and not through the channels is sufficient to compensate for the loss and hence maintain and add to the intertidal flats. The present patterns of net sediment loss and gain appear to indicate that in the long term the intertidal flats are at least stable but that the controlling factors of deposition and resuspension are in a finely balanced equilibrium. The presence of the seagrass vegetation is considered particularly important in maintaining the present conditions.

Phosphorus distribution in Bass Strait surface waters

by A. Longmore, Marine Chemistry Laboratory, School of Chemistry, University of Melbourne

Water samples were collected across Bass Strait between Melbourne and Devonport during July and December 1976 using an underway sampler from a passenger vessel. The samples were analysed for temperature, salinity suspended solids, total dissolved phosphorus (TDP) and dissolved inorganic phosphorus (DIP); dissolved organic phosphorus (DOP) was taken as the difference between TDP and DIP. In the central Strait region, DOP levels were about 50% higher in July than in December. The same pattern was found for the suspended solids distribution.

Variations in the parameters determined can be explained in terms of inputs from rivers and effluent, with vertical mixing occurring in the shallow Strait waters during stormy periods.

NUMBERS THROW NEW LIGHT ON TORNADO DYNAMICS

(Reprinted with the permission of Monash Review)

A Monash [University] mathematician and a former postgraduate student have developed a series of numerical models of tornadoes which throw new light on the way the highly destructive storms form and on many aspects of their dynamics.

The models overcome many of the problems associated with attempts to simulate tornadoes in laboratory experiments.

The researchers are **Dr Roger Smith,** a senior lecturer in mathematics, and **Dr Lance Leslie,** who completed his Ph.D. course at Monash, and later joined the Melbourne-based Australian Numerical Meterology Research Centre.

The centre is an independent unit, jointly sponsored by the Department of Science (Bureau of Meteorology) and the CSIRO.

Smith says tornadoes are the most violent wind storms in nature. They are long, narrow, swirling vortices which develop beneath massive thunderstorms, causing intense damage where the funnel-like vortex makes contact with the ground.

On the rare occasions when meteorological measuring equipment has been in their path, it has usually been completely demolished.

Wind speeds up to 350 km/h

Their associated wind speeds have been estimated to exceed 350 km an hour. The vortex can vary, but it is normally less than 1000 metres and is more typically about 100 metres wide.

Their lifetime is usually only a few minutes although some vortices survive for up to twenty minutes, and they can leave a path of damage several kilometres long.

The most devastating tornadoes occur in the mid-west of the United States, where they cause the loss of many lives and property damage running into hundreds of millions of dollars annually.

In Australia, they occur in all the mainland states, but are relatively less frequent than in the U.S., with an estimated 15 a year in NSW and about five reported each year in Victoria.

Last year, two people in Victoria were killed when a tornado passed over the car in which they were travelling and demolished it.

According to Smith, there have been numerous theories on the way in which tornadoes form, but none have been very satisfactory.

Part of the difficulty has been the paucity of observational data.

Because of this, there have been many attempts to simulate tornado-type vortices on a smaller scale in laboratories.

Smith says that it is easy, up to a point, to generate the vortex, but it is not possible to obtain very complete measurements of the three dimensional flow fields as the vortex grows or to get an understanding of the mechanism of its growth.

He says the numerical model, which contains the essential ingredients of the type of thunderstorms capable of spawning tornadoes, overcomes these problems, and all the air flows can be calculated.

Using the model, the researchers have been studying how the vortex develops and the circumstances under which a particular cloud is likely to spawn a tornado.

Smith says U.S. scientists have recently developed radar techniques which enable direct measurements of air movements in a thunderstorm to be made.

These studies have led to the discovery of radar "signatures" in clouds which seem to be directly linked with tornado vortices.

"What appear to be embryonic tornado vortices have been observed at heights of four to five km in cloud, up to half an hour before the tornado touches down on the ground," he says.

"The radar signature is observed to develop downwards and may or may not reach the ground, but where it does, it follows the track of the tornado, and when it does not, a tornado does not form."

Smith says: "Our theory explains how downward development can occur, and by feeding in observed magnitudes for the cloud rotation, we have been able to correctly simulate core size, vortex strength, atmospheric pressure across the vortex, and the observed time scale for the growth of the tornado."

Air updrift intensifies

The numerical models have shown that tornadoes form as the air updraft in upper levels of the storm cloud intensifies and draws air towards it from outer parts of the cloud.

This converging air, which already is rotating about the updraft, conserves its angular momentum, and, the further in it is drawn, the faster it rotates, and the centrifugal forces it experiences increase.

Ultimately, these become large enough to prevent further radial motion at upper levels of the cloud, and a core of strongly rotating air — the vortex — is formed about the updraft.

This vortex acts like the end of a pipe drawing into it rotating air from lower levels in the cloud. Again this air reaches a radius at which the centrifugal forces balance the pressure forces sucking it in. In this way, the core of rotating air is extended downward.

On reaching the ground, the swirling velocities, and hence the centrifugal forces on inflowing air, are reduced, and air converges into the vortex in a shallow layer at its base.

The vortex formation requires the updraft strength and rotation strength to be within fairly rigid limits, which explains why thunderstorms only rarely spawn tornadoes, Smith explains.

How then do the typical "dust devils" of the Australian outback relate to tornadoes?

Says Smith: "We have done some research on dust devils and we have deduced their dynamics as well. Like tornadoes, they are long, thin, rotating air flows, but they are driven quite differently.

"The tornado, like its counterpart at sea, the waterspout, develops as a vortex downwards from a cloud, and is driven by strong air convection currents in the cloud.

"Dust devils, on the other hand, are produced on hot days by convection currents near the ground which intensify the rotation of gusts of wind.

"One of the aspects not fully understood about dust devils was the relationship between buoyancy and the vertical motion in the core of the dust devil.

"The buoyancy force and the vertical motion of air in the core had both been measured, but the buoyancy force was too small to account for the rapid vertical acceleration.

"From our theories, we have been able to show that there is an additional mechanism associated with the development of the rotational field which adds to buoyancy and helps accelerate vertical air flow near the ground."

Tropical cyclones are different

Smith says tropical cyclones are differently structured, but often spawn tornadoes when they hit land.

"Cyclones, which may be up to 200 km across and 12 to 16 km deep, are squat, fat vortices. They are driven by a ring of thunderstorms around the 'eye' and their 'fuel' is the moisture they pick up from the sea.

"This moisture is fed by surface winds into the central clouds and the heat released in the clouds as the moisture condenses provides buoyancy to maintain the cyclone.

"Cyclones cause damage over wide areas, but the tornadoes they spawn can be highly destructive in small areas. We suspect that tornadoes are to blame for severe local devastation which does not fit the overall pattern of damage caused by the passage of the cyclone," he says.

Tornadoes in Australia tend to be less severe than their U.S. equivalents, and often occur in relatively uninhabited areas.

Traces of their strikes have been found in forests, where a swathe has been cut through trees, leaving trees skewed in different directions, indicating the rotational effect of the wind, Smith adds.

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DRAFT INVENTORY OF INTRODUCED MARINE ORGANISMS

by R.J. WILLIAMS, E.J. van der WAL and J. STORY
N.S.W. State Fisheries, P.O. Box N211, Grosvenor Street, Sydney, N.S.W. 2000

Some AMSA members are aware that research is being carried out by New South Wales States Fisheries on the introduction of non-indigenous marine organisms via ballast water. The research was commissioned because vessels coming to Australia from various parts of the world generally have their ballast tanks filled with water taken on at one or more of their ports of call. When the vessel reaches its Australian destination, the ballast water with associated marine organisms may be discharged.

Of the various types of vessels which come to Australia, the ships which carry bulk cargoes such as iron ore or grain would discharge by far the largest amount of ballast water. These bulk carriers are the vessels of choice to export the bulk products which form the backbone of the Australian economy.

Ballast from bulk carriers is being discharged at a number of ports throughout Australia including: north-west Western Australia where ballast is exchanged for iron ore; Gladstone, Queensland, in exchange for coal; Eden, N.S.W.; and Triabunna, Tasmania, in exchange for woodchips.

In the N.S.W. State Fisheries project, plankton samples are taken from ballast tanks of ships calling at the above ports so that an attempt may be made to identify plankton being introduced and to assess the potential problem posed by introducing non-indigenous marine organisms.

In assembling the available literature it became apparent that a number of marine introductions to Australia have previously been reported. A draft list of these introductions is summarised below. Its purpose is to solicit critical comment from Association members. Comments on the following would be appreciated:

- Nomenclatural changes.
- Additional introductions.
- Sightings in areas other than those indicated.
- Any information which suggests that species assumed to be introduced are indigenous.

Organism	Origin	New Location	Reference
BRYOZOA			
Bugula flabellata	North Atlantic	N.S.W., S.A.	E.J. Ferguson-Wood and F.E. Allen, 1958.
Watersipora cuculata	Warm tropical ocean	N.S.W., Qld., Vic.	E.J. Ferguson-Wood and F.E. Allen, 1958.
Shizoporella unicornus	Japan	N.S.W., W.A.	F.E. Allen, 1953.
Anguinella palmata	Atlantic Ocean	N.S.W.	F.E. Allen, 1953.
Konopeum tubegerum	West Indies	Qld.	F.E. Allen, 1953.
HYDROZOA			
Bougainvillia ramosa	United Kingdom	Australia (entire coast)	F.E. Allen, 1953.
POLYCHAETA			
Hydroides sp.	United Kingdom	N.S.W., Vic., Tas., S.A.	L. Walford and R. Wicklund, 1973.
Mercierella enigmata- non Fauvel 1923 *Ficopomatus uschakovi*	Western Australia	Australia (east coast)	F.E. Allen, 1953.
MOLLUSCA			
Thercacera pennigera	United Kingdom	Australia (entire coast)	F.E. Allen, 1953.
Crassostrea gigas	Japan	N.S.W., Tas.	J.C. Medcof and P.H. Wolf, 1973.
CRUSTACEANA			
Cirripedia			
Balanus improvisus	North & South America	Australia (southern half of continent)	L. Walford and R. Wicklund, 1973.
Balanus amphitrite	Tropical Pacific	Australia (entire coast)	L. Walford and R. Wicklund, 1973.
Balanus algicola	South Africa	N.S.W.	F.E. Allen, 1953.
Decapoda			
Palaemon macrodactylus	Japan	S.A.	T. Walker, 1977, personal communication.
Carcinides maenas	Europe	Australia (south coast)	L. Walford and R. Wicklund, 1973.
ASCIDIACEA			
Molgula manhattensis	North Atlantic	Qld., Vic.	Patricia Kott, 1976.
Styela clava	Japan, Korea	Vic.	N. Holmes, 1976.
VERTEBRATA			
Acanthogobius flavimanus	Japan	N.S.W.	D. Hoese, 1973.
Tridentiger trigonocephalus	Japan	N.S.W.	D. Hoese, 1973.

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