Instituut voor Zeewetenschappelijk onderzoek
Institute for Marine Scientific Research
Prinses Elisabethlaan 69
8401 Bredene - Belgium - Tel. 059 / 80 37 15

LABORATORIUM VOOR EKOLOGIE EN SYSTEMATIEK

FAKULTEIT WETENSCHAPPEN
VRIJE UNIVERSITEIT BRUSSEL

PLEINLAAN 2
B - 1050 BRUSSEL

18635

Instituut voor Zeewetenschappelijk onderzoek
Institute for Marine Scientific Research
Prinses Elisabethlaan 69
8401 Bredene - Belgium - Tel. 059 / 80 37 15

18635

KENYA REPORT

JULI 1986.

Contents

1. Foreword

This is the first review report on the Kenyan-Belgian Project in Marine Ecology (KBP).
It explains our approach and methodology : the linkage between equipment, education and research. Interaction between fundamental and applied research.
Real co-operation between Kenyan and Belgian Scientists.
We are always accessible to remarks and advices and hope to be able to continue.

Prof. Dr. Polk, Ph.
Mombasa, July 1986

2. Acknowledgement

We like to thank, in the first place, both governments, the Kenyan and the Belgian, for initiating a program on Marine Sciences and to put confidence in the Kenyan and Belgian Scientists.
We thank the administrations who made it possible to work out and run the project.
We are also gratefull to the Authorities of the Free University of Brussels (VUB), who gave me the opportunity to go on partial leave to work as a director and co-ordinator for the project.
The Authorities of KMFRI, who provided the necessary help to welcome the project, who helped us finding our way and gave us the necessary room to develop the program in an optimal way.
The N.V. Volvo, who lend us, via the VUB, a splendid car for the project. The work done up to now, is due for an important part to the use of the Volvo. Unfortunately the Kenyan driver had an accident wiht it and the car was totally destroyed.
The N.V. Olivettei, who via the help of the VUB, gave us a typewriter and a Computer. The fact that we need a second computer and a word-processor, shows that the equipment is used in an optimal way.
Thanks to the Belgian experts who, together with their Kenyan homologues, worked very hard and conscientious and by doing so implanted a scientific spirit in the KBP.
The Kenyan technicians, sampling and analysing day and night are at least as important as the scientists.
Thanks to Ingrid, the administrative help, who succeeded in setting right the administration of the project, which was a complete chaos before her arrival.
Els, who came at the moment I had to go to hospital and who assured the continuity and organisation of the scientific work during my absence.
All these synergies of different phenomena made that the Belgians are feeling at home in Kenya, at 8000 km from their country.
But only an 8 hour flight away with SABENA, who always gave us a good service.

3. Introduction

The aim of the project was to develop a program on Marine Ecology and the Management of the Coastal Zone (living and non-living resources).
We started the inventory and descriptions of the different Marine biotopes and their trophic levels. This fundamental research guided us to initiate applied research : we started a small-scale oyster culture to prevent the loss of the high primary production of the mangrove creeks. By doing so we provided work for the local population and used only local materials for the building of the rafts.
Both, the fundamental and the applied research must go on with the present project as backbone. Other, subprograms, fitting in the framework of the KBP, will be added. A common project between Kenyan and Belgian Universities will be worked out and submitted to the EEC, on specific mangrove research.
The Belgian experts will submit an interuniversity program for fundamental research to the National Science Foundation.
And in collaboration with the KMFRI and the Kenyan and Belgian Universities, we will organise a Regional Course on Marine Biology, with the support of UNESCO and UNEP.
In this way, we will cover most of the aspects of Marine Ecology, needed for the Management of the Coastal Zone.

4. The Belgian Experts and the Kenyan Homologues

The residential expert, Prof. Dr. Polk, arrived in Kenya on the 17th of December 1984. When he has to leave Kenya in order to fulfill his obligations in Belgium (for courses and examinations at the Free University of Brussels or important meetings of the National Science Foundation, EEC, etc.) he has, each time, been replaced by a Belgian expert.

Thus, up to now, the following experts have worked in Kenya :

4.1. Prof. Dr. Decleir, W.* (January 3 - January 27, 1985) University of Antwerp - Ecophysiology.

4.2. Prof. Dr. Egghe, L.* (January 27 - February 13, 1985) University of Limburg - Librarian Sciences.

4.3. Drs. Pissiersens, P.** (January 27 - February 13, 1985) University of Brussels - Computer Sciences.

4.4. Dr. Heip, C.* (February 1 - 23, 1985) University of Ghent - Benthos.

4.5. Dr. Dehairs, F.* (February 1 - 23, 1985) University of Brussels - Marine Chemistry.

4.6. Dr. Daro, N.* (March 15 - April 12, 1985) University of Brussels - Plankton.

4.7. Dr. Frijdal, A. (April 6 - 19, 1985) University of Brussels Computer Sciences.

4.8. Dr. Somers, E.* (May 10 - 26, 1985) University of Ghent Law of the Sea.

4.9. Dr. Bergmans, M.* (April 12 - May 16, 1985) University of Brussels - Taxonomy, Harpacticoids.

4.10. Prof. Dr. Ronday * (May 1985) University of Liège - Physical Oceanography.

4.11. Dr. De Greve, J.P.* (June - July 1985) University of Brussels - Computer Sciences.

4.12. Dr. Coppejans, E.*(June 21 - July 28, 1985) University of Ghent - Phycology.

4.13. Drs. Revis, N. (September 12 - October 10, 1985) University of Limburg - Taxonomy & Copepods.

4.14. Dr. Coppejans, E. & Drs. Beeckman, T. (January 8 - February 8, 1986) University of Ghent - Phycology . (see 4.12.)

4.15. Dr. Daro, N.*(January 30 - February 27, 1986) University of Brussels (see 4.6.)

4.16. Dr. Martens, E. (April 20 - July 30, 1986) University of Limburg

4.17. Drs. Tackx, M. (May 23 - June 21, 1986) University of Brussels - Plankton & Seston.

4.18. Dr. Dehairs, F.* (June 21 - July 28, 1986) University of Brussels - Marine Chemistry.

* Several of the short-term experts developed specific programs with the Kenyan counterparts. (see 8.2.1)

** Drs. Pissiersens, P. is currently employed by KMFRI. He is doing our computer work and, with his practical knowledge, is a great asset to the project. (see annex 1 & 7).

We also had the assistance for the research done on underwater ecology (coralreef ecology & marine algae) of the divers Martens D., Elskens,H. and Sweefelt, J. from Vilvoorde, Brussels. We hope to develop in the near future, with their help, a Scientific Diving Centre.

5. Equipment

5.1. Laboratory Equipment

The equipment provided by the Belgian Government, is mentioned in annex 2.
There is a basic equipment for Marine Research and extra material is bought in function of the research.
The equipment is now stored in two air-conditioned labs at KMFRI When this equipment is needed for research, it is registered and used by the scientist who remains responsible for it. When he doesn't need the instrument anymore, it is checked and put back in the store.
Nevertheless, equipment regularly used in the field, is ruined too fast due to the high temperature, the humidity and salinity of the environment. The fast substitution of the field equipment is unavoidable. So, extra responsability is asked from the scientists and technicians.
At present the Computer Section is functioning very well. We plan to buy a second , bigger computer, a word processor and a photostat, as the input of scientific data, the documentation centre and the administration of the project are growing fast.
But we request urgently the Kenyan Authorities to provide a generator, to prevent the spoiling of programs and work due to power failure, as happened before.
As the present equipment is listed on computer, and the listing is regularly updated, other African and European Scientists who will participate in the programs and use the equipment, can be fully informed on the present infrastructure. (annex 2).

5.2. Transport

The difficulties of transport the project is facing, are tremendous. We insist on both governments to find a solid sloution for this primordial problem.

5.2.1. The Cars

The Kenyan-Belgian Project used to have two cars. One car given by the Belgian Government (Renault 9) and one lend to the University of Brussels for the project, by the N.V. Volvo.
As sampling at different biotopes **at the same time** is sometimes necessary (e.g. spring-tides), the two cars were used in an optimal way. But unfortunately, the Kenyan driver appointed by the Institute had an accident and the Volvo was totally destroyed. He drove too fast, was blinded by oncoming cars and crashed at full speed into a lorry, stationed on the road without lights nor reflectors. Luckily he was driving a Volvo, otherwise he would have been killed on the spot.
When asked for help to the Belgian Co-operation Section in Nairobi we got the answer we had to wait until the mixed commission meets in October 1986. But in the meantime the project has to go on, and for that regularly sampling has to be done in different places along the coast.
From the Ministry in Brussels we got the original and friendly telex saying : "... look for another maecenas!!!"
No written reply came from the Kenya Authorities although Article 6.4. of the Agreement is very clear on this matter.
KMFRI gave at the disposal of the project a fourwheel-drive.
Two weeks later, this car was also damaged in a car accident and is still broken down.
To assure the continuity of the work, we rented a car on our own expenses. Indeed, if some ecological work is not done at certain moments, we are losing a whole year.
Our remarks on this matter are pertinent: what will happen

with the destroyed car?
To be able to do our research in an optimal way, the project needs two safe, solid, all-roads cars.

5.2.2. The Boats

The Kenyan-Belgian Project needs at the moment a small boat with an outboard motor. At KMFRI there is one, in a very bad condition, another one has been stolen. Our work is badly hampered by this.
It is also unacceptable in view of safety standards that there is only one boat that can be used for the sampling in Tudor Creek.

CONCLUSION

If the Kenyan-Belgian Project wants to succeed in all her aims and if it will become the nucleus of a Centre with Regional importance, then a solution for the transport (cars and boats) must be worked out. This is only possible if both parties take their responsabilities.

6. The Documentation Centre

6.1. Introduction

Up-to-date literature is a sine qua non for research. We need the necessary recent publications related to the research-objects, but financially we can't afford a complete overview of Marine Publications.

Magazines, where only a few articles a year are of direct interest, are too expensive in the actual situation. Therefore, we opted for an as complete as possible 'SELECTIVE SYSTEM'. We need and purchase the adequate literature for the ongoing research. This principle was worked out and explained to the Librarian of KMFRI, by Prof. Dr. Egghe (University of Limburg). In collaboration with Mrs. Mwobobia, Librarian at KMFRI, we were able to start the Documentation Centre.

6.2. Present Situation

At present we have more than 25.000 pages of scientific literature, regarding the ongoing research. The literature has been bound, registered and dispatched to the scientists. The listing of the literature present is found in annex 3.

6.3. Extension of the Project

The KBP Documentation Centre is extending its scope: at the moment, we are doing the same work, with the same methodology for the Marine Scientists of the University of Nairobi and

the Regional Dugong Project of IUCN (International Union for the Conservation of Nature).
To develop the present Centre into a Regional Centre, we have to establish a practical catalogue (keywords, computerisation, dispatch facilities etc.). To work out these aims, we will send Mrs. Mwobobia to the University of Limburg - Belgium (Prof. Dr. Egghe).
During the Regional Course of UNESCO (see 7.5.) we will have the opportunity to convert the Centre into a Regional one.

7. Education

We consider "education" as a combination of 'theory' and 'praxis'. Which is of course only possible when we have the equipment.

7.1. Visiting Experts

Each visiting expert gave one or several seminars on his own speciality, to the scientific community of KMFRI. They established personal collaboration in the laboratory or the field, with the Kenyan homologues during their stay. If necessary, we try to obtain fellowships to send African Scientists to a Belgian Laboratory for up-to-date specialisation (see 7.3). Some of those collaborations result into full programs. (Annex 18)

7.2. Kenyan Scientists working in the KBP

7.2.1. At the occasion of the visit of Mr. Beck, Head of the Co-operation Section at the Belgian Embassy in Nairobi, at the KBP, every Kenyan Scientist working in the framework of the project, gave a seminar on his work. (see annex 4).

7.2.2. An important contribution to the International Congress on Tropical Aquatic Ecosystems (UNESCO - October 1985 in Nairobi), was presented by several Kenyan Scientists. Their conferences belonged to the best ones and their data were on an international level. (annex 5)

7.2.3. UNEP funded two fellowships for East-Africa for the International Workshop on Coralreef Ecology. (Phillipines, May 1986). One of them was for a member of the KMFRI-staff working in the KBP. (Annex 16)

CONCLUSION

As in every Institute, anywhere in the world, we have at KMFRI some very good, motivated scientists whom merit the necessary help and facilities to continue their research.

7.3. Fellowships

7.3.1. The Belgian Government

The Belgian Government, provided us, after discussion with the Kenyan Authorities, the necessary fellowships.

7.3.1.1. Long-term fellowships

The Belgian Government provided two long-term fellowships for Kenyans, to follow the Postgraduate two years course 'FAME' (Fundamental and Applied Marine Ecology). This Postgraduate course on an interuniversity basis results into a Masters Degree. (Annex 17)
The Kenyan students of KMFRI are Mr. Odido and Mr. Oteko.
On the request of the Kenyan Authorities, there will be one specialisation in Physical Oceanography and one in Marine Pollution (Prof. Dr. Ronday and Dr. Baeyens (Phys. Ocean.) and Dr. Dehairs - Marine Pollution)

7.3.1.2. Short-term felowships

In 1985, a fellowship was offered to Mr. Kazungu (KMFRI-KBP), who specialised in nutrient-determinations, during three months. He came back with extra equipment in order to continue his work in Kenya. (Dr. Dehairs, Lab. For Analytical Chemistry, University of Brussels). (annex 6)
In 1986, two fellowships are offered for a five month specialisation in Marine Ecophysiology (Prof. Dr. Decleir - University of Antwerp). The Kenyan Scientists are Mrs. Okoth and Mr. Omolo. They left Kenya on May 19, 1986.
Another fellowship is promised to Mrs. Mwobobia, Librarian for computerisation of the Documentation Centre (Prof. Dr. Egghe - University of LImburg).

7.3.2. Belgian Government and Internatinal Organisations

For the end of 1986, a mixed fellowship (airticket from UNESCO and a two months stay in Belgium from the Belgian Government) is offered to Mr. Ruwa, R.K. (KMFRI-KBP) for specialisation in Quantitive Ecology (Dr. Heip - University of Ghent).

7.3.3. International Organisations

In 1986 a fellowship is offered by UNEP to Mrs. Muthiga, KMFRI-KBP for a workshop in the Phillipines on Coralreef Ecology. (see also 7.2.3.) (Annex 16)

CONCLUSION

In 1985 and 1986 we obtained from the Belgian Government, scolarships for 7 scientists for specialisation in Belgium and 6 return tickets Nairobi-Brussels-Nairobi.
The International Organisations gave us two airtickets and a two week stay.
We like to thank the people in the different Institutions who were responsible for delivering these fellowships. We can assure those people that these grants are being used in an optimal way. We hope we will have the same or even a better cooperation in the future.

7.4. The Kenyan Universities and the KBP

In March 1986, the students of the University of Nairobi (Dept. of Zoology) visited the experimental oyster cultures in Gazi. Prof. Dr. Polk gave a field course on the theoretical and practical scientific approach on oyster cultures and Mangrove biotopes.

In April 1986, the teaching staff of Kenyatta University (Dept. of Zoology) visited Gazi. Mr. Ruwa (KMFRI-KBP) gave them a field course on oyster cultures.

In May 1986, the students of the Naivasha Fisheries and Wildlife Training Institute, visited Gazi & KMFRI. Mr. Ruwa and Dr. E. Martens gave them an introduction on mangrove systems and a contribution in the field.

7.5. Regional seminar on Fundamental and Applied Marine Ecology

UNESCO-Nairobi requested the KBP to organise in 1986 a Regional Seminar on Fundamental and Applied Marine Ecology. We'll organise this course in MOmbasa at KMFRI in collaboration with the Kenyan and Belgian Universities (extra funds have been asked from the Belgian Government and the International Organisations. We'd like to organise the seminar with a regional follow-up.

7.6. Cooperation between KBP and other scientists

Assistance and collaboration was asked by:

Mr. Little,M. U.K. Plymouth Technical High School. Mangrove area as spawning and nursery grounds.

Mr. Orr, D. Canada. Feeding mechanisms by shrimps. FAO-project in Malindi.

Mr. Weston, J. U.S.A New York. Total Environmental Study of the oyster cultures.

CONCLUSION

The KMFRI and the KBP are de facto becoming very important for Marine Sciences in East Africa.

PROJECT	KENYAN RESPONSIBLE	BELGIAN RESPONSIBLE
General Supervision	Mr. Allela, S.O.	Prof. Dr. Polk, Ph.
Computer Section	Ms. Ogaye, W.	Mr. Pissiersens, P.
	Mr. Onyango, H.	
Documentation Centre	Mrs. Mwobobia, J.	Prof. Dr. Egghe, L.
Mangrove Ecology	Mr. Ruwa, R.K.	Dr. Heip, C.
Plankton Ecology	Mr. Okemwa, E.	Dr. Daro, N.
	Ms. Kimaro, M.	Drs. Tackx, M.
	Ms. De Souza, M.	
Phycology	Mrs. Oyieke, H.	Dr. Coppejans, E.
		Drs. Beeckman, T.
Marine Chemistry	Mr. Kazungu, J.	Dr. Dehairs, F.
Coralreef Ecology	Mrs. Muthiga, N.	Prof. Dr. Polk, Ph.(1)
Prawns Biology	Mr. Wakwabi, E.O.	Prof. Dr. Polk, Ph.(1)
Fish Biology	Mr. Nzioka, R.M.	Prof. Dr. Polk, Ph.(1)
Ecophysiology	Mrs. Okoth, B.	Prof. Dr. Decleir, W.
	Mr. Omolo	
Oyster Culture	Mr. Ruwa, R.K.	Prof. Dr. Polk, Ph.
	Mr. Okemwa, E.	
Biochemistry in Marine Organisms (Food Quality)	Ms. Abubaker, L.	Prof. Dr. Polk, Ph.(1)
	Mr. Oduor	

(1) Provisional

See also Annex 8 (1-11) : ongoing work

8. Research

8.1. Introduction

The interaction between fundamental and applied research must enable us to obtain a global long-term management of the Coastal Zone. The priorities are:

a) an increase of protein production or other valuable sea-products.

b) to put a halt to the degradation and destruction of the marine environment for short-term profits.

To fulfill these aims in a pragmatic way, we consider four different biotopes, going from land to the sea:

1. The Mangrove areas
2. The Inshore Waters
3. The Coralreef
4. The Outshore Waters

8.2. Ongoing Research

8.2.1. General Research

The Kenyan and Belgian Experts are working in the biotopes 1,2 and 3.
Each ad hoc individual research program has to be integrated in a holistic model, indicating the pathways and quantities of energyfluxes through the Ecosystem.
The following Scientific Programs are in progress:

8.2.2. Specific Research on Oyster Culture

The Kenyan and Belgian Authorities insisted, after studying our intermediate reports, to focus on oyster culture. We can fully approve this for the following reasons:

1. The watercolumn in the Mangrove creeks has a very high primary production (more than 100 ton a day for Kenya). This potential high valued "food" is at the moment washed out in the Ocean without use.
2. Culturing oysters in a tridimensional biotope, we can have a conversion up to 20%, 7.5 X more efficient than culturing cattle.
3. 1.000 oysters/M^2 can be cultured, or 10 million per ha. (Kenya has 52.000 ha of mangrove area).
4. Oyster cultures are labour-intensive and can provide work for the local villagers.
5. The necessary investment is very low: only local material is requested (mangrove poles, nylon strings, marine cement, local labour) besides research.
6. There is already a home-market for oysters due to Kenya's tourist industry. But, as this market of collecting wild oysters becomes insufficient, the culture of oysters is needed.
7. The oyster biotopes in the industrialised world are deteriorating more and more, due to industrial pollution. The demand for oysters is increasing on the world market.
8. A first class road along the coast from Malindi to Tanzania, an International Airport in Mombasa and a direct railway communication Mombasa-Nairobi facilitates the transport of oysters.
9. Oysters are protein-rich sea products. With the modern communication network (newspapers, weeklies, broadcastong and television) and publicity techniques, we can try to integrate this product in the local food-customs (annex 9).

10. In the sheltered Mangrove Creeks, the possibilities of destruction of the infrastructures by tempates, as in the Far East, are low.

8.2.3. Scientific Publications

If scientific results are consistent, we publish them in the Kenyan Journal of Science and Technology Series, the African Journal of Ecology or in Hydrologia, so that they are accessible for the scientific community.

8.2.3.1. Accepted Scientific Papers

1. The Autecology of the Edible Oyster *Crassostrea cucculata* Born, 1778 : Size realted distribution at Mkomani, Mombasa, 1986, Kenyan Journal of Science and Technology Series. Okemwa, E.; Ruwa, R.K. & Polk, P. (annex 10)
2. Some observations and remarks on Mangrove Distribution in Kenya. Kenyan J. Science & Techn. Series. Ruwa, R.K. & Polk, Ph. (Annex 11)
3. The biology of Marine Copepods in Kenya Waters. Planktonic Copepods from Coastal and Inshore Waters of Tudor Creek. Kenyan J. Science & Techn. Series. Okemwa, E. & Revis, N. (Annex 12)
4. Changes in Kenyan Coralreef community structure and function due to exploitation. Hydrologia. McClanahan, T.R. & Muthiga, N.A. (Annex 13)
5. Changes in the population structure of the sea urchin *Echinometra mathaei* de Blainville at Diani Beach, Mombasa Kenya. African J. of Ecology. Muthiga, N.A. & McClanahan, T.R. (Annex 14)

8.2.3.2. Submitted Papers

1. Non-encrusting Macroalgal Zonation on Rocky cliffs around Mombasa, Kenya.
   Oyieke, H.A. & Ruwa, R.K. (Annex 15)

8.2.3.3. Papers in preparation

1. The Diurnal Cycle of Zooplankton in Tudor Creek during the Southeast Monsoon.
   Kimaro, M.
2. Relative abundance, diurnal and seasonal variation of the zooplankton entering and going out of Port Reitz Creek, Mombasa, Kenya.
   Okemwa, E.
3. Aspects of the biology of the reef fish Scolopsis bimaculatus (Ruppell 1828) in Kenya. II Age, growth and mortalities.
   Nzioka, R.M.

9. Future and extension of the Kenyan-Belgian Project

9.1. Belgium as the backbone for the project

9.1.1. The Belgian Ministry of Cooperation

The Belgian Ministry of Co-operation gave us the opportunity to start the Kenyan-Belgian Project and as, it has been insisted we will stress the present project on oystercultures. (see 8.2.2) Presently, 150.000 oysters (May 1986) are growing at Gazi. It only depends on the possibilities of investment to increase this number and to start, after discussions with the authorities, a semi-commercialisation or even a big-scale commercialisation. But we have to switch, as soon as possible, from an incomplete oysterculture (culturing wild oysters) to an integral oysterculture (from spatfall till marketable oysters). To collect spat ad-illimitum seems succesfull (May-June '86). The possible bottle-neck from spat till marketable size has to be studied and tested out (1987-88), as well as the fouling problems (June-July '86).

We hope that the Ministry of Co-operation will give us those possibiblities and remains the backbone for the follow-up and extension of the project.

We also asked our Ministry of Co-operation an extra subvention for the organisation of the regional course, to be used for the Belgian experts.

10. The "Belgian House" in Nyali

The Kenyan Government offered housing to the Belgian Resident and his family. The house, located in Nyali, has hosted not only all the Belgian Experts, but also African, European and American scientists used the infrastructure of the Belgian House.
At the moment (July '86) our visitor's book has exactly 111 signatures and nearly as many creative suggestions, remarks or proposals. We hope that the Kenyan and Belgian Governments will give us the possibility to continue this melting-pot of International Scientific creativity and friendship.

11. Health-Care & Medical Services

Untill now , the KBP-staff had no serious health problems.
For minor health problems of the permanent resident, his children or the Belgian Experts, the Kenyan Authorities fullfilled totally their obligations.
When the Director of the KBP had to undergo an operation, everything happened in optimal conditions with a very helpfull administration.
Our congratulations to the Kenyan Authorities and the staff of the Mombasa Hospital.

"When I'm in Belgium and if I need to undergo an operation, I'll come back to Mombasa Hospital!"

Prof. Dr. POLK

12. Post-Scriptum

As the responsable for the KBP, I'm happy to send this report to those persons who followed the experiences attentively, who helped us often in an enthusiastic way, practical or spiritual.

If the results of the KBP will lead to a stronger cooperation between Kenya, this beautifull country with so many potentialities, and Belgium, with his overspecialised scientists, this will be positive for both countries.

And if the results will lead to a better Management of an important part of a not-yet-totally-destroyed environment in East-Africa, then we would like to continue this work. For some years...

13. Annexes

1. Computer Section : Activities. Pissiersens P.; Ogaye W. & Onyango H.
2. List of the laboratory equipment (21/7/86)
3. List of the publications available in the Library of KMFRI.
4. Lectures given during visit of Mr. Beck.
5. Lectures given at the International Congres on Tropical Aquatic Ecosystems (UNESCO, 1986).
6. Report on the study of nutrients and particulate carbon. Kazungu, J.M.
7. Pogramme payroll user's manual. Pissiersens P. & Onyango H.
8. Reports on the ongoing research work :
    1. Zooplankton research & research work plan on daily basis. Okemwa, E.
    2. Zooplankton in the Tudor Creek Kimaro, M.
    3. Phycology study at Mackenzie Point, Mombasa Oyieke, H.A.
    4. Study on the nutrients in Kilindini and Tudor Estuaries. Kazungu,J.M.
    5. Study on mayor Peneidae shrimps in Tudor Creek. Wakwabi, E.O.
    6. The estuary fishes of Kenya. Nzioka, R.M.
    7. Fish quality parameters in Mombasa markets. Oduor, P.M.
    8. Biochemical levels in oysters. Abubaker, L.U.
    9. Mangrove ecology. Ruwa, R.K.
    10. Gazi oyster project. Ruwa, R.K.
    11. Coral Reef Ecology. Muthiga, N.
9. Articles of Reuters on the oyster culture : Kenya, Belgium, Maleysia.

10. The autecology of the edible oyster Crassostrea cucullata Born, 1778 : size related vertical distribution at Mkomani, Mombasa.
Okemwa, E.; Ruwa R.K. & Polk, P.

11. Some observations and remarks on mangrove distribution in Kenya.
Ruwa, R.K. & Polk, P.

12. The biology of Marine Copepods in Kenyan waters.
Okemwa, E. & Revis, N.

13. Changes in Kenyan coral reef community structure and functior due to exploitation.
McClanahan, T.R. & Muthiga, N.A.

14. Changes in the population structure of the sea urchin Echinometra mathei de Blainville at Diani Beach, Mombasa/Keny
Muthiga, N.A. & McClanahan T.R.

15. Non-encrusting macroalgal zonation on rocky cliffs around Mombasa, Kenya.
Oyieke, H.A. & Ruwa R.K.

16. Report on the workshop on Coral Reef Ecology in the Phillipir
Muthiga, N.

17. F.A.M.E. : Program of the courses.

18. Instruction Manual on Field and Laboratory Sampling work for Laboratory Assistants.
Dr. Martens, E. Pissiersens, P.

ANNEX 1

KENYA - BELGIUM COOPERATION IN MARINE SCIENCES

Activities of the KBP-KMFRI Computer section

1/ Introduction

The computer section is active in three fields : Administration , Science and Word-processing .

a/ Administration

As the Institute currently employs over 680 people , divided over 4 stations (Mombasa , Kisumu, Turkana , Sangoro) , handles over 5000 accountancy vouchers a year and has more than 1500 items on the stores inventory , automation of the Administration has become a must .
Until the instalLation of the Computer Section , all the information had to be handled manually . Due to the time , consumed by the treatment of all these data , valuable time was lost for management in general .

As good management and Scientific Research have to go together in an Institution of this size , it was decided that Salaries Section , Personnel Section , Stores Section and Accounts were to be computerised .

b/ Science

There are now 36 Research Officers in the Institute (Mombasa) . If they work at their full capacity , a lot of valuable Scientific information is produced .
They work in different fields : Marine chemistry (Nutrients ,Pollution) , Phytoplankton , Zooplankton ,Coral Reef ecology and Fisheries , corresponding with the different trophical levels . Furthermore , there are Geologists and Physical Oceanographers .
If we combine the data , collected by the different groups , we can start making an ecological model (as it has been done in Belgium for the Mathematical Model for the North-Sea and the Scheldt Estuary) . As it has been proven in many parts of the World such Models can be of great importance to the Fishing Industry , Fisheries Management and Coastal Management, the prime task of this Institute.

c/ Word processing

Following the collection and treatment of the data , Scientific reports and articles have been and will continue to be written . To enable the Scientists to present decent publications , typed within a short period , the Computer Section offers a Word-Processing service . (Since June 1986)

13. Annexes

1. Computer Section : Activities. Pissiersens P.; Ogaye W. & Onyango H.
2. List of the laboratory equipment (21/7/86)
3. List of the publications available in the Library of KMFRI.
4. Lectures given during visit of Mr. Beck.
5. Lectures given at the International Congres on Tropical Aquatic Ecosystems (UNESCO, 1986).
6. Report on the study of nutrients and particulate carbon. Kazungu, J.M.
7. Pogramme payroll user's manual. Pissiersens P. & Onyango H.
8. Reports on the ongoing research work :
    1. Zooplankton research & research work plan on daily basis. Okemwa, E.
    2. Zooplankton in the Tudor Creek Kimaro, M.
    3. Phycology study at Mackenzie Point, Mombasa Oyieke, H.A.
    4. Study on the nutrients in Kilindini and Tudor Estuaries. Kazungu, J.M.
    5. Study on mayor Peneidae shrimps in Tudor Creek. Wakwabi, E.O.
    6. The estuary fishes of Kenya. Nzioka, R.M.
    7. Fish quality parameters in Mombasa markets. Oduor, P.M.
    8. Biochemical levels in oysters. Abubaker, L.U.
    9. Mangrove ecology. Ruwa, R.K.
    10. Gazi oyster project. Ruwa, R.K.
    11. Coral Reef Ecology. Muthiga, N.
9. Articles of Reuters on the oyster culture : Kenya, Belgium, Maleysia.

2/ History and present of the Computer Section

Thanks to the arrival of an Olivetti M21 microcomputer (with 640 KBRAM and 2x 360 KB floppy -disks) , donated by the Free University of Brussels , the computer Section started its activities around March 1985 . In March 1985 and May 1985 , experts from Belgium (Dr. J.P de Greve & Mr. P.Pissierssens , Free University of Brussels) came to Mombasa to give a first introduction to the use of the equipment.

In October 1985 , a Belgian ABOS volunteer (Peter Pissierssens ref.nr 704745) was employed by the Institute for two years to set up the Computer section and train local staff .

His Kenyan counterparts are Miss Winnie Ogaye and Mr. Hezborne Onyango . Furthermore , several employees of each section concerned (Salaries , Personnel , Stores , Accounts and Science) have been or will be trained to use the computer(s).

Another computer (Kaypro 1) was donated by UNESCO . This unit is to be used for introductory lessons in BASIC computer language . Due to its memory limitations and less powerful processor it can not handle big tasks.

In October 1985 we started the activities of the Section with the design of a Store Mangement system (using software package Open Access) for the Equipment and chemicals , purchased by the Kenya Belgium Project (Oceanography) . This enables us to keep a continuouis record of the quantities in stock . Furthermore , we can foresee running-out of chemicals in advance so they can be purchased in time . To visiting experts , we can give an updated list of equipment and chemicals (and send it to Belgium before their visit) so they can plan their visit , according to the present equipment and bring with them what is missing .

Around December 1985 , we started writing the Program for the Payroll of the Institute . This program calculates the salaries , prints pay-slips, generates reports , prints vouchers which are sent to the banks , performs cash-breakdown for cash-payments etc. We started using the Program fully from May 1986 on .

To enable employees from Salaries section and Personnel section to operate the Program , a detailed User's Manual was written (see attached) .

Around February 1986 , Researchers have started coming to the Computer Section with Scientific data . To handle these data , small Scientific data-bases were set-up , together with Graphics and Statistical Analysis Software . Through the Faculty of Applied Science and Faculty of Science (Section Informatics) we will probably get even more software for this purpose !

In July , we have started writing programs for the Stores section , which will handle the complete inventory , produce monthly reports on the Stock balance and keep track of all of the inventorised items . Purchase orders will be printed automatically as well .

3/ Future

After completion of the Stores Program , we will continue with writing a Program for Accounts .
At the same time we will start with the Scientific data-base . The importance of this was already described above .

Furthermore,in cooperation with the University of Limburg ,Belgium ,a Scientific Publication Data-base will be set-up (The Librarian , Mrs. Janet Mwobobia will visit the LUC (Prof.Dr.L.Egghe)in a few months to learn how to use this data-base , which was created in the LUC and has been used there for some time)

Thanks to the cooperation of the Free University of Brussels (Faculty of Science , Faculty of Applied Science , Faculty of Economic , Social and Political Science) we received a considerable package of computer software (language compilers for PASCAL,COBOL,C , SPSS (Statistical Package for the Social Sciences)) . These will enable us to handle the Scientific data in the most advanced way .

However , it has become clear that the present computer hardware will not be able to handle all the described tasks . For the Scientific-data base, for the SPSS program as well as for the Scientific Publication data-base , a Hard-disk is neccessary as information storage medium .
Therefore , we have planned the purchase of an Olivetti M24 SP microcomputer with a 20 MB HDU around August , this year , if approved by ABOS. If later more M24-units would be purchased , a Local network is possible .

Computer Section staff :

Mr. B.A.H Onyango (KMFRI)
Miss W. Ogaye (KMFRI)
Mr. P. Pissierssens (KMFRI,ABOS)

ANNEX 2 KMFRI-KBP CONSUMABLE STORES-CHEMICALS

 7-21-86

CODE	DESCRIPTION	UNIT	REQBAL	ISSUED	NEWBAL
PACETAC	ACETIC ACID	ML	1000.0	100.0	900.0
PACTON	ACETON	ML	60000.0	43420.0	16580.0
PAgNO3	SILVER NITRATE	gram	700.0	200.0	500.0
PALIZARINRED	ALIZARIN RED	gram	100.0	0.0	100.0
PASCAC	ASCORBIC ACID L(+)	gram	400.0	211.5	188.5
PBaCl2.2Aq	BARIUM CHLORIDE	gram	0.0	0.0	0.0
PBGLYPDINaSLT	Beta-GLYCEROLPO4-di-Na-salt	gram	500.0	0.0	500.0
PBr2	BROMIDE	ml	250.0	0.0	250.0
PBUF6	BUFFER pH 6	ml	1000.0	0.0	1000.0
PBUF6.4-amp	BUFFER AMPOULE pH 6.4	amp	1.0	0.0	1.0
PBUF8-amp	BUFFER AMPOULE pH 8	amp	1.0	0.0	1.0
PC2H5OH/.96	ETHANOL 96 %	ml	25000.0	17405.0	7595.0
PC2H5OH/.99	ETHANOL 99 %	ml	3000.0	3000.0	0.0
PCaCO3	CALCIUM CARBONATE	gram	500.0	536.0	464.0
PCd	CADMIUM GRANULATED	gram	1250.0	750.0	500.0
PCHCl3	CHLOROFORM	ml	2500.0	1450.0	1050.0
PCLEAN	LASER MULTIPURPOSE CLEANER	ml	100000.0	19000.0	81000.0
PCu(II)SO4	COPPER (II) SULPHATE	gram	1500.0	123.0	1377.0
PCu(II)SO4.5Aq	COPPER(II)SULPHATE.5HYDRATE	gram	1500.0	93.0	1407.0
PDIFASA-Ba-slt	DIPHENYLAMINESULFONIC AC.Ba-slt	gram	5.0	0.0	5.0
PDIFASA-Na-slt	DIPHENYLAMINESULFONIC AC.Na-slt	gram	5.0	0.0	5.0
PEDTA	ETHYLENEDIAMINETETRAACETATE	gram	50.0	50.0	0.0
PFORMOL/.37	FORMALDEHYDE 37 %	ml	60000.0	56000.0	4000.0
PGLUC/D	D-GLUCOSE	gram	1000.0	30.0	970.0
PGLYC/.87	GLYCEROL 87 %	ml	1000.0	1000.0	0.0
PH2O2	HYDROGEN PEROXIDE	ml	835.0	15.0	820.0
PH2SO4/.95	SULPHURIC ACID 95-97%	ml	15000.0	6520.0	8480.0
PH3PO4/.85	ORTHO-PHOSPHORIC ACID 87 %	ml	5000.0	206.0	4794.0
PHCl-amp/.1N	HYDROCHLORIC ACID AMPOULE 0.1N	amp	1.0	0.0	1.0
PHCl/.37	HYDROCHLORIC ACID 37 %	ml	10000.0	8912.0	1088.0
PHNO3/.65	NITRIC ACID 65 %	ml	1000.0	1000.0	0.0
PI2	IODINE	gram	250.0	50.0	200.0
PIDRANAL	IDRANAL	gram	0.0	0.0	0.0
PK2Cr2O4	POTASSIUM CHROMATE	gram	1000.0	257.4	992.6
PK2Cr2O7	POTASSIUM DICHROMATE	gram	1000.0	12.7	987.3
PKCl	POTASSIUM CHLORIDE	gram	500.0	500.0	0.0
PKDIAMTART	POTASSIUM DIAMM.TARTR.	gram	500.0	0.7	499.3
PKH2PO4	POTASSIUM-di-HYDROGEN PHOSPHATE	gram	0.0	0.0	0.0
PKI	POTASSIUM IODIDE	gram	600.0	105.0	495.0
PKNaO6C4H4.4Aq	POTASSIUM SODIUM TATRATE.4HYDR	gram	1000.0	0.0	1000.0
PKNO2	POTASSIUM NITRITE	gram	1000.0	1.0	999.0
PKNO3	POTASSIUM NITRATE	gram	250.0	1.0	249.0
PMARAGAR	MARINE AGAR 2216	gram	2724.0	0.0	2724.0
PMARBROTH	MARINE BROTH 2216	gram	1816.0	0.0	1816.0
PMCAGAR	MAC CONKEY AGAR	gram	2500.0	0.0	2500.0
PMETAMNFENSUL	4-(METHYLAMINO)PHENOLSULPHATE	gram	1000.0	0.0	1000.0
PMgcL2	MAGNESIUM CHLORIDE	gram	250.0	250.0	0.0
PMgSO4	MAGNESIUM SULPHATE	gram	500.0	0.0	500.0
PMNSO4.1Aq	MANGANESE SULPHATE.1HYDR	gram	2000.0	865.0	1135.0
PNa2B4O7.10Aq	di-SODIUMTETRABORATE.10HYDRATE	gram	1000.0	0.0	1000.0
PNa2CO3	SODIUM CARBONATE ANHYDR.	gram	1000.0	0.0	1000.0
PNa2Fe(CN)5NO	SODIUM NITROPRUSSIDE	gram	100.0	54.0	46.0

CODE	DESCRIPTION	UNIT	REQBAL	ISSUED	NEWBAL
PNa2S203.5Aq	SODIUM THIOSULPHATE	gram	250.0	-517.6	767.6
PNa2Si03.5Aq	SODIUM METASILLICATE	gram	500.0	0.0	500.0
PNa2S04	SODIUM SULPHATE	gram	1000.0	270.0	730.0
PNa2W04.2Aq	SODIUM TUNGSTATE	gram	250.0	0.0	250.0
PNaAC	SODIUM ACETATE	gram	1000.0	0.0	1000.0
PNaCITR	SODIUM CITRATE	gram	1000.0	400.0	600.0
PNaCl	SODIUM CHLORIDE	gram	690.0	1603.4	396.6
PNaHOCl	SODIUM HYPOCHLORITE	ml	5000.0	1500.0	3500.0
PNaMo	SODIUM MOLYBDATE	gram	250.0	125.0	125.0
PNaN03	SODIUM NITRATE	gram	500.0	263.0	237.0
PNaOH	SODIUM HYDROXIDE	gram	1500.0	953.4	1046.6
PNaPDSul	SODIUM PEROXODISULPHATE	gram	500.0	0.0	500.0
PNEDADCL	N-NAPHTYL-ETHYLENEDIAMM.DICHL.	gram	25.0	0.4	24.6
PNH3/.25	AMMONIA 25%	ml	2500.0	0.0	2500.0
PNH4CL	AMMONIUM CLORIDE	gram	1000.0	528.0	472.0
PNH4FeS04	AMMONIUM-IRON(II)SULFATE	gram	1000.0	0.0	1000.0
PNH4Mo	AMMONIUM MOLYBDATE	gram	1250.0	119.0	1131.0
PNH4S04	AMMONIUM SULFATE	gram	500.0	0.0	500.0
PNUTAGAR	NUTRIENT AGAR	gram	2724.0	0.0	2724.0
PNUTBROTH	NUTRIENT BROTH	gram	1696.0	0.0	1696.0
POXALAC	OXALIC ACID	gram	500.0	90.0	410.0
PPAPLITBLU	BLUE LITMUS PAPER INDICATOR	box	2.0	0.0	2.0
PPAPLITRED	RED LITMUS PAPER INDICATOR	box	2.0	0.0	2.0
PPHENOL	PHENOL	gram	1000.0	150.0	850.0
PSbKOC4H406	ANTIMONY POTASSIUM(+)TARTRATE	gram	0.0	0.0	0.0
PSFNAMID	SULFANILAMID	gram	250.0	15.0	235.0
PSiGEL	SILICA GEL	gram	20000.0	0.0	20000.0
PSTARCH	STARCH INDICATOR	gram	2500.0	60.0	2440.0
PTHYMOL	THYMOL	gram	100.0	0.0	100.0
PTRINaCITR.2Aq	tri-SODIUM CITRATE.2HYDR	gram	0.0	0.0	0.0
PTSTAQMKNH4	AQUAMERCK TEST AMMONIUM 150 tst	box	3.0	3.0	0.0
PTSTAQMKN02	AQUAMERCK TEST NITRITE 50tst	box	10.0	4.0	7.0
PTSTAQMKN03	AQUAMERCK TEST NITRATE 50 tst	box	10.0	5.0	5.0
PTSTAQMKP04	AQUAMERCK TEST PHOSPHATE	box	3.0	3.0	0.0
PTSTAQMKSi	AQUAMERCK TEST SILICA	box	3.0	3.0	0.0
PTSTAQQTN02	AQUAQUQNT TEST NITRITE 14424	box	1.0	1.0	0.0
PTSTMIQTSi	MERCK MICRQUANT TEST SILICA	box	1.0	1.0	0.0
PTSTSPQTSi	MERCK TEST SPECTROQUANT Si	box	1.0	1.0	0.0

KMFRI-KBP CONSUMABLE STORES-LAB SMALL EQUIPMENT

7-21-86

CODE	DESCRIPTION	UNIT	REQBAL	ISSUED	NEWBAL
SBAT1.5AA	SIZE AA 1.5 VOLT BATTERY ALKAL	NR	12	12	0
SBAT1.5D	SIZE D 1.5 VOLT BATTERY	NR	62	62	0
SBAT9	9 VOLT BATTERY	NR	4	4	0
SBULB60SCR	BULB 230V/60W SCREW fr SPROCON	NR	5	5	0
SCORKRUB	RUBBER CORK	NR	400	47	353
SCOVSLIP	COVER SLIPS MICROSC. 20 MM SQ.	BOX	100	8	92
SDISHPETRI	PETRI DISH PLASTIC	NR	953	264	669
SFILMEM/.2	MEMBR.FILTERS 0.2 MICR. 100/BX	BOX	4	0	4
SFILMEM/.45	MEBR.FILTERS 0.45 MICR. 100/BX	BOX	5	0	5
SFILMEM/.8	MEBR.FILTERS 0.8 MICR. 100/BX	BOX	5	0	5
SFILPAPGFC25	WHATMAN FILT.GF/C 25 MM 100/BX	BOX	10	6	4
SFILPAPGFC47	WHATMAN FILT.GF/C 47 MM 100/BX	BOX	50	38	12
SLABEL	GUMMED LABORATORY LABELS	PCK	13	7	6
SMICRSLID	MICROSCOP. SLIDES 50/BX	BOX	10	8	2
SNEEDPT	POINTED TIP NEEDLE	NR	20	8	12
SNEEDRE	ROUND EYE TIP NEEDLE	NR	10	-1	10
SPAPTISSUE	KLEENEX TISSUE BOX	BOX	53	46	7
SPARAFILM	PARAFILM	BOX	10	8	2
SPIPATIP1	AUTOPIPET YELLOW TIP 20-100 MIC	NR	5000	0	5000
SPIPATIP2	AUTOPIPET BLUE TIP 200-1000 MIC	NR	5000	1000	4000
SPIPPASTEURLT	PASTEUR PIPETS LONG TIP 2500/BX	BOX	2500	1	2499
SPLGAUZ100	PLANKTON GAUZE 100 MICR.	MET.	5	5	0
SPLGAUZ200	PLANKTON GAUZE 200 MICR.	MET.	5	5	0
SPLGAUZ50	PLANKTON GAUZE 50 MICR	MET.	5	5	0
SPLGAUZ500	PLANKTON GAUZE 500 MICR.	MET.	5	5	0
SSBLD1	SURGICAL BLADE TY25	NR	200	112	88
SSBLD2	SURGICAL BLADE TY21	NR	20	20	0
SSURGLOV	SURGICAL GLOVES 50/BX	BOX	20	4	16
STUBGAS9/17	GAS TUBE 9/17	MET.	10	0	10
STUBPVC4/6	PVC TUBE 4/6	MET.	10	2	8
STUBPVC6/10	PVC TUBE 6/10	MET.	10	1	10
STUBSIL	SILICON TUBE	MET.	10	0	10
STUBVAC5/15	VACUUM TUBE 5/15	MET.	10	1	10

CODE	DESCRIPTION	REQBAL	LOSS	ISSUED	NEWBAL
GBEKG8	GLASS BEAKER 600 ML	10	1	7	2
GBEKG9	GLASS BEAKER 1000 ML	10	0	6	4
GBEKP7	PLASTIC BEAKER 500 ML	10	0	10	0
GBEKP9	PLASTIC BEAKER 1000 ML	12	0	9	3
GBOTD	DROPPER BOTTLE	12	0	7	5
GBOTG2	BOD BOTTLE 50 ML	10	0	10	0
GBOTG3	BOD BOTTLE 100 ML	100	0	49	51
GBOTG5	BOD BOTTLE 250 ML	100	0	68	32
GBOTG7	BOD BOTTLE 500 ML	50	0	23	27
GBOTG9	BOD BOTTLE 1000 ML	50	1	20	29
GBOTP3	PLASTIC SAMPLE BOTTLE 100 ML	200	0	200	0
GBOTP5	PLASTIC SAMPLE BOTTLE 250 ML	228	0	228	0
GBOTP9	SAMPLE BOTTLE 1000 ML	10	0	10	0
GBOTPSPEC	SPECIMEN BOTTLE PLASTIC (vial)	340	0	27	313
GBOTPSPEC5	SPECIMEN BOTTLE PLASTIC 250 ML	500	0	180	320
GBOTPSPEC9	SPECIMEN BOTTLE PLASTIC 1000 ML	50	0	21	29
GBUCP	PLASTIC BUCKET GRADUATED 12L	4	0	4	0
GBUR	BURET 50 ML	2	0	2	0
GBURA	AUTO BURET + RESERVOIR	2	0	0	2
GCONPL	LARGE PLASTIC CONTAINER	2	0	2	0
GCONPS	SMALL PLASTIC CONTAINER	2	0	2	0
GCONS	SPIRAL CONDENSER	2	0	0	2
GCOVSH	HAEMA COVER SLIP	20	0	18	2
GCUV1	SPECTRO CUVET 10x10x45 BOX OF 3	1	0	0	1
GCUV2	SPECTRO CUVET 10x40x45 BOX OF 3	1	0	1	0
GCUVMATCH1	CUVETS MATCHED ref.SG 10 00 82	2	0	2	0
GCYLMG1	MEASURING CYLINDER GLASS 25 ML	10	0	6	4
GCYLMG3	MEASURING CYLINDER 100 ML	10	0	10	0
GCYLMG7	MEASURING CYLINDER GLASS 500 ML	10	0	2	8
GCYLMG9	MEASURING CYLINDER GLASS 1000 ML	5	0	0	5
GCYLMP3	PLASTIC MEASURING CYLINDER 100 ML	5	0	0	5
GCYLMP7	MEASURING CYLINDER PLASTIC 500 ML	5	0	1	4
GCYLMP9	PLASTIC MEASURING CYLINDER 1000 ML	5	0	2	3
GDESSIC30	DESSICATOR GLASS 30 CM+TAP	2	0	1	1
GDISEVES	EVAPORATING DISH EMAIL SMALL	1	0	0	1
GDISEVQL	EVAPORATING DISH QUARTZ LARGE	14	0	0	14
GDISEVQS	EVAPORATING DISH QUARTZ SMALL	19	0	0	19
GDISP	DISPENSER BOTTLE PLASTIC 500 ML	10	1	9	0
GRL10	ERLENMEYER 2000 ML WIDE MOUTH	10	0	0	10
GERL3	ERLENMEYER 100 ML	10	0	10	0
GERL5	ERLENMEYER 250 ML	10	0	10	0
GERL7	ERLENMEYER 500 ML (WIDE MOUTH)	10	0	6	4
GERL9	ERLENMEYER 1000 ML	10	0	2	8
GERLC5	ERLENMEYER FOR CONDENSER 250 ML	2	0	2	0
GERLF11	ERLENMEYER FOR FILTRATION 5000 ML	3	0	0	3
GERLF9	ERLENMEYER FOR FILTRATION 1000 ML	5	0	2	3
GFIBA	FILTER BASE MILLIPORE	5	0	4	1
GFICLA	FILTER CLAMP MILLIPORE	5	0	2	3
GFIFUN	FILTER FUNNEL MILLIPORE	5	0	2	3
GFISYRSYR	SYRINGE 50 ML FOR GFYSYRSYS	2	0	0	2
GFISYRSYS	MILLIPORE SYRINGE FILTER SYSTEM	2	0	0	2

CODE	DESCRIPTION	REQBAL	LOSS	ISSUED	NEWBAL
GFLVOL2	VOLUME FLASK 50-55 ML	2	0	2	0
GFLVOL4	VOLUME FLASK 200-220 ML	10	1	4	5
GFLVOL6	VOLUME FLASK 400-440 ML	1	0	1	0
GFUNG1	GLASS FUNNEL 100 MM	4	0	2	2
GFUNG2	GLASS FUNNEL 200 ML	4	0	0	4
GFUNM	METAL FUNNEL	1	0	0	1
GFUNP1	PLASTIC FUNNEL 100 MM	6	0	6	0
GFUNP2	PLASTIC FUNNEL 150 MM	3	3	-1	1
GFUNP3	PLASTIC FUNNEL 260 MM	3	0	1	2
GHCM	HAEMACYTOMETER	5	0	2	3
GKOL9	KOLVE FLAT BOTTOM 1000 ML	10	0	1	9
GKOLSC	KOLVE FOR SPIRAL CONDENSER 2000 ML	2	0	0	2
GPETS	PETRI SLIDES BOX OF 100	7	0	0	7
GPIP1	MEASURING PIPET 1 ML	18	0	10	8
GPIP10	MEASURING PIPET 10 ML	20	1	4	15
GPIP2	MEASURING PIPET 2 ML	20	0	9	11
GPIP20	MEASURING PIPET 20 ML	12	0	0	12
GPIP5	MEASURING PIPET 5 ML	20	0	3	17
GPIPB10	BULB PIPET 10 ML	3	0	3	0
GPIPB25	BULB PIPET 25 ML	5	0	1	4
GPIPB50	BULB PIPET 50 ML	5	1	2	2
GREDCOL	REDUCTION COLUMN + TAP	10	0	7	3
GREDFUN	REDUCTION FUNNEL	9	0	6	3
GRESG	GLASS RESERVOIR 20 L	2	0	1	1
GRESGT	SPARE TAP FOR GRESG	1	0	0	1
GRESPL	PLASTIC RESERVOIR 20 L	10	0	10	0
GRESPS	PLASTIC RESERVOIR 10 L + TAP	3	0	3	0
GROD	GLASS STIRRING ROD	16	0	3	13
GTAPP	PLASTIC TAP	1	0	0	1
GTHOM	TISSUE HOMOGENIZER (POTTER)	2	2	0	0
GTUBC1	CENTRIFUGE TUBE 15 ML CONICAL	200	31	34	135
GTUBC2	CENTRIFUGE TUBE 100 ML	10	0	9	1
GTUBT	TEST TUBE	973	0	0	973
Totals:	All				

KMFRI-KBP NON CONSUMABLE STORES-LAB SMALL EQUIPMENT

 7-21-86

CODE	DESCRIPTION	REQ.BAL	LOSS	ISSUED	NEWBAL
SBLDHOL	SURGICAL BLADE HOLDER	10	0	14	6
SBOR	CORK BORER SET OF 12	1	0	1	1
SBOXSLID	SLIDE BOX	5	0	1	4
SBRUWL	LARGE BRUSH WASHER	4	0	2	2
SBRUWS	SMALL BRUSH WASHER	5	0	3	2
SBULBHOL	BULB HOLDER SREWFIT fr SPROCON	4	0	8	0
SBUR	GAS BURNER	3	0	0	3
SBURNALL	ALL PURPOSE GAS BURNER	1	0	0	1
SCABL	ELECTRIC CABLE FOR SPROCON	4	0	3	1
SCLMPRETST	CLAMP FOR RETORT STAND	10	0	-4	14
SCLP	CLIP FOR RUBBER TUBE	20	0	0	20
SCOUNTER	COUNTER 1 CHAN. HAND	2	0	0	2
SCUT	CUTTER	2	0	1	1
SCUVHOL1	REF.CUVET HOLDER 1 CM SPECTRO	1	0	1	0
SCUVHOLL	CUVET HOLDER LONG PATH	1	0	0	1
SDISKIT	DISSECTING KIT	5	0	5	0
SDISTRIVAR500	DISTRIVAR 500	2	0	0	2
SDIVBACPAC	DIVING BACK PACK	2	0	2	0
SDIVREG	DIVING REGULATOR	2	0	2	0
SFILPOC	FILING POCKET FOR MET.CABINET	290	0	290	0
SGAUZTRIP	GAUZE FOR TRIPOD	5	0	0	5
SGCUT	GLASS CUTTER	2	0	0	2
SGMARK	GLASS MARKER (INK TYPE)	2	0	1	1
SHOLN	NEEDLE HOLDER	10	4	8	6
SHYGRO	HYGROMETER(HAIR) 0-100 %	5	0	3	2
SKOLCLMP	KOLVE CLAMP	10	0	6	4
SMAFMIL	SAMPLING MANIFOLD MILLIPORE 12 HOL	2	0	0	2
SMECAB	METAL CABINET MEWAF	1	0	1	0
SMULPLUGSQP	MULTIPLUG SQ.PIN	5	0	4	1
SNABOT10	NANSEN BOTTLE 10 L	3	0	1	2
SPINCCOVSLIP	COVER SLIP PLINCERS	2	0	1	1
SPINCFL	FLAT END PINCERS	10	0	1	9
SPIPA20-100	AUTOMATIC PIPET 20-100 MICL	3	0	1	2
SPIPA200-1000	AUTOMATIC PIPET 200-1000 MICL	3	0	3	0
SPIPAHOL	AUTOMATIC PIPET HOLDER	2	0	0	2
SPIPBAL	PIPET BALL	5	0	7	3
SPIPCON	PIPET CONTAINER	10	0	2	8
SPIPST	PIPET STAND PLEXIGLASS	5	0	1	4
SPIPWASHB	PIPET WASHER BASKET	2	0	2	0
SPIPWASHC	PIPET WASHER CONTAINER	2	0	2	0
SPLATMET	METAL PLATE STAINLESS	1	0	1	0
SPLNETR55	PLANKTON NET + RES. 55 MICR.	2	0	2	0
SPLUGSQP	TOP PLUG SQ.PIN	12	0	8	4
SPROCON30	PROTECTING CONTAINER 30	1	0	1	0
SPROCON40	PROTECTING CONTAINER 40	2	0	2	0
SPROCON50	PROTECTING CONTAINER 50	1	0	1	0
SRACDRY	DRYING RACK FOR GLASSWARE	2	0	2	0
SRACTUBT	RACK FOR TEST TUBES 4x12	5	3	6	2
SRACTUBTS	RACK FOR TEST TUBES 3X8	5	0	0	5
SREFRAC	REFRACTOMETER ATAGO 0-100 PPM	4	0	2	2
SRODMA12X55	MAGNETIC STIRRER 12 X 55	5	0	1	4
SRODMA7X25	MAGNETIC STIRRER 7 X 25	10	1	1	10

KMFRI-KBP NON CONSUMABLE STORES-LAB SMALL EQUIPMENT

7-21-86

CODE	DESCRIPTION	REQ.BAL	LOSS	ISSUED	NEWBAL
SRODMA9X35	MAGNETIC STIRRER 9 X 35	10	0	2	8
SRODMAG	MAGNETIC ROD	2	0	2	0
SSAFGLAS	SAFETY GLASSES	2	0	0	2
SSCIS	SCISSORS	3	0	3	0
SSPATSMIC	SPATULA SEMI MICRO	5	0	5	0
SSTARODBAS	STAND ROD + BASE (RETORT STAND)	5	0	3	2
SSWATCH	STOP WATCH	2	0	2	0
STHERMALC100	ALCOHOL THERMOMETER 100 C	2	0	0	2
STHERMHG110	MERCURY THERMOMETER 110 C	14	5	13	6
STHERMHIQ	THERMOMETER 0.1 C PRECISION	2	0	0	2
STONGCRUC	CRUCIBLE TONG	5	0	0	5
STRIST	TRIPOD STAND	3	0	0	3

Totals: All

CODE	DESCRIPTION	REQ.BAL	LOSS	ISSUED	NEWBAL
HAQPUMP	AQUARIUM AIR PUMP RENA 301	5	0	1	4
HAUTOCLAV	AUTOCLAVE	1	0	1	0
HBALANAL	ANALYTICAL BALANCE SARTORIUS	1	0	1	0
HBALELEC	ELECTROBALANCE CAHN C29	1	0	1	0
HBALELECACC	ACCESSORIES CAHN BALANCE	1	0	1	0
HBATCHARGE	BATTERY CHARGER TELWIN	1	0	1	0
HBINOWM3	STEREOMICROSCOPE WILD M3	3	0	3	0
HBINOWM5	STEREOMICROSCOPE WILD M5	1	0	1	0
HBINOWM5MICM	MICROMETER FOR WILD M5	1	0	1	0
HBINOWM5MOC	MEASURING OCULAR FOR WILD M5	1	0	1	0
HCAMNIK5BAG	BAG FOR CAMERA NIKONOS 5	1	0	1	0
HCAMNIK5BODY	CAMERA NIKONOS 5 BODY	1	0	1	0
HCAMNIK5FLASH	FLASH FOR CAMERA NIKONOS 5	1	0	1	0
HCAMNIK5OBJ	OBJECTIVE LENS FOR CAMERA NIKONOS 5	1	0	1	0
HCENTRIF	CENTRIFUGE ALC 4226	1	0	1	0
HFREEZLIEB	FREEZER LIEBHERR	1	0	1	0
HGENKAW	GENERATOR KAWASAKI 220/12 V-2600 W	1	0	1	0
HINCUBMT30	INCUBATOR MEMMERT T30 53 L	1	0	1	0
HMAGSTIR	MAGNETIC STIRRER PLATE CENCO	2	0	1	1
HMAGSTIRHOT	MAGNETIC STIRRER + HOT PLATE	1	0	1	0
HMICLLABD	MICROSCOPE LEITZ LABORLUX D	1	0	1	0
HMICLLDMICM	MICROMETER FOR LEITZ LABORLUX D	1	0	1	0
HMICLLDMOC	MEASURING OCULAR FOR LEITZ LABLUXD	1	0	1	0
HMILPUMP	MILLIPORE VACUUM PUMP/COMPRESSOR	3	0	2	1
HOPRO	OVERHEAD PROJECTOR	1	0	1	0
HOVENMTV15U	OVEN MEMMERT TV 15U 34 L	1	0	1	0
HOXMETCOZ80	OXYGEN METER CONSORT Z80	1	0	1	0
HPAMETOR231	PH METER ORION 231	1	0	1	0
HPARAMIX	TEST TUBE MIXER PARAMIX JULABO	1	0	0	1
HPHMETELOR231	PH METER ORION 231 COMB.ELEKTRODE	2	0	1	1
HPHMETOR231	PH METER ORION 231	1	0	1	0
HRADMOBIL	MOBILE RADIO UNIDEN	4	0	4	0
HRADMOBILAMP	MOBILE RADIO AMPLIFIER MOSQUITO	4	0	4	0
HREFRIZ	REFRIGERATOR ZOPPAS	1	0	1	0
HSPECTRO	SPECTROFOTOMETER SHIMADZU	1	0	1	0
HSTILL	WATER DISTILLER VEL 7Q	1	0	1	0
HWPUMP	WATER PUMP JL 130 + TUBE	1	0	1	0
HWWBATHMW350	WARM WATER BATH MEMMERT W350	1	0	1	0

Annex 3

KENYA MARINE & FISHERIES RESEARCH INSTITUTE

LIBRARY DEPARTMENT

13th March, 1986.

Ref: KMF/PUB/13

Dear

Attached is a list of references covering Fisheries and Oceanography received from Belgium between January 1985 and December 1985. Documentary Informations is a project which was promoted under the umbrella of Kenya - Belgium project in Biological Oceanography based at KMFRI, Mombasa, with the objective of making scientific Literature available to researchers. The project is financed partly by the Free University of Brussels (V. U. B.) and partly by Limburg University Centru (L.U.C) Belgium. The online searches and interlibrary lending services are realized in Belgium (L.U.C.) and references sent to our Library by Airmail.

Yours sincerely,

JKMwobobia

J.K. Mwobobia

For DIRECTOR.

JK/et.

0001 Lugo, E.A.; Snedaker, C.S. 1974.
The ecology of mangroves. J. Rev. Ecol. System., 5:39-64.

0002 Vervoort, W. 1965.
Three new species of Bomolocridae(Copepoda, Cysclopoida from Tropical Atlantic Tunnies. Zoologische Verladelingen 76:3-40.

0003 Scott, T. 1906.
Notes on new and rare copepoda from the scottish Seas. Twenty fourth Annual Report of the Fishery Board of Scotland. Pt., III. 275-280.

0004 Smith, J.R., Strehlow, D.R. 1983.
Algal induced spawning in the marine mussel Mytilus Californianus 3p.

0005 Schmaus, P.H.; Lehnhofer, K. 1927.
Copepoda 4: Rhincalanus Dana 1852 der Deutschen Tiefsee Expedition. Systematik und Verbreitung Der Gattung. Deutsche Tiefsee Expedition 1898-1899. Bol. XXIII (8):46-51.

0006 Seliger, H.H.; Boggs, J.A.; Biggley, W.J. Aspden, K.R.H. 1982.
The transport of oyster larvae in an estuary. Mar. Biol. 71:57-72.

0007 Hummerinck, P.W. 1969.
Studies on the fauna of Curacao and Caribbean Islands. Vol XXVIII:1-125.

0008 Culture of molluscs. Kyoto, Japan, 26th May-2nd, June 1976. Fir: AQ/Conf/76. 125p.

0009 Dialog Information Retrieval Files. [illegible]

0010 Biosis Search guide: Master index. 244p.

0011 Biosis Search guide: Subject classification. [illegible]

...../2

0012 Giesbrecht, W. 1992. Systematik und faunistik dert pelagischen Copepoden des Golfes von Neapel und der Angrenzenden meers-absehnitte veon W. Giesbrecht. (Systematics and fauna of pelagic copepods of the gulf of Naples and nearby seas). 831p.

0013 Strickland, J. D. H.; Parsons, T. R. 1968. A practical handbook of seawater analysis. Bull. Fish. Res. Bd. Can., 167: 311p.

0014 Fischer, B.R.; Peters, G. D. 1969. A brief introduction to quantitative chemical analysis. 537p.

0015 Wickstead, H. J. 1965. An introduction to the study of tropical plankton. 160p.

0016 Giesbrecht, W. 1892. Systematik und Feunistik der pelagischen Copepoda Cofes von Neapel. 49p.

0017 Lang, K. 1974. Monographic der harpacticiden. 2 vols. 1682p.

0018 Broecker, W. S. 1974. Chemical oceanography. 214p.

0019 Parsons, T. R. Y.; Maita, Y.; Lalli, C. M. 1984. A manual of chemical and biological method of sea water analysis. 173p.

0020 Witkowski, Z. 1970. The problem of species diversity in biocenotical studies. Wiadomosci Ekologiczne XVII (2): 117-132.

0021 Mukundan, C. 1971. Plankton of Calicut inshore waters and it relationship with Coastal Pelagic Fisheries. Indian J. Fish., 14 :271-292.

0022 Braud, J., Peter, P. 1973. Farming on pilot scale of Eucheuma Spinosum (Florideophyceae) in Djibouti waters. Proc. Int. Seaweed Symp., 9:533-539.

0023 Pillai, P.P.; Qasim, S. C., Kesavannair, A. K. 1973 Copepod component of zooplankton in a tropical Estuary. Indian J. Mar. Sci., 2 (1):38-46.

.../3

0024 Shan, M. 1963. Diunal changes in certain oceanographic features in the Laccadiv sea off Cochin in September, 1966. Bull. Dept. Mar. Biol. Oceanogr. Univ. Cochin, 3:19-27.

0025 Decker, A. D. E. 1964. Observations of the ecology and distribution of copepoda in the marine plankton of South Africa. Invest. Rep. Div. Sea Fish. S. Afr. no. 49. Reprinted from "Commerce & Industry June pp. 1-33.

0026 Wilhm, J. L. 1968. Use of biomas units in Shannon's formula. Ecol., 49:153-156.

0027 Evans, F. 1977. Seasonal density and production estimates of the commoner planktonic copepods of Northumberland coastal waters. Estuar. Coast. Mar. Sci., 5:223-241.

0028 Bainbridge, V. 1964. The zooplankton. Bull. IFAN Ser. A, 26 (2): 390-401.

0029 Conover, R. J. 1979. Production in marine planktonic communities. Report of the first International Congress. Ecology, 159-164.

0030 De Nie, H. W.; Bromley, H. J.; Vijverberg, J. 1980. Distribution patterns of zooplankton in Tjeukemeer, The Netherlands. J. Plank. Res., 2(4):317-334.

0031 Hure, J.; Ianora, A.; Bruno, S. D. C. 1980. Spatial and temporal distribution of copepod communities in the Adriatic Sea. J. Plank. Res., 2(4): 295-316.

0032 Mshigeni, K. E. 1979. Contri[illegible] seasonality and Gelling [illegible] oid from three Hypnea species [illegible] Marine Algae in Pharmaceutical [illegible] de Gruter, Berlin. p. 721-242.

0033 Misra, A.; Sinha, R. 1979. Algae [illegible] in India. In: Marine algae in [illegible] Science (Hoppe, H. A.; Levring, [illegible] eds), pp. 237-242. Walter de Gruyter [illegible]

0034. Betterton, C. 1981. A guide to the [illegible] Peninsular Malaysia (excluding th[illegible] Malay. Nat. J., 34 (4) : 171[illegible]

0035 Eriksson, S. 1973.
The Biology of marine planktonic copepoda on the west coast of Sweden. Zoon.1-37-68.

0036 Qasim, S.Z. 1973.
Productivity of Backwaters and Estuaries In: the Biology of Indian Ocean-10p Handbook no. 3 Ecolgical Studies, pp. 144-154.

0037 Rochford, D.J. 1973.
Seasonal Variations in the Indian Ocean along 110 °E Aust. J. Mar. Freshwater Res. 20:1-50.

0038 Fisher, R.A.; Corbet; A.S.; William, C.B. 1943.
The Relation between the number of species and the number of individuals in a random sample of an animal population J. Anim. Ecol. 12. 42-58.

0039 Richard, A.G.; Cutkomp, L.K. 1946.
Correlation between the possession of a chitinous cuticle and sensitivity to DDT.
Biol. Bull. 97-107.

0040 Dialog Files for Information Retieval Service 128p.

0041 Paech, K.; Tracey, M.V. 1955.
Modern methods of plant Analysis Vol II. 626p.

0042 Kumar, S.; Hansem, P.M.T.; Schulman, S.G. 1972.
New Reaction mixture for Spectrophotometric Determintion of N-Acetylhexosamines, Anomalous Fluorocence and Excited state protolysis of 8 marcaptoquinotine. Anal Chem. 44(2) : 398-400.

0043 Foster, A.B.; Hackman, R.H. 1957.
Application of Ethyleediaminetetra-acetic Aci[illegible] the Isolation of crustacean chitin. Nature 18[illegible] 40-41.

0044 Blumenthal, H.J.; Rosenman, S. 1957.
Quantitative estimation of Chitin in Fungi. J. [illegible]
74:222-224.

0045 Kinne, O. 1964.
The Effects of Temperature and salinity on [illegible] and brackish "water animals" Oceanogr. Mar. Biol. Ann. Rev. 2:281-339.

0046 Venrick, E.L. 1971.
The statistics of sub-sampling. Limnol Ocea[illegible]
16:811-818.

0047 Dworkin, N.B.; Infante, A.A. 1978.
RNA Systhesis in unfertilized sea Urchin Eggs.
Dev. Biol. 62(1):247-257.

0048 Takeuchi, K.; Yolosawa, E.; Hoshi, M. 1979.
Purification and characterization of hatching Enzyme of strongyloc ntrotus intermedius Eur J. Biochem. 100:257-265.

0049 Baum, B.J.; McDonald, J.A; Crystal, R.G. 1977.
Metabolic fate of the major cell surface protein of Normal Human Fibrobeasts. Bioch. Biophy. Res. Com. 79 (1):8-15

0050 Ashwell, G.; Morell, A.G. 1977.
Membrane glycoproteins and recognition phenomena.
Trends Biochem. Sci., 2: 76-78.

0051 Sekiguchi, K.; Hakomori, S. 1980.
Functional domain structure of fibronectin.
Proc. Nat. Acad. Sci. 77:2661-2665.

0052 Engvall, E; Ruoslahti, E.; Miller, E. 1978.
Affinity of Fibronectin to collagens of different genetic types and to fibrinogen J. Exp. Med., 147: 1584-1595.

0053 Mshigeni, K.E.; Wevers, I.M. 1979.
Effects of the Environment on the early stages of development in gracilaria corticata J. Agardh.
Nova Hedwigia XXXI (1&2: 479-491.

0054 Shang, Y.C. 1976.
Ecomonic Aspects of Gracilaria Culture in Taiwan
Aquaculture. 8:1-7.

0055 Mshigeni K.E.; Semesi, A.K. 1977.
Studies on Carrageanans from the Ecomomic Red Algal Genus Eucheuma in Tanzania Bot. Mar. XX:239-242.

0056 Semesi, A.K.; Mshigeni, K.E. 1977.
Studies on the yield and infrared Sectra of Phycocolloids from Chondrococcus hornemannii (Lyngbye) Schmitz and Sarconema filiforme (Sonder) Kylin from Tanzania
Bot. Marine XX:271-275.

0057 Mshigeni, K.E.; Nzalalila, E. 1977.
Contributions on the content and Nature [illegible] Phycocoloid from Laurencia Papillosa ([illegible]) [illegible] (Rhodophyta, Ceramiales) Bot. Mar. [illegible]

0058 Dall. W. 1956.
A Revision of the Australian Species of Penaeinae (Aust. J. Mar Freshwat. Res. 8:131-231.

0059 Ranch, D. W. 1955.
Fluctuations of animal population, and a measure of community stability. Ecol. 36 (3) :533-536.

0060 Carpenter, S.M. 1977.
Further studies of Plankton Ecosystems in the Eastern Indian Ocean IV. Numerical Treatment of site-species Data. Aust. J. Mar. Freshwat. Res. 28;585-591.

0061 Borgne, R.L. 1982.
Zooplankton production in the eastern tropical Atlantic Ocean: Net growth efficiency and P.B. in terms of carbon, nitrogen and phosphorus. Limnol. & Ocenogr. 27 (4) : 681-698.

0062 Sutcliffe, W.H. 1960.
On the Diversity of the Copepod population in the Sargasso Sea off Bermuda Ecol. 41 (3):585-586.

0063 Miller, C.B.; Johnson, J.K.; Heinle, D.R. 1977.
Growth rules in the marine copepod genus Acartia. Limnol. Oceanog. 22(4):326-335.

0064 Simpson, E.H. 1949.
Measurement of Diversity Nature, 163:688-

0065 Gagnon, M., Locroix, G. 1981.
Zooplankton sample variability in a tidal estuary Limnol. 26(3). 401-413.

0066 Hulburt, E.M. 1963.
The Diversity of Phytoplanktonic Populations in Oceanic Coastal, and Estuarine Regions. J. Mar. Res. 21, (2): 81-93.

0067 Greenwood J.G. 1980.
Composition and Seasonal Variations of Zooplankton populations in Moreton Bay, Queensland Proc. R. Soc. Qd. 91: 85-103.

0068 Bainbridge, V. 1960.
Oceanography Occurrence of Calanoides Carinatus (Kroyer) in the plankton of the gulf of Guinea Nature 188:932-933.

0069 Deevey, G. 1966.
Seasonal Variations in length of copepods in South Pacific New Zealand Waters. Aust J. Mar. Freshwat. Res. 17: 155-168.

0070 Rudjakov, 1970.
The possible causes of diel vertical migrations of planktonic animals. Marine Biology 6:98-105.

0071 Millar, R.H.; Scott, J.M. 1967.
The larvae of the Oyster Ostrea Edulis during starvation. J. Mar. Biol. Ass. U.K. 47:475-484.

0072 Lebour, M.V. 1947.
Notes on the Inshore Plankton of Plymouth. J. Mar. Biol. Ass. Vol. XXVI.:527-547.

0073 Wickstead, J.H. 1962.
Food and Feeding in Pelagic Copepods Proc. Zool. Soc. Lond. 139:545-555.

0074 Campbell, F.L. 1929.
The detection and Estimation of insect chitin: and the irrelation of Chitinization to hardness pigmentation of the culicula of the American cochroach periplaneta Americana L. Ann. Entomol. Soc. Ann. P 401-426.

0075 Taylor, W.M.T. 1967.
Notes on Indo-Pacific Turbinari as Hydrobiologia [illegible] 28:91-100.

0076 Hall, D.N.F. 1962.
Observations on the taxonomy and biology [illegible] Indo-West-Pacific Penaeidae (Crustacea [illegible]) Colonial Office Fishery Publications No. [illegible] pp. 194 & 195 mising.

0077 Tregouboff, F.; Ross, M. 1957. [illegible]
Phytoplankton Manual : Centre National [illegible] Recherche Scientifique, Paris. 225p

0078 Abstracts of various disciplines in Oceanogra[illegible] 826p.

0079 Wang, L.; Spudich, J.A. 1984.
A 45,000-mol-wt protein from unferti[illegible] Sea Urchin eggs severs Actin [illegible] calcium-dependent manner and [illegible] state concentration of [illegible] J. cell Biol. 99 [illegible]

0080 Detrich, H.W.; Wilson, C. 1983.
Purification, characterization, and assembly properties of Tubulin from unfertilized Eggs of sea Urchin Strongylocentrotus Purpuratus. Biochem. 22(10):2453-2462.

0081 Blankenship, J.; Benson, S. 1984.
Collagen metabolism and Spicule formation in sea urchin micromeres. Exp. Cell Res. 152 (1):98-104.

0082 Kopf, G.S.; Moy, F.W.; Vacquier, V.D. 1982.
Isolation and characterization of sea Urchin.
J. Cell Biol., 95 (3):924-932.

0083 Paulinose, V.T., George, M.J. 1976.
Abundance and distribution of Penaeid larvae as an index of penaeid prawn resources of the Indian Ocean.
Indian J. Ocean, 23 (182):127-133.

0084 Balachandran, T. 1974.
Phenoxetol A. as good sorting medium-cum preservative for zooplankton in the tropics.
Current Science, 43(12):380-381.

0085 Balachandran, T. 1974.
On methods of collection, handling and storage of Zooplankton in Tropica.

0086 Peter, K.J. 1967.
A note on the record of Raatrelliger (Mackerel) Larvae from the Indian Ocean.
Current Science, 36(10):373-274.

0087 Rao, T.S.S.; Madhupratap.; Naridas, P. 1975.
Distribution of zooplankton in space and [illegible] a tropical estuary. Bull Dept. Mar. Sci. [illegible]
Cochin. VII. 4.:695-704.

0088 Rao, T.S.S. 1973.
Tropical Plankton. Mahasagar 6(2):109-[illegible]

0089 Ohlhorsk, S.L. 1982.
Diel migration patterns of Dermesal Reef [illegible]
J. Exp. Mar. Biol. Ecol. 60:1-15

0090 Alldredge, A.L.; King, J.M. 1980.
Effects of moonlight on the vertical [illegible] of Dermesal zooplankton. J. Exp. Mar. Biol. [illegible]
156.

0091 Marande, Y.; Lacroix G. 1983.
Temparal variability of zooplankton Biomass (ATP Content and Dry weight)..in the St. Lawrence Estuary:Advective Phenomenadurin during Neap Tide.

0092 Omori, M.; Hammer, W.M. 1982.
Patchy distribution of zooplankton: behavior, population assessment and sampling problems. Mar. Biol. 72:193-200.

0093 Rosson, P. 1974.
Changing traditional distribution systems:fish marketing in Tanzania. Int. J. Physical Distribution, 4(5):e305-316.

0093 Grame, J.A. 1980.
Succession and diversity in the pleistocene coral Reefs of the Kenya Coast. Palaeontology, 23 (1):1-37.

0095 Crame, J.A. 1981.
Ecological stratification in the pleistocene Coral Reefs of the Kenya Coast. Palaeonlology, 24(3):609-646.

0096 Silas, E.G.; Srinivasan, M. 1970.
Chaetognaths of the Indian Ocean, with a key for their identification Proc. Indian Acad. Sci. 71:171-192.

0097 Wickstead, J. 1959.
A Predatory Copepod. J. Animal Ecology. 28:69-72.

0098 Corkett, C.J.; Zillioux, E.J. 1975.
Studies on the effects of temperature [illegible] laying of Three Species of Calanoid Copepods in the laboratory (Acartia tonsa, Temora longicornis and Psendocalanus elongatus). Bull. Plankton Soc. Japan., 21 (2):77-85.

0099 Itô, T. 1981.
Descriptions and record of marine Harpacticoid Copepods from Hakkaido VIII. J. Fac. Sci Hokkaido Univ. Ser Vi, Zool. 22 (4):422-450.

00100 Bainbridge, V. 1972.
The zooplankton of the Gulf of Guinea.
Bull. Mar. Ecol, 8: 61-97.

00101 Flessa, K.W.; Brown, T.J. 1983.
Selective solution of macroinvertebrate Calcareous hard parts: a laboratory study.
Lethaia, 16 (3) : 193-205.

00102 Holland, N.D.; Nealson, 1978.
The Fine structure of the Echinoderm Cuticle and the Subcuticular Bacteria of Echinoderm. J. Acta. Zool. (stockl) 59:169-185.

00103 Naidenko, T.K.L.; Dzyuba, 1983.
Growth and maturation of the sea urchin Strongylocemtptis Iintermedius in laboratory conditions.
Sov. J. Mar. Biol. 8(4):197-202.

00104 Naidenko, T.K.H. 1983.
Laboratory cultivation of Sea Urchin Strongylocentrotus Intermedius Sov. J. Mar. Biol. 1:46-50.

00105 Burkhardt, A.; Hansmann, W.; Markel, K.; Niemann, H.J.
Mechanical design in spines of diadematoid echinoids (Echinodermata, Echinoidea). Zoomorphology, 102: 189-203.

00106 Badve, R.M.; Nayak, K.K. 1981.
Nature of preservation of Echinoid skeletal remains and their significance in study of fossil algae.
Biovigyanam, 7(2):163-168.

00107 Sarkar, R.; Krishnamoorthi, K.P. 1977.
Biological method for monitoring water pollution level. Studies at Nagpur. Indian J. Environ. Hlth., 19(2):132-139.

00108 Marsh L.M.; Bradbury, R.H.; Reichelt, R.E. 1984.
Determination of the physical parameters of local distribution using line transect data Coral Reefs 2:175-180.

00109 Bruce, J.G. 1977.
Somali current: recent measurements during the south west monsoon. Science 197 (4298):51-53.

..../11

0010 Snedaker, S.C.; Brown, M.S. 1981.
Water quality and mangrove Ecosystem Dynamics EPA-600/4-81-022 (April 1981), U.S. EPA Office of Research and Development, pp 1-80.

00111 Vervoort, W. 1949.
Some new and rare copepoda calanoida from East Indian Seas. Zoologische Verhand Elingen., 5:1-50.

00112 Ktari, F,; Ktari, M.H. 1974.
Occurence in the Gulf of Gabes Bull. Inst. Oceanogra. Peche. Salambo, 3(14):95-98.

00113 Esterly, C.O. 1905.
The pelagic copepoda of the San Diego Region. Marine Biological Association of San Diego, 2(4):113-233.

00114 Bowers, A.B.; Holiday F.G.T. 1961.
Histological changes in the gonad associated with the Reproductive cycle of the herring (Clupea, harengus L.). Ecpt. Agr. Fish. for Scotland Marine Res. No. 5:1-16.

00115 Yamamoto, K.; Yoshioka, H. 1964.
Rhythm of development in the oocyte of themedaka, oryzias latipes. Bull. Fac. Fish Hokkaido Univ., XV(1):5-19.

00116 Khan, J.A. 1976.
Distruction and abundance of fish larvae off coast of West Pakistan. Mar. Biol., 37:305-324.

00117 Steedman, H.F. 1974.
Laboratory methods in the study of marine zooplankton: a summary report on the results joint working group 23 of the Scientific Committee on Oceanic Research and the United Nations Educational, Scientific and Cultural Organisation 1968-1972. J. Cons. Int. Explor. Mar. 35(3):351-358.

00118 Castel, J.; Courties, C. 1982.
Composition and differential distribution of zoop-lankton in Arcachon Bay. J. Plankt, Res., 4(3) 417-433.

00119 Paulinose, V.T.; George, M.J. 1976.
Abundance and distribution of penacid larvae:
Indian J. Fish, 23(1-2):127-133

00120 Vannucci, M.; Santhakumari, V. 1972.
Abundance of plankton animal in relation to the age of ecosystem. Indian J. Mar. Sci. 1:119-124.

00121 McWilliam, P.S. 1977.
Further studies of plankton ecosystems in the Eastern Indian Ocean VI. ecology of the euphausiaca.
Aust. J. Mar. Freshwat. Res., 28:627-

00122 Tranter, D.J.; Kerr, J.D., 1977.
Further studies of plankton ecosysterm in the Eastern Indian Ocean III. numerial abundance and biomass. Aust. J. Mar. Freshwat. Res. 28:557-583.

00123 Tortonese, E. 1976.
Researches on the coast of Somalia seastars of the genus monachaster (Echinodermata asteroidea).
Monitore zool. ital. (N.S.) Suppl. VII:271-276.

00124 Devaney, D.M. 1977.
Ophiomastix Koehleri, A. New Ophiocomid Brittlestar (Echinodermata. Ophiuroidea) from the wester Indian Ocean. Proc. Biol. Soc. Wash 90 (2): 274-283.

00125 Gregory, D.R.; Ronald, F.L.; Combs, C.L. 1982.
Reproductive dynamic of the spiny lobster Panulirus orgus in South Florida. Trans. Amer. Fish. Soc. III: 575-584.

00126 Sea Fisherie Research Institute Cape Town, South Africa 1983.
South Africa Fisheries and Research Report for (1981). ICSEAF (Part 11). Colln scient. pap. Int. Commn SE. Atl. Fish, 10(2) : 27-31,

00127 Shojima, E.; Otaki H. 1982.
Stock assessment of the korai prawn; Penaeus orientalis
Bull. Seikai Reg. Fish Res. Lab. No. 58:23-51.

00128 Cascalho, A.R.; Arrobas, I., 1983.
Further contributions to the knowledge about biology and fishery of Parapenaeus longirostris (Lucas, 1846) of South Portuguese coast. ICES, Copenhagen (Denmark) 26p.

00129 Anonymous, 1982.
State of the Fisheries of Western Australia 1980.
Fins. 15 (1) : 8-11.

00130 Rainer, S.F.; Munro, I.S. R. 1982.
Demersal fish and cephalopod communities of an unexploited coastal environment in Northern Australia.
Aust. J. Mar. Freshw. Res. 33:1039-1055.

00131 Ennis, G.P.,; Collins, G.W.; Dave, G. 1982.
Fisheries and population biology of lobsters (Homarus americanus) at comfort Cove, Newfoundland.
Can. Tech. Rep. Fish. Aquat. Sci., No. 1116, P.

00132 Yamamoto, K. 1956.
Studies on the formation of Fish Eggs 1.
Annual cycle in the development of ovarian eggs in the Flounder, liopsetta obscura. J. Fac. Sci.
Hokkaido Univ. Ser. Vl Zool. 12:362-373.

00133 Westernhagen, H.V. 1974.
Food preferences in cultured Rabbitfishes (Siganidae)
Aguaculture, 3:109-117.

00134 Law, T.J. 1974.
Siganids: their biology and mariculture potential.
Aquaculture. 3:325-354.

00135 Bryan, P.G.; Becky, B.M. 1977.
Larval rearing and development of Siganus [illegible]
(Pisces:Siganidae) from hatching through metamorphosis,
Aquaculture, 10:243-252.

00136 Gushima, K. 1981.
Study on the feeding ecology of reef [illegible]
Kuchierabu Island. J. Fac. A. Biol. [illegible]
Abstract.

00137 Chicirinsky, A. I. 1970.
The nature of Orogenesis of Japanese. [illegible]
VOP IKHT IOL 10:1005-1011. Japanese.

00138 Djamali, A. 1978.
Some biological aspects of rabbitfish, [illegible]
around Kongsi Island. Oceanol. Indones. [illegible]

00139 Barnes S.U. 1976.
Geology and oil prospects of Somalia, [illegible]
The American Association of petroleum [illegible]
Bulletin Vol. 60 (3):389-413.

00140 Shadanow, A. N.; Shumilova, M.B. 1983.
Regional hydrocarbon migration as a factor in the formation of major petroleum accumulation zones. Internat. Geology Rev., 25 (5):569-573.

00141 Zaghloul, Z.M.; EL Ayouty M.K.; EL Sawy, M.M. 1974.
The subsurface miocene evaporities in the Gulf of Suez Region and their genetic relation with petroleum. Egypt. J. Geol. 18, (2):77-86.

00142 Daniels, J.J.
Development of hole to hole and deep penetrating electrical and acoustic borehole-geophysical systems. Abstract In.

00143 Sedlar, P.A.; Carron, C. 1983.
Isolation and localization of a 45k DA Actin-binding protein from sea urchin eggs. J. Cell Biol., 97 (5 part 2) 280 A.

00144 Lopo, A.C.; Hershey, J.W.B. 1983.
Purification and characterization of Eukaryotic Initiation factor 2 (elf2) from Sea Urchin Eggs. J. Cell. Biol. 97 (5 part 2) 182A.

00145 Niman, H.L.; others 1984.
Proteins of the Sea urchin egg vitelline layer. Dev. Biol. 102:390-401.

00146 Talbot, C.F.,; Victor, D.V. 1982.
The purification and characterization of an Exo-B (1-3)-glucanohydrolase from sea urchin egg. The J. Biol. Chem. 257 (2):742-746.

00147 Gundersen, R.G.; Shapiro, B.M. 1984.
Hapten-mediated immunopurification of membrane proteins labeled with fluorescein derivatives Biochem. Biophys. Acta, 799:68-79.

00148 Rossignol, D.P.; Aimee, J.R.; William, J.L. 1981.
Sperm egg binding:identificationof a Species-specific sperm receptor from eggs of Strongylocentrotus purpuratus. J. Supramol. Struct. and Cell Biochem. 15:347-358.

00149 Glabe, C.G.; Lennarz, W.J. 1981.
Isolation of a high molecular weight glycoconjugate derived from the surface of purpuratus eggs that is implicated in sperm Adhesion. J. Supramol. Struct. and Cell Biochem. 15:387-394.

00150 Sova, V.V.; Prokopenko, I.V.; Polyakora, N.E.; Gorgunova, L.E.; Sakharova, N.K.; Yurin, V.L. 1980.
Isolation and characterization of poly (A) containing 8-105 mRNA from Strongylocentrotus intermedius sea urchin embryos at the middle blastula stage. Mol. Biol. (MOSC) 1243-1252.

00151 Cross, N.L. 1983.
Isolation and electophoretic characterization of the Plasma Membrane of sea urchin sperm.
J. Cell. Sci. 59:13-25.

00152 Yoshidam M.; Aketa, K., 1982.
Partial purification of the sperm-binding factor from the egg of the sea urchin, Anthocidaris Crassispina, followed by an immunological method.
Develop. Growth and Differ: 24(1) : 55-63.

00153 Takeuchi, K. 1983.
Purification and characterization of exo-B-1, 3-glvcanase from a hatching Supernatant of Strongylocentrotus intermedius. Can J. Biochem. Cell Biol. 61:54-62.

00154 Boghen, A. D.; Castell, J.D.; Conklin, D.E. 1982
In search of a reference protein to replace vitamin-pree Casein in losbster nutrition studies.
Can. J. Zool. 60:2033-2038.

00155 Podgornaya, O. L.; Orozdov, A.L. 1981.
Interaction between gelating proteins of the sea urchin egg cytoplasm and rabbit actin.
Cytology 23, (1):101-104.

00156 Kuo, P.; Mimura, N.; Akira, A. 1982.
Purification and characterization of [illegible], a calcium-sensitive actin-accessory [illegible] from Rat Liver. Eur. J. Biochem. 125(2) [illegible]-282.

00157 Radany, E.W.; Gerzer, R.; Garbers, D.L. 1983.
Purification and characterization of Particulate [illegible] Guanylate cyclase from sea urchin spermatozoa.
J. Biol. Chem., 258 (13) :8346-8351.

....../16

00158 Akasaka, K.; Terayama, H. 1982.
Sulfated fucogalactan-protein conjugate present in the EDTA-extract from Anthocidaris embryos (Mid-gastrula) J. Fac. Sci Univ Tokyo. Section IV Zool 15 (2): 181-190.

00159 Rogers, C.S. 1979.
The effect of shading on coral reef structure and function. J. Exp. Mar. Biol Ecol. 41:269-288.

00160 Benayahu, Y., Loya, Y. 1981.
Competition for space among coral-reef sessile organisms at Eilat, Red Sea. Bulletin of Marine Science, 31(3) 4514-22 Abstract.

00161 Fadlallah, Y.H. 1982.
Reproductive Ecology of the Coral Astrangia lajollaensis sexual and asexual petterns in a kelp forest habitat. Oecologia 55 (3): 378-388.

00162 Verseveldt, J. 1973.
Octocorallia from North-Western Madagascar (Part IIIA) Proc. Koninkl. Med. Acad. Weterns Chappen Asterda Ser. C. 76:69-171.

00163 Coll, J.C. and Others. 1982.
Chemical defences in soft corals (Coelenterata Octocorallia) of the great Barrier Reef: a study of comparative toxicities. Mar. Ecol. Prog. Ser. 8:271-278.

00164 Sheppard, C.R.C. 1980.
Coral cover, zonation and diversity on reef slopes of chagos atolls and population structures of the major species. Mar. Ecol Prog. Ser. 2:183-205.

00165 Robarts, R.D. 1979.
Underwater light penetration, chlorophyll and primary production in a tropical Africa Lake (Lake Mellwaine, Rhodesia). Arch. Hydrobol, 86(4):423-444.

00166 Furet, J.E., Benson-Evans, K; Grey, J.B. 1983.
A battery operated incubater for in situ primary productivity studies in small lakes and rivers Hydrobiologia, 101:243-245.

..../17

00167 Shepard, R.B. (1982.
Primary Productivity and phytoplankton distribution in a small illinois (U.S.A.) Lake Int. Revue ges. Hydrobiol. 67(4):555-565.

00168 Flik, B.J.G.; Keyser, A. 1981.
Estimation of the primary production in Lake Maarsseveen I with an Incubator techinque.
Hydrobiol. Bull. (5) 1-2: 41-50.

00169 Estrada, M. 1981.
Phytoplankton biomass and primary production in the western Mediterranean at the beginning of Autumn.
Inv. Pesq. (Barc) 45: 211-230.

00170 Redalje, D.G; Laws, E.A. 1981.
A new method for estimating phytoplankton growth rates and carbon biomass. Mar. Biol. 63:73-79.

00171 Estrada, M. 1980.
Phytoplankton biomass and production in the up-welling region of N.W. Africa. relationships with hydrographic parameters. Mar. Biol., 60:63-71.

00172 Voituriez, B. Herbland, A. 1981.
Primary production in the tropical Atlantic Ocean mapped from oxygen valves of Equalant and 2 (1963.
Bull. Mar. Sci. 31(4) 853-863.

00173

00173 Ryther, J.H; Hall, J.R.; Pease, A.K.; Bakun, A. Jones; M.M. 1966.
Primary organic production in relation to the chemistry and hydrography of the western Indian Ocean.
Limnol. Oceanogr. 11 (3) : 371-380.

00174 Witte, W.G.; Whitlock, C.H.; Harriss, R.C.; Usry, J.W.; Poole, L.R.; Houghton, W.M.; Morris, W.D.; Gurganus, E.A.; 1982.
Influence of dissolved organic materials on Turbid water optical properties and Remote-sensing Reflectance
J. Geophy. Res. 87: 441-446.

00175 Apel, J.R. 1975.
Ocean remote sensing.
Scientific and Technical Asrospace reports [illegible]
Jan 1983. 21p.

00176 Klemas, V; Davis, G.; Henry, R.
Studies of current circulation at Ocean waste disposal sites. Scientific and technical Aerospace report 14(4):319-

00177 Fevre, J. L.; Viollier, M.; Le Corre, Dupouy, C.; Grall, J-R. 1983.
Remote sensing observation of Biological material by landsat along a tidal thermal front and their relevancy to the Available Field Data. Estuarine Coastal and Shelf Science, 16 37-50.

00178 Nishimura, T.; Tanaka S.; Onishi, S. 1984.
Landsat Remote sensing of the tidal current at a strait consisting of multiple water courses. Coast Eng. Japan. Vol 24: 267-

00179 Anderson, D.L.T.; Moore, D.W. 1979.
Cross-equatiorial inertial jets with special relevance to very remote forcing of the somali current. Deep-Sea Research. 26A: 1-22.

00180 Kaczynski, V.; Le Vieil, D.
International joint Ventures in world Fisheries Journal of Contemporary Business 10 (1): 75-89.

00181 Smith, R.C.; Baker, K.S., 1978.
Optical classification of natural waters. Limnol. Oceanogr. 23 (2) :260-267.

00182 Klemas, V. Bartlett, D. S.; Murillo, M. 1960.
Remote sensing of coastal environment and resources. Proc. 14th Intern. Symp. 10:543-555.

00183 Klemas. V, Davis, G; Wang, H.; 1977.
Remote sensing of coastal currents and pollutants. Geoscience and Man. Vol XVIII : 193-204.

00184 Ohnishi. S.; Aitani. H, 1961.
Study on circulating surface current in closed water Basin. Coast Engineering Japan 24:264

00185 Nelepo, B.A. 1929.
Remote sensing of the ocean in the USSR Intergov. Oceanographic Commission. Tech Series. report : 41-50.

..../19

00186 Austin, T. 1981.
Review and forecast: Remote sensing and fisheries Sea Technolgy 22 (1) : 21-22.

00187 Sidran, M. 1980.
Infrared sensing of sea surface temperature from space Remote Sensing Environ. 10 (2) : 101-114

00188 Broche, P. 1962.
Remote sensing of sea condition using high frequency doppler techniques. 15th Annv. OK L ASTEO 1962 pp. 58-64.

00189 Reese, D.G. 1976.
Geophysics has history of ups, Downs offshore. 39 (10) 130-138.

00190 Mitnik, L. M. 1979.
Possibilities for remote sensing of temperature in a thin surface layer of the ocean. Izcestiya, Atmospheric and Oceanic Physics 15 (3): 236-239.

00191 Egan, W.F. 1980.
Optical remote sensing of the sea-A Caribbean example. Proc. 14th Into Symp. Vol. 1 1980 pp 563-586.

00192 Born, G.H.; Dunne, J.A.; Lame, D.B. 1979.
Seasat mission overview.
Science, 204 : 1405-1406.

00193 Chelton, D.B.; Hussey, K. J.; Parke, M. E. 1891.
Global satellite measurements of water vapour, wind speed and wave height. Nature, 294 (10) : 529-532.

00194 Sheres; D. 1981.
Remote synoptic surface current measurement by gravity wave, a method and its test in a small body of water. J. Phys. Oceanogr. 12:200-207

00195 Witte, W.G.; Whitlock, C.H.; Harriss, R.C.; Usry, J.W. Poole, L.R.; Houghton, W.M.; Morris, W.D. and Gurganus, E.A.
Influence of dissolved organic materials on turbid water optical properties and remote sensing reflectance. J. Geophys. Res. 87: 441-446.

..../20

00196 Krishnamoorthi, K.P; Abdulappa, M.K.; Godkari, A., 1978.
Biological indicators of pollution . Proc. Indian Natn. Sci. Acad 44, Pt B:98-110.

00197 Fleminger, A., 1979.
Labidocera (copepoda, calanoida) New and poorly known Caribean species with a key to species in the western Atlantic.
Bull Mar. Sci., 29(2): 170-190.

00198 Pangarajan. K, 1958.
Diurnal tidal cycle in vellar estuary.
J. Zool. Soc. India, 10, (1):54-64.

00199 Porper, D.; Pitt, R; Zohar, Y. 1979.
Experiments on the propagation of Red Sea Siginids and some notes on their reproduction in nature.
Aquaculture, 16: 177-181.

00200 Popper, D,; Nurit, G., 1975.
Some ecological and behavioural aspects of siganid populations in the Red Sea and Mediterranean coast of Israel in relation to their suitability for Aquaculture, 6(2):127-142.

00201 Tortonese, E. 1980.
Researches on the coast of Somalia littoral echinodermata. Monitore Zool. ital. (N.S.) Suppl. X111:99-139.

00202 Vannini, M. 1980.
Researches on the coast of Somalia: the shore and the dune of sar uanle, 27. burronts and digging behavior in ocypode and other crubs (crustacea brachyra). Monitore Zool. ital. (N.S.) Suppl. X111:11-44.

00203 Edmunds, M.; Thompson, T.E. (1972.
Opisthobranchiate mollusca from Tanzania
Proc. Malac. Soc. Lond., 40:219-234.

00204 Lewinsohn, C. 1979.
Researches on the coast of Somalia; the shore and the dune of sar uanle:23. porcellanidae (crustacea Decapoda anomura) Monitore Zool. [illegible])
Suppl. X11:39-57.

00205 Ugolini, A. and Chelazzi, G. 1978.
Researches on the coast of Somalia: the shore and the dune of sar uanle: 16 notes on cypraeidae (Mollusca gastropoda). Monitore Zool. ltal. (N.S.) Suppl X: 85-103.

00206 Telford, M. 1982.
Echinoderm spine structurem feeding and host relationships of four species of Dissodactylus (Brachyura: Pinnmotheridae)
Bull. Mar. Sci., 32 (2):584-594.

00207 Lewinsohn, C. 1979.
Researches on the coast of Somali the shore and the dune of sar uanle. 21. Dromiidae (crustacea decapoda brachyura) Monitore Zool. ltal. (N.S.) Suppl. Xll:1-15.

00208 Sakamoto, M.; Tilzer, M.M.; Gachter, R.; Rai, H; Collos, Y.; Tschumi, P.; Berner, P.; Zbaren, D.; Zbaren, J.; Dokulil, M.; Bossard, P.; Uehlinger, U. Nusch, E. 1984.
Joint field experiments for comparisons of measuring method of photosynthetic production.
J. Plankt. Res,. 6(2):365-383.

00209 Selley, R.C. 1983.
Petroleum geology for geophysicists and Engineers. International human Resources Development Corporation Boston: 88pp.

00210 Ryabushko, Zhuchikhina,A.A.; Lutsik, N.V. 1980.
Effects of environmental oxygen concentrations on the level of metabolism of some echinoderms from the sea of Japan.
Comp. Biochem. Physiol. 67B:171-174.

00211 Deits, T.; Farrance, M.; Kay, E.S.; Medill, [illegible] Turner, E.E.; WeidmanP.J.; Shapiro, B.M. 1984.
Purification and properties of Oveperoxidase, the Enzyme Responsible for hardening the fertilization membrane of the Sea Urchin Egg.
J. Biol. Chem. 259(21):13525-13533.

00212 Mesolella, K.J.; Weaver, O.W. 1975.
What is the effect of salt-collapse structures on finds in Michigan basin arena?
The Oil and Gas Journal 73 (14):166-168.

.../22

00213 Luyten, J.R. 1982.
Equatorial current measurements, moored observation.
J. Mar. Res. 40(1):19-41.

00214 Peter, K.J. 1981.
Influence of environmental changes on the distribution of Ichthyoplankton in the bay of Bengal.
Rapp. P-V Revn. Gons. Int. Explor. Mar. 178:210 -216.

00215 Kitaigorodskii, S.A. 1973.
The physics of Air Sea Interaction.
Earth Sciences and Oceanography, 73(20):80
Abstract.

00216 Mooers, C.N.K. 1983.
Satellite remote sensing and ocean physics
Ocean. Sci. Ocean Eng. 1:4-5.

00217 Grove, R.S.; Sonu, C.J. 1983.
Lagrangian coastal processes with application of remote sensing technology.
Ocean Sci. Ocean Engi.:318-325.

00218 Malay, J.T. Donald, N.B. 1983.
Spaced-Based ocean remote sensing capabilities and deficiencies in the 1980.
Ocean Sci. Ocean Eng. 1:326-327.

00219 Dueing, W.; Szekield, K.H. 1971.
Monsoonal response in the western Indian Ocean.
Earth Sciences and Oceanography, p. 65. Abstract.

00220 Onishi, S.; Tanaka, S.; Nishimura, T. 1980.
Study on Tidal-exchange Phenomenaat strait applying remote-sensing from Landsat. Transactions of JSCE, 12:143-146.

00221 Jenyon, M.K. 1983.
Seismic response to collapse structures in the Southern North Sea. 1:27-36.
Marine and Petroleum Geology 1:27-36.

00222 Edmundson, H. 1979.
Radioctive logging parameters for common minerals.
Log. Analyst, 20(5):38-47.

00223 Bryan, P.G. Becky, B.M. & James P.M. 1975.
Hormone induced and natural spawning of captive siganus canaliculatus (Pisces Siganidae) year round.
Micronesica 11 (2):199-204.

00224 Baginski, R.M. Carrolle, EJ.; Moblaine, P.J. 1980.
Isolation and processing of Sea Urchin cortical granule exudate.
AM Zool. 20 (4): 3839

00225 Klemasy V.; Philpot, W.D.
Remote sensing of ocean-dumped waste drift and dispersion pp 193-211.

00226 Brown, O.B.; Evans, R.H. 1982.
Visible and infrared satellite remote sensing. A statue report. Nav. Res. Rev. 34 (1): 7-22.

00227 Stevenson, M.R. 1983.
A synoptic approach to studying changes in sea surface temperature using geostationary satellite data. Seventeenth International Sympsium on Remote Sensing of Environment Ann. Arbor, Michigan, May 9- 13pp 703-714.

00228 Barnett, T.P. 1978.
Ocean temperatures:precursors of climate changes. Oceanus 21 (4):27-32.

00229 Cormack, D. 1980.
Recent developments in oil spill response
UNEP Industry and Environment 3: 18-19.

00230 Corwin, H. L.; Hartwig, J.H. 1983.
Isolation of Actin-Binding protein and cillin from Toad Oocytes.
Dev. Biol. 99: 61-74.

00231 Yamada, Y.; Aketa, K, 1982.
Purification and partial characterization of Hemagglutinins in seminal plasma of the sea urchin, hemicentrotus pulcherrimus. Biochim. Biophys. Acta, 709: 220-226.

00232 Wells, J.B.J. 1976.
Keys to aid in the identification of marine harpacticoid copepods. U.K. University of Aberdeen, 215 p.

..../24

00233 Orr, M. H. and F.R. Hess. 1970.
Remote accustic sensing of fluid and biological process in the ocean. J. Acoust. Soc. Am. Suppl. 1 Vol. 66. 98th meeting: Accoutical Society of America.

00234 Burhanuddin and Others, 1975.
The genus siganus in the collection of the national institute of oceanology (siganidae) Penelitian Indones 15:21-36.

00235 Hopkins, T.L. 1977.
Zooplankton distribution in surface waters of Tampa Bay Florida.
Bull. Mar. Sci. 27(3):467-478.

00236 Philips, B.F. 1981.
The circulation of the sourtheastern Indian ocean and the plankton life of the western rock lobster. Oceanogr. Mar. Biol. Ann. Rev. 19:11-39.

00237 Qasim, S.Z. 1968.
Some problems related to the food chain in a tropical estuary. Proc. Symp. Marine food chains Denmark. 21: 45-51.

00238 Phillips, B.F. 1983.
Migration of pre-adult western rock lobsters panulirus cygnus, in Western Australia.
Mar. Biol. 76:311-318.

00239 Canaris, A.G. and Ogambo, A. H. 1973.
Parasites and food habits of a littoral feeding lizard (Ablepharus, Scincidae).
Copea 2 :, 245-246.

00240 Jones, D.A. 1982.
New Isopods of the Ianocira (Conallanidae) from the Indian Ocean Region, Crustaceana, 42(I) :65-75.

00241 Liversidge, M.J. 1963.
A collection of cypraea from Diani Kenya.
J. Conch, 25 (4) : 166-169.

00242 Haig, J. 1983.
Pocellanidae (Decapoda, Anomura) from the Seychelles, Western Indian Ocean Crustaceana, 45 (3): 279-289.

..../25

00243 Chelazzi, G.; Focardi, D.; Deneubourg J. L. 1983.
A comparative study on the movement patterns of two sympatric tropical chitons (Mollusca: Polyplacophora). Mar. Biol. 74:115-125.

00244 Smith, M.T. 1977.
West Indian Ocean phytoplankton; a numerical Investigation of phytohydrographic regions and their characteristic phytoplankton associations. Mar. Biol. 9: 115-137.

00245 Nel, E.A., 1968.
The microplankton of the south-west Indian Ocean. Ivestl. Rep. Dic. Sea. Fish. S. Afr. 62:1-106.

00246 Morgunov, Y.G.; Kalinin, A.V.; Kalinin, V.V.; Kuprin, P.N. Limonov, A.F. 1978.
Geological structure at the upper part of the platform mantle in the gulf of Sidra (Mediterranean Sea) Oceanology 18 (3): 323-326.

00247 1977.
Siebens to test potential of new basin in Western Indian Ocean. The Oil and Sea, 75(42) 170-171.

00248 Tursch, B.; Tursch, A., 1982.
The soft coral community on a sheltered reef quadrat at Laing Island (Papua New Guinea). Mar. Biol. 68:321-332.

00249 Barre, S.; Coll, S.C., 1982.
Movement in soft corals: an interaction between Nephthea brassica (Coelenterata Octoçorallia) and Acropora hyacinthus (Coelenterata;Scleractinia). Mar. Biol., 72:119-124.

00250 Forer, A.; Zimmerman, A.M. 1984.
Composition of the isolated mitotic apparatus: analysis by polyacrylamide gel electrophoresis. Cytobios, 39:109-123.

00251 Swarup, G.; Garbers, D.L. 1982.
Phosphoprotein phosphatase activity of sea urchin spermatozoa. Biol. Reprod. 26:955-960.

00252 Szekielda, K.H., 1976.
Spacecraft oceanography
Ocenogr. Mar. Ann. Rev. 14:99-166.

00253 Colinvaux, L.H. 1980.
Ecology and Taxonomy of Halimeda primary producer of coral reefs.
Adv. Mar. Biol. 17:1-327.

00254 Coppejans, E. 1983.
Iconographic d' Algues mediterraneanes.
317p (Thesis).

00255 Jaasund, E. 1976.
Intertidal seaweeds in Tanzania University of Tromso. 159p.

00256 Sars, G.O. 1901.
An Account of the crustaecea of Norway Copepoda Calancida. Vol. lV part I&II. p. 1-28
Bergen Musenm, Bergen.

00257 Sars, G.O., 1902.
An Acount of the crustacea of Norway:Copepoda calanoida, part 11&1V. p. 29-48. Bergen museum, Bergen.

00258 Sars, G.O. 1902.
An Account of the crustaca of Norway. Copepoda Calanoida. part V& Vl p. 49-72.
Bergen Musenm, Bergen.

00259 Sars, G.O. 1902.
An Account of the crustacea of Norway: copepoda calanoida. calanoida. part V11 & V111 p. 72-96
Bergen Museum, Bergen.

00260 Sars, G. O. 1902.
An Account of the crustacea of Norway:Copepoda calanoida. part 1x & x. Vol. 1V part 1x & x.
p97-120. Bergen Museum .

00261 Sars, G. O. 1902.
An Account of the crustacea of Norway: Copepoda calanoida. Vol. 1V part xl & xll p. 121-144.

00262 Sars, G.O., 1903.
An Account of the crustacea of Norway. Vol 1V Copepoda calanoida. part x111 & x1V. p 145-171.
Bergen Museum, Bergen.

..... /27

00263 Sewell, R.B.S. 1948.
The free-swimming planktonic copepoda geographical distribution. The John Murray Expedition 1933-34. Sci. Reports, V111, No. 3. The British Museum (Nat. Hist.) p. 319-592.

00264 Fraser, J. H. 1957.
Chaetognatha.
Fich Ident. Zooplancton 1:6p.

00265 Russell, F.S. 1939.
Hydromedusae:
Fich. Ident. Zooplancton, 2:4p.

00266 Buckmann, A. 1969.
Appendicularia.
Fich. Ident. Zooplancton, 7:9p.

00267 Fraser, J.H. 1947.
Thatiacea-1
Fich. Ident. Zooplancton, 9:4p.

00268 Fraser, J.H. 1947.
Thaliacea-11.
Fich. Ident. Zooplancton, 10:4p.

00269 Farran, G.P. 1948.
Copepoda.
Fich. Ident. Zooplancton, 11:4p.

00270 Farran, G. P. (1948.
Copepoda.
Fich. Ident. Zooplancton, 12:4p.

00271 Farran, G. P. 1948.
Copepoda
Fich. Ident. Zooplancton, 13.4p.

00272 Farran, G.P. 1948.
Copepoda
Fich. Ident. Zooplancton.14:4p.

00273 Farran, G.P. 1948.
Copepoda
Fich. Ident. Zooplancton, 15:4p.

00274 Farran, G.P. 1948.
Copepoda
Fich. Ident. Zooplancton, 16:4p.

.../28

00275 Farran G.P. 1948.
"Copepoda: Calanoida"
Fich. Ident. Zooplancton, 17. 4p.

00276 Nouvel, Par. H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 18. 6p.

00277 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 19. 4p.

00278 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 20. 4p.

00279 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 21. 4p.

00280 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 22. 4p

00281 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 23. 3p.

00282 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 24. 4p.

00283 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 25. 4p.

00284 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton 26. 3p.

00285 Nouvel, Par H. 1950.
"Mysidacea"
Fich. Ident. Zooplancton, 27. 4p.

00286 Russell, F. S. 1950.
"Hydromedusae"
Fich. Ident. Zooplancton, 28. 3p.

00287 Rusell, F.S. 1950.
" "
Hydromedusae" Fich. Indent. Zooplancton, 2[illegible]

00288 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 32. 4p

00289 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 32. 4p

00290 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 34. 4p

00291 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 35. 4p

00292 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 37. 4p

00293 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 38. 4p

00294 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 39. 4p

00295 Farran, G.P. 1951.
"Copepoda"
Fich. Ident. Zooplancton, 40. 3p

00296 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton 41. 4p

00297 Vervoort, W. 1952.
Fich. Ident. Zooplancton, 42. 4p

00298 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton. 43. 4p

00299 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 44. 4p

00300 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 45.4p.

00301 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 47. 5p.

00302 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 47. 5p.

00303 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 48. 4p.

00304 Vervoort, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 49.4p.

00305 Ogilvie, W. 1952.
"Copepoda"
Fich. Ident. Zooplancton, 50. 4p.

00306 Russel, F.S. 1953.
"Hydromedusae"
Fich. Ident. Zooplancton, 51.6p

00307 Muus, B.J. 1953.
Polychaeta"
Fich. Ident. Zooplancton, 52.6p.

00308 Muus, B.J. 1953.
"Polychaeta"
Fich. Ident. Zooplancton, 53. 5p.

00309 Russell, F. S. 1955.
"Hydromedusae"
Fich. Ident. Zooplancton, 54. 6p.

....../31

00310 Totton, A.K. and J.H. Fraser 1955.
"Siphonophora"
Fich. Ident. Zooplancton, 55. 4p.

00311 Totton, A.K. J. H. Fraser, 1955.
"Siphonophara"
Fich. Ident. Zooplancton, 56. 4p.

00312 Totton, A.K.; J.H. Fraser, 1955.
"Siphonophora".
Fich. Ident. Zooplancton, 57. 4p

00313 Totton, A.K., Fraser, J. H. 1955.
"Siphonophora"
Fich. Ident. Zooplancton 58. 4p.

00314 Totton, A.K., J.H. Fraser, 1955.
"Siphonophora"
Fich. Ident. Zooplancton, 59. 4p

00315 Totton, A.K.; J.H. Fraser, 1955.
"Siphonophora"
Fich. Ident. Zooplancton, 60. 4p.

00316 Totton, A.K.; Fraser, J.H., 1955.
"Siphonophora"
Fich. Ident. Zooplancton, 61. 4p.

00317 Totton, A.K.; J.H. Fraser, 1955.
"Siphonophora"
Fich. Ident. Zooplancton, 62. 4p.

00318 Lovergrove, T. 1956.
"Copepod Nauplii (11)"
Fich. Ident. Zooplancton, 63. 4p.

00319 Coe, W.R. 1956.
"Pelagic nemertea"
Fich. Ident. Zooplancton, 65. 4p.

00320 Boschma, H., 1957.
"Ellobiopsidae"
Fich. Ident. Zooplancton, 65. 4p.

00321 Dales R.P., 1957.
"Heteropoda".
Fich. Ident. Zooplancton, 66. 4p.

00322 Williamson, D.I. 1957.
"Crustacea, Decapoda: Larvae"
Fich. Ident. Zooplancton 67: 7p.

00323 Williamson, D.I. 1957.
"Crustacea, Decapoda: Larvae"
Fich. Ident. Zooplancton, 68: 5p

00324 Forneris, L 1957.
"Phoronidea"
Fich. Ident. Zooplancton, 69: 4p.

00325 Burdon-Jones, C. 1957.
"Hemichordata"
Fich. Ident. Zooplancton, 70:6p.

00326 Jones, N.S. 1957.
"Cumacea"
Fich. Ident. Zooplancton, 71:3p.

00327 Jones, N. S. 1957.
"Cumacea".
Fich. Ident. Zooplancton, 72:6p.

00328 Jones, N.S. 1957.
"Cumacea"
Fich. Ident. Zooplancton, 73:3p

00329 Jones, N. S. 1957.
"Cumacea"
Fich. Ident. Zooplancton, 74: 3p.

00330 Jones, N.S. 1957.
"Cumacea".
Fich. Ident. Zooplancton, 75: 3p.

00331 Jones, N.S. 1957.
"Cumacea"
Fich. Ident. Zooplancton, 76: 4p.

00332 Naylor, E. 1957.
"Isopoda"
Fich. Ident. Zooplancton, 77: 4p.

00333 Naylor, E. 1957.
"Isopoda"
Fich. Ident. Zooplancton, 78: 4p.

00334 Morton, J. E. 1957.
"Opisthobranchia"
Fich. Idant. Zooplancton, 79: 4p.

00335 Morton, J. E. 1957.
"Opisthobranchia"
Fich. Ident. Zooplancton, 80: 4p.

00336 Pike, R.B., Williamson, D. I. 1959.
"Crustacea Decapoda: Larvae"
Fich. Ident. Zooplancton, 81: 9p.

00337 Broch. H. 1959.
"Cirripedia"
Fich. Ident. Zooplancton, 83: 4p.

00338 Berzins, B. 1960.
"Rotatoria. I"
Fich. Ident. Zooplancton, 84: 7p.

00339 Berzins, B. 1960.
"Rotatoria II"
Fich Ident. Zooplancton, 85: 3p.

00340 Berzins, B. 1960.
"Rotatoria III"
Fich. Ident. Zooplancton, 86: 4p.

00341 Berzins, B. 1960.
"Rotatoria IV"
Fich. Ident. Zooplancton, 87: 5p.

00342 Berzins, B. 1960.
"Rotatoria V"
Fich. Ident. Zooplancton, 88: 4p.

00343 Berzins, B. 1960.
"Rotatoria VI"
Fich. Ident. Zooplancton, 89: 4p.

00344 Williamson, D. I. 1960.
"Crustacea Decapoda: Larvae"
Fich. Ident. Zooplancton, 90: 5p.

00345 Hannerz, L. 1961.
"Polchaeta:Larvae"
Fich. Ident. Zooplancton, 91: 12p.

00346 Williamson, D., 1962.
"Crustacea Decapoda : Larvae"
Fich. Ident. Zooplancton, 92.

00347 Leloup, E. 1962
"Anthozoa".
Fich. Ident. Zooplancton, 93:7p.

00348 Muus, B.J.; 1963.
"Cephalopoda".
Fich. Ident. Zooplancton, 94: 5p.

00349 Muus, B.J., 1963.
"Cephalopoda".
Fich. Ident. Zooplancton, 95: 3p.

00350 Muus, B.J. 1963.
"Cephalopoda"
Fich. Ident. Zooplancton, 96. 6p.

00351 Muus, B.J. 1963.
"Cephalopoda"
Fich. Ident. Zooplancton, 94: 5p.

00352 Vareschi, E. 1978.
The ecology of Lake Nakuru (Kenya)
Oecologia (Beri) 32, 11-35.

00353 Elzarka, M.H. 1984.
"A model for gerenation, migration and accumulation of oil of the South Bakr, Gulf of Suef, Egypt,"
Geoscience journal, Vol. 1 pp. 1-12.

00354 Sammarco, P.W, and Others 1983.
"Competitive strategies of Soft Corals (Coelentorata:Octocorallia). Allelopathic effects on selected scleractinian corals"
Coral reefs 1: 173-178.

00355 Armi, L. 1978.
Mixing in the deep ocean; the importance of boundaries
Oceanus 21 (1) : 14 - 19.

00356 Thomson, J. A., Henderson W.D. 1902.
"Alcyonarians from Zanzibar"
Proc. Camp. Ph. 1. Soc. kl p 493 & xii p. 35.

00357 Muus, B.J. 1963.
"Cephalopoda"
Fich. Ident. Zooplancton, 98. 4p

00358 Russell, F.S. 1963.
"Hydromedusae"
Fich. Ident. Zooplancton, 99. 4p

00359 Russell, F.S. 1963.
"Hydromedusae"
Fich. Ident Zooplancton, 1004p

00360 Russell, F.S. 1963.
"Hydromedusae"
Fich. Ident. Zooplancton, 101: 4p

00361 Russell, F.S. 1963.
"Hydromedusae"
Fich. Ident Zooplancton, 102: 4p

00362 Dunbar, M.J. 1963.
"Amphipoda"
Fich. Ident. Zooplancton, 103, 4p

00363 Shih, C-T., Durbar, M.J. 1963.
"Amphipoda"
Fich. Ident. Zooplancton, 104, 6p

00364 Geiger, S.R. 1964.
"Echinodermata:Larvae"
Fich. Ident. Zooplancton, 105. 5p

00365 Hadfield, M.G. 1964.
"Opisthobranchia"
Fich. Ident. Zooplancton, 106. 3p

00366 Ryland, J.S. 1965.
"Polyzoa (Bryozoa)"
Fich. Ident. Zooplancton, 107: 6p

00367 Be, A.W.H. 1967.
"Foraminfera"
Fich. Ident. Zooplancton, 108. 8p.

00368 Williamson, D.I. 1967.
"Crustacea Decapoda. Larvae"
Fich. Ident. Zooplancton, 109: 5p

00369 Bock, K.J. 1967.
"Protozoa"
Fich. Ident. Zooplancton, 110. 4p

00370 Wickstead, J.H. 1967.
"Chordata"
Fich. Ident. Zooplancton, 111. 4p

00371 Rice, A.L. 1967.
"Crustacea: Decapoda"
Fich. Ident. Zooplancton, 112. 7p

00372 Hamond, R. 1967.
"Polypchaeta: Syllidae"
Fich. Ident. Zooplancton. 115. 4p

00373 Massera, E.B., Nencini, G. 1969.
"Acantharia: Holocantha: Holocantha"
Fich. Ident. Zooplancton 114. 4p

00374 Poulsen, E.M. 1969.
"Ostracoda 11-Myodocopa: Halocypriformes"
Fich. Ident. Zooplancton 116. 7p

00375 Marshall, S.M. 1969.
"Protozoa: Tintinnidiidae"
Fich. Ident. Zooplancton, 117. 12p

00376 Marshall, S.M. 1969.
"Tintinnida: Codonellidae
Fich. Ident. Zooplancton, 118. 5p

00377 Marshall, S.M. 1969.
"Tintinnida: Codonellepsidae"
Fich. Ident. Zooplancton, 119. 7p

00378 Marshall, S.M. 1969.
"Tintinnida: Coxliellidae"
Fich. Ident. Zooplancton, 120 5p

00379 Marshall, S.M. 1969.
"Tintinnida: Favellidae"
Fich. Ident. Zooplancton, 121. 6p

00380 Marshall, S.M. 1969.
"Tintinnida: Petalotrichidae"
Fich. Ident. Zooplancton, 122. 8p

.....37

00381 Marshall, S.M. 1969.
"Tintinnida: Xystonellidae (1)"
Fich. Ident. Zooplancton, 123. 4p

00382 Marshall, S.M. 1969.
"Tintinnida: Xystonellidae (2)"
Fich. Ident. Zooplancton, 124. 6p

00383 Marshall, S.M. 1969.
"Tintinnida: Undellidae"
Fich. Ident. Zooplancton, 125. 5p

00384 Marshall, S.M. 1969.
"Tintinnida: Tintinnidae (1)"
Fich. Ident. Zooplancton, 126. 5p

00385 Marshall, S.M. 1969.
"Tintinnida:Tintinnidae (2)
Fich. Ident. Zooplancton, 127. 7p

00386 Russell, F.S. 1970.
"Hydromedusae:Aequoreidae"
Fich. Ident. Zooplancton, 128. 4p

00387 Mauchline, J. 1971.
"Euphausiacea: Adults"
Fich. Ident. Zooplancton, 134. 8p

00388 Mauchline, J. 1971.
"Euphausiacea: Larvae"
Fich. Ident. Zooplancton, 135/137. 16p

00389 Corral, J. 1972.
"Copepoda: Calanoida"
Fich. Ident. Zooplancton. 138. 7p

00390 Pike, R. B. 1972.
"Crustacea Decapoda: Larvae"
Fich. Ident. Zooplancton, 139, 5p

00391 Spoel, S. Van Der 1972.
"Pteropoda thecosomata"
Fich. Ident. Zooplancton, 140. 12p

00392 Della Croce, N. 1974.
Fich. Ident. Zooplancton, 143. 4p
"Cladocera"

00393 Isaac, M.J.
"Copepoda"
Fich. Ident. Zooplancton 144/145

00394 Greve, W. 1975.
"Ctenophora"
Fich. Ident. Zooplancton, 146. 6p

00395 Cheng, L. 1975.
"Insecta. Hemiptera: Heteroptera"
Fich. Ident. Zooplancton, 147. 4p

00396 Demir, N. 1976.
"Callionymidae of the Nouth Eastern North Atlantic"
Fich. Ident. Zooplancton, 148. 5p

00397 Fives, J.M. 1976.
"Labridae of the Eastern North Atlantic"
Fich. Ident. Zooplancton, 149. 7p

00398 Nichola, J.H. 1976.
"Soleidae of the Eastern North Atlantic"
Fich. Ident. Zooplancton, 150/151 10p

00399 Russell, F.S. 1976.
Scyphomedusae of the North Atlantic,
Fich. Ident. Zooplancton 152, 4p

00400 Russell, F.S. 1977.
Hydromedusae: Families Zancleidae, Cladonemidae and Eleutheriidae,
Fich. Ident. Zooplancton 153: 4p

00401 Russell, F.S. 1977.
Hydromedusae: Families Clavidae and Hydractiniidae,
Fich. Ident. Zooplancton 154: 4p

00402 Lagardere, J.P. 1978.
Crustacea pelagiques,
Fich. Ident. Zooplancton, 155/156/157: 15p

00403 Russell, F.S. 1978.
Scyphomedusae of the North Atlantic (2)
Fich. Ident. Zooplancton 158: 4p

00404 Fincam, A.A., Williamson, D.I. 1978.
Decapoda, Larvae, VI, Caridea,
Fich. Ident. Zooplancton 159/160: 8p

00405 Russell, F.S. 1978.
"Addenda to Hydromedusae"
Fich. Ident. Zooplancton, 161. 4p

00406 Marters, P. 1978.
"Faecal pellets"
Fich. Ident. Zooplancton, 162. 4p

00407 Lang, W.H. 1980.
"Balanonmorph nauplii of the NW Atlantic shores"
Fich. Ident. Zooplancton 163. 6p

00408 Russell, F.S. 1980
"Trachymedusea"
Fich. Ident. Zooplancton 164. 4p

00409 Russell, F.S. 1981.
"Trachymedusae"
Fich. Ident. Zooplancton 165. 4p

00410 Russill, F. S. 1981.
"Harcomedusae"
Fich. Ident. Zooplancton, 166. 5p

00411 Williamson, D.I. 1983.
"Decapoda, Larvae, VIII".
Fich. Ident. Zooplancton, 167/168. 8p

00412 Malt, S.J. 1983.
"Copepoda, Oncaea"
Fich. Ident. Zooplancton, 169/170/171. 11p

00413 Bryan, F.G., Madraisau, B.B., Mevey, J.P. 1975.
"Hormone induced and natural spawning of
captive sigamus canaliculatus (pisces: Siganidae)
Micronesia, 11: (12) 199-204

00414 Gundermann, N., Popper, D.M. Lichatowich, [illegible] 1983.
"Biology and life cycle of Sigamus vermiculatus
(Siganidae, Pisces)"
Pacific Science, 37 (2) : 165-180.

00415 Woodland, D.J. 1983.
"Zoogeography of the Siganidae (pisces):
An Interpretation of distribution and Richness
pattern"
Bulletin of marine science. 33 (3) 713-717.

00416 Bryan, P.G. 1975.
"Food habits, functional digestive morphology, and assimilation efficiency of the Rabbitifish Siganus Spinus (Pisces Signaidae on Guam).
Pacific Science 29(3): 269-277.

00417 Yamanoto, K., Yamazoki, F. 1961.
Rythm of development in the Oocyte of the Gold-Fish, Carassius Auratus"
Bull. Fac. Fish. 12: 93-110.

00418 Chutter, F. 1960.
"On the ecology of the Fauna of stones in the current in a South African River supporting a very large simulium (Diptera) population".
Journal of applied ecology, 5: 531-561.

00419 Chutter, F.M. 1972.
"An Empirical biotic index of the quality of water in south African streams and Rivers".
Water Research, 6: 9-30.

00420 Harrison, A.D. 1965.
"River donation in Southern Africa"
Arch. Hydrobiol. 61, (3) 380-386

00421 Hall, A., Valente, I. M. C. B. S., Davies, B.R. 1977
"The Zambezi Rivers in Mozambique. The phusico-chemical status of the middle and lower Zambezi prior to the closure of the Cabora Bossa Dam
Freshwater Biology 7, 187-206.

00422 Jackson, B. N. 1961.
The impact of predation, especially by the Tiger-Fish (Hydrocyon vittatus cast) on African freshwater fishes.
Proc. Zool. Soc. London, 136: 603-662.

00423 Holden, M.J., Green, J. 1960.
"The hydrology and plankton of the River Sokoto"
Journal of Animal biology (29) 65-84.

00424 Middleton, H.E. 1930.
Properties of soils which Influence soil erosion
U.S. Dept. of Agric. Tech. Bull. 178: 1-6.

00425 Gaudet, J.J. 1977.
"Uptake, Accumulation, and loss of nutrients by papyrus in tropical swamps.
Ecology 58: 415-422.

00426 Fryer, G. 1973.
"The lake victoria fisheries: some facts and fallacies"
Biol. Cons. 5: 304-308

00427 Bruton, M.N. 1972.
The food and feeding behaviour of clarias gariepinus (pisces: Clariidae) in lake sibaya South Africa, with emphasis on its role as a predator of cichlids"
Trans. Zool. Lond, 47-114

00428 Talling J. F. 1957.
"The longitudinal succession of water characteristics in the white nile".
Hydrobiologia 11: 73-89.

00429 Chilver, R.M.; Gee, J.M. 1974.
The food of Bagrus docmoe (Forsk) (Pisces: S. puriformes) and its relationship with Haplochromis Hilgenderf (Pisces: cichlidae) in the Lake Victoria, East Africa.
J. Fish biol. 6: 483-505

00430 Wellcomme, R.L. 1976.
"Some general and theoretical consideration on the fish yield of African rivers"
J. Fish. Biol. 8: 351-364

00431 Talling, J.F.; Rzoska, J. 1967.
The development of plankton in relation to hydrological regime in the blue Nile.
J. Ecol. 55: 631-662

00432 Harrison, A.D. 1965.
"Geograhical distribution of Riverine: investebrated in Southern Africa .
Arch. Hydrobiol. 61 (3): 387-394

00433 Kendall, R.L. 1969.
"An Ecological history of the lake victoria basin."
Ecol. Monogr. 39 (2): 121-176.

00434 Deelstra, H. 1977.
"Organochlorine insecticide levels in various fish species in lake Tanganyika"
Med. Fac. Landbouww. Rijksuniv. Gent. [illegible]
869-882.

00435 Jackson, P.B.N. 1961.
"The impact of predation, especially by the tiger-fish (<u>Hydrocyon Vittatus Cast</u>) on African Fresh-water Fishes"
Trans. Zool. Soc. Lond., 136:603-622

00436 Degens, E. T.; Von Herzen, R.P.; Wong, H.K.; Deuser, W.G.; Jannasch, H.W. 1973.
Lake Kivu: Structure, chemistry and biology of an East African Rift Lake.
Geologische Rundschau 62: 245-277

00437 Talling, J. F. 1966.
"The Annual cycle of stratification and phytoplankton Growth in Lake Victoria (East Africa)"
Int. Revue gas. Hydrobiol. 51 (4): 545-621.

00438 Lewinsohn, C. 1982.
"Researches on the coast of somalia. The shore and the Dune of Sar Vanle. 33. Diogoudae, Paguridae and Coenobitidae (Crustacea, Decapoda Paguredea)"
<u>Monitore zool. Ital</u>. (N.S.) Suppl XVI (d) 35-68

00439 Lewinsohn, C. 1981.
Researches on the coast of Somalia (<u>Galathea Tanegashimae baba</u> (Crustacea Decapoda) from Somalia and notes on Galathea Spinosorostris Dana".
Monitore zool. Ital. (N. S.) Suppl XIV (12): 181: -188

00440 Edmunds, M. 1969.
"Opisthobranciate mollusea from Tanzania. I Eolidacea (Eubranchiate and Aeolidiidae)",
Pro. Malac. Soc. Lond., 38 (5) 451-469.

00441 Jones, D.A., Icely, J.D. 1981.
"Excirolana Bowmani, new mangrove Boring Isopod from Kenya (Isopoda, [illegible])
Crustraceana, 40(3): 266-271

00442 Ferreira, A.J. 1983.
"Researches on the coast of Somalia. The chiton Fauna (Mollusca polyplacophora)
Monitore Zool. Ital. (N.S.) Suppl XVIII (9) 249-297.

00443 Foxton, D. 1956.
The distribution of the standing crop of Zooplankton in the southern ocean"
Discovery Reports, XXVIII 191-236.

00444 Kruger, I. 1980.
"Achecklist of South West African Marine phytoplankton with some phytogeographic relations".
Fish. Bull. S. Afr. 13: 31-53.

00445 Mordasova, N.V. 1980.
"Marine biology: Chlorophyll in the Southwestern Indian Ocean in relation to hydrologic conditions
Oceanology 20(1): 75-79.

00446 Sarkar, R. Krishnamoorthi, K.P. 1977.
"Biological method for monitoring water pollution level: studies at Nagpur".
Indian J. Environ. Hlth, 19 (2): 132-139

00447 Borgne, R. 1981.
"Relationship between the hydrological structure chlorophyll and zooplankton biomasses in the Gulf of Guinea."
J. Plankt. Res. 3(4): 577-592.

00448 Rosenberg, G.G. 1980.
"Filmed observations of filter feeding in the Marine planktonic copepod Acartia Clausi"
Limnol. Oceanogr. 25(4): 738-743.

00449 Qasim, S.Z., Bhattathiri, P.M.A., Abidi, S.A.H. 1968.
"Solar radiation and its penetration in a tropical Estuary".
J. Exp. Mar. Biol. Ecol. 2: 87-103

00450 Joint. I.R. 1978.
"Microbial production of an estuarine Mudflat".
Estuarine and Coastal Marine Science, 7: 185-195

00451 Hecky, R.E.; Kling, H.J. 1981.
The Phytoplankton and protozooplankton of the euphotic zone of Lake Tanganyila: Species composition biomass, chlolrophll Content, and spatio-temporal distibution".
Limnol. Oceanogr. 26 (3): 548-546.

00452 Heinbokel J.F.; Beers J.R. 1979.
"Studies of the functional yole of Tintinnids in the Southern California Bight. III. Grazing Impact of Natural Assemblages"
Mari-- Biol. , 52: 23-32.

00453 Heinbokel J.F. 1978.
"Studies on the Functional role of Tintinnids in the Southern California Bight. 11. grazing rates of field populations".
Mar. Biol. 47: 191-197.

00454 Navea, E.; Miranda, Y.O. 1982.
"Carbonate de calcio en moluscos equinodermos de de Antofagasta, chile"
Rev. Biol. Mar. Valparaiso, 18(2): 117-128.

00455 Emlet, R.B. 1983.
"Locomotion, drag, and the rigid skeleton of larval echinoderms".
Biol. Bull. 164: 433-445.

00456 Hudinaga, M. 1942.
"Reproduction, development and rearing of Penaeus Japonicus Bate".
Jap. Journ. Zool. Vol. X: 305-393.

00457 Costello, T.J.; Allen, D.M. 1968.
"Mortality rates in population of pink Shrimp, Penaeus Duorarum on the sanibol and tortugas Grounds, Florida".
Fish. Bull. 66(3); 491-502.

00458 Barnard, K.H. 1962.
"New record of Marine crustacoc from the West African Region".
Crustaceana, 3(3): 239-245.

00459 Paulinose V.T.; George, M.J. 1976.
"Abundance and distrigution of penaeid larvae as an Index of penaeid prqwn resources of the Indian Ocean".
Indian. J. Fish. 23(1 - 2) p. 127-133.

00460 Rothlisberg, C.P.; Jackson, C.J.; Pendrcy, R.C. 1983.
"Specific identification and assesement of the distribution and abundance of early Penaeid Shrimp larvae in the Gulf of Carpentaria, Australia"
Biol. Bull. 164: 279-298.

00461 George, L.C.; Grant, W.E. 1983.
"A.stochastic simulation model of brown shrimp (Penaeid Aztocus Ives) Growth, movement, and survival in Galveston Bay, Texas."
Ecological Modelling, 19: 41-70.

00462, Jones, A.C.; Dimitriou, D.E.; Ewald, J.J.; Tweedy, J.H. 1970.
"Distribution of early developmental stages of pink shrimp, Penaeid Duorarum, in Florida waters".
Bull. Mar. Sci. 20(3) 634-661.

00463 Fleminger, A. 1979.
"Labidocora (copepoda, Calanoida)
New and poorly known Caribbean species with a key to species in the western Atlantic".
Bull. Mar. Sci., 29 (2): 170-190.

00464 Longhurst, A.R. 1959.
"Prediction of Selection factors in a tropecal Trawl Fishery".
Nature, 184: 1170 .

00465 Barlow J.P. 1955.
Physical and biological process determining distribution of Zooplankton in a Tidal Estuary.
Biol. Bull., 109: 211-225.

00466 Runge, J.A. 1980.
"Effects of hunger and season on the feeding behavior of Calanus Pacificus."
Limnol. Oceanogr. 25(1): 134-145.

00467 Ketchum, B.H. 1954.
"Relation between circulation and Planktonic Population in Estuaries."
Ecol. 35 (2): 191-200.

00468 Orton, J.H. 1920.
"Sea-Temperature, Breeding and distribution in Marine Animals.
J. Mar. Biol. Ass. U.K., 12: 339-366.

00469 Woodmansee, R.A. 1966.
Daily Vertical migration of Lucifer; Plankton numbers in relation to solar and Tidal Cycles.
Ecol. , 47 (5): 847-850.

00470 Smith, S.L.; Hall, B.K. 1980.
"Transfer of Radioactive carbon with the Copepod Temora Long-Cornis"
Mar. Biol. 55: 277-286.

00471 Heinbokel, J.F. 1978.
Studies on the functional role of Tintinnids in the Southern California Bight. 1.
Grazing and growth rates in Laboratory Cultures",
Mar. Biol., 47: 177-189.

00472 Rabinowitz, P.D. 1971.
"Gravity Anomalies across the East Africa Continental Margin."
J. of Geohys. Res. 76(29): 7107-7117.

00473 Cannon, R.T, Siambi, S.W.M.N.; Karanja, F.M. 1981.
"The Proto- Indian Ocean and a probable Paleozoic/Mesozoic Triradial Rift system in East Africa."
Earth and Planetary Science Letters, 52 419-426.

00474 Miller, R.L, 1954.
" A model for the Analysis of Environments of sedimentation."
J. Geol., 62 : 108-113.

00475 Beer, T. 1983.
"Environmental Oceanogrphy. An Introduction to the behavior of coastal waters"
Oxford:Pergamon Press. 262p.

00476 Miquel, J.C. 1982.
Le genre Metapenaeus (crustacea, penaeidae Taxonomie, biologie et Peches Mondiales."
Zoologische Verhandelingen, no. 195:1-137.

00477 Eisler, T.J., Clark, J.A. 1979.
Theoretical and experimental study of acoustic scattering in turbulent water."
J. Acoust. Soc. Amr. Suppl. 1 Vol 66. Abstract 1p.

00478 Wu, J., 1979.
Temporal rates of growth and decay of Microscopic and Macroscopic surface structures in wind-wave Tank."
J. Phys. Oceanogr. 9: 802-814.

00479 Price, J.F, Mooers, C.N.K., Van Leer, J.C., 1978.
"Observation and Simulation of storm-Induced mixed-layer Deepening."
J. Phys. Oceanogr., 8:582-599.

00480 Toba Y. 1978.
"Stochastic form of the growth of wind waves in a single parameter representation with physical implications."
J. Phys. Oceanogr. 8:494-507.

00481 Kraus, B.E., Hanson, H.P., 1983.
"Air-Sea interaction as a propagator of equatorial Ocean surface Temperature Anomalies."
J. Phys. Oceanogr. 13:130-138.

.../47

00482 Klein, P. 1980.
"A simulation of the effects os Air-sea transfer variability on the structura of marine upper Layers".
J. Phys. Oceanogr., 10: 1824-1841.

00483 Lawson, R.; Robinson, M. 1983.
"Artisanal fisheries in West Africa problems of management implementation"
Marine Policy, October, 279-2990,

00484 Branno, M. 1980.
"Effects of Trypsin on the methylation of nuclear proteins in sea urchin embryos."
Boll. Soc. Ital. Biol. Sper 56(17) 6p

00485 Kline, D.L. 1953.
"The purification and crystalization of plasminogen"
J. Biol. Chem. 2o4 (2) 949-955.

00486 Vaheri, A. Mosher, D.F. 1978.
"High molecular weight, cell surface Associated glyco-protein (Fibronectin) lost in Malignant transformation"
Bioch. Biophys. Acta. 516: 1-25.

00487 Hirs. C.H.W. 1956.
"The Oxidation of ribonuclease with performic Acid".
J. Biol. Chem. 219: 611-621.

00488 Duing, W.; Szekielda, K.H. 1971.
"Monsoonal response in the western Indian Ocean".
J. Geophys. Res. 76: (18) 4181-4187.

00489 Mosesson, M.W.; R.A. Umfleet. 1970
"The cold- Insoluble globulin of human plasma: I Purification, primary characterization and relationship to fibrinogen and other cold-insoluble fraction componints."
J. Biol. Chem. 245 (21): 5728-5736

00490 Engvall, E.; Ruoslati, E. 1977.
"Binding of solubse form of Fibroblast surface protein, Fibronectin, to Collagen."
Int. J. Cancer., 20: 1-5.

00491 Hedman, K.; Vaheri, A.; Wartiovaara, J. 1978.
"External Fibronectin of cultured human fibroblasts is predominantly a matrix protein."
J. cell biol., Vol. 76: 748-760.

00492 Keski-Oja, J., Mosher, D.F., Vaheri A. 1976.
"Cross-linking of a major fivroblast surface associated glycoprotein (Fibronectin) Catalysed by blood coagulation factor XIII".
Cell. 9: 29-35

00493 Keski-Oja, J.; Mosher, D.F.; Vaheri; A. 1977.
"Dimerici character of Fibronectin, a major cell surface Associated glycoprotein".
Biochem. Biohys. Res. Commun. 74(2): 699-706.

00494 Stathakis, N.S., Mosesson, M.W. 1977.
"Interactions among heparin, cold-insoluble globulin, and Fibrinogen in formation of the heparin-precipitable fraction of plasma."
The J. Clini. Invest. 60: 855-865.

00495 Amrani, D.L.; Homandberg, G.A.; Tooney; N.M., Wolfenstein-Todel C., and Mosesson, M.W. 1983.
"Separation and Analysis of the major forms of plasma Fibronectin".
Biochem. Biophys. Acta., 748: 308-320.

00496 Blaxhall, P. C. 1972.
"The haemotological Assessment of the health of freshwater fish: A review of selected literature".
J. Fish Biol, 4: 593-604.

00497 Robinson, J. 1970.
"Persistent pesticide".
Annual Review of Pharmacology, 10: 353-378.

00498 Sundstrom, G. 1977.
"Metabolic Hydroxylation of the Aromatic rings of 1. 1-Dichloro-2-2bis (Chlorophenyl) ethylene (P.P. -DDE) by the Rat".
J. Agric. Ed. Chem. 25(1):18-21.

00499 Van, DYK. L.P., Greeff. C. G. 1977.
"Endosul Fan Pollution of rivers and streams in the Loskop Dam Cotton-Growing Area".
Agrochemcphysica, 9: 71-76.

00500 Peterson, J.E., Ronbison, M.W. H. 1964.
"Metabolic product of P.P-DDT in the Rat".
Toxicology and applied pharmacology.
6: 321-327

00501 Judah, J.D. 1949.
"Studies on the metabolism and mode of action of DDT".
Bri. J. Pharmacol. 4: 120-131.

00502 Ellgaard, E.G.; Ochsner, J.C.; Cox, J.K. 1977.
"Locomotor hyperactivity induced in the bluegill sunfish, <u>Lepomis macrochirus</u> by sublethal concentrations of DDT".
Can. J. Zool., 55: 1077-1081.

00503 Giam, C.S.; Wong, M.K. 1972.
"Problems of Background contamination in the analysis of the Ocean Biota for Chlorinated Hydrocarbons".
J. Chromatogr. 72:283-292.

00504 Eicheiberger, J.W.; Lichtenberg, J.J. 1971.
"Persistence of pesticide in River water
Environmental Science & Technology, 5(6)
541-544.

00505 Harrisson, H.L., Loucks, O.L.; Mitchell, J.W.; Parkhurst, D.F., Tracy C.R., Watts D.G.; Yannacone, V.J. 1970.
"Systems studies of DDT transport, a system studies analysis provides new insights for predicting long-term impacts of DDT in ecosystems
Science 170: 503-508.

00506 Reddy. T.G., Gomathy, S. 1977.
"Toxicity andrespiratory effects of pesticide. Thiodan on Catfish, Mystus Vittatus".
Indian. J. Environ. Hlth. 19:(4) 360-363.

00507 Youngs, W.D.; Gutenmann, W.H.; Lisk D. J. 1972.
"Residues of DDT in lake Trout as function of age."
Environ. Sci. Technol. 6(5): 451-452.

00508 Delela, R.C.; Verma, S.R.; Bhatnagal, M.C. 1978.
"Biocides in relation to water pollution part I Biossay studies on the effects of the few Biocides on freshwater fish, <u>Channa Gachwa</u>".
Acta. Hydrochim. Hydrobid. 6(1): 15-25.

00509 Gorbach S. G.; Christ, O. E.; Kellner, H.M. Kloss, G.; Bokiyer, E. 1968.
"Metabolism of Endosulfan in milk sheep"
J. Agr. Fd. Chem. 16(6) 950-953.

00510 Gorbach, S.; Haarring, R.; Knauf, W.; Werner, H.J. 1971.
"Residue analysus in the water system of East Java (River Brantas, Ponds, Seawater) after continued large scale application of Thiodan in Rice".
Bull. Environ. Contam. Toxicol. 6(1) 40-47.

00511 Maitlen, J.C., Waiker, K. C., Westlake, W.E. 1963.
"An improved colometric method for determining Endosulfan (Thiodan) Residues in vegetable and beef fat."
J. Agri. Fd. Chem. 11(5): 416-418.

00512 Koeman, J.H.; Denboer W.M.J.; Feith A.F.; Deiongh, H.H.; Spliethoff, P.C.; Naisa, B.K.; Spielberger (1978).
"Three years observation on side effects of helicopter applications of Insecticides used To Exterminate Glossinap species in Nigeria"
Environ. Pollut. 15:31-59.

00513 Magadza, C.H.D. 1978.
Field observations on the environmental effect of large-scale aerial applications of endosulfan in the eradication of Glossina Morsitans Centralis westw. In the Western province of Zambia in 1968.
Rhod. J. Agric. Res. 16: 211-220.

00514 Robertson R. 1973.
"Sex changes under the waves." New scientist, 58: 538-54.

00515 Bortone, S.A. 1977.
"Gonad Morphology of Hermaphroditic fish".
Copeia 3: 448-453.

00516 Harrington; R.W. jr. 1971.
"How ecological and Genetic factors interect to determine when self-fertilizing Hema prodite of Rivulus Marmoratus change into functional secondary males, with a Reappraisal of the modes of intersexuality among fishes".
Copeia, No. 3: 309-432.

00517 Dixit: R.K.; Agrawala, N. 1974.
"Studies on the development Rythm in the cocyte of Pautius sophore (Ham)
AGTA anat 90: 133-144.

00518 Haley, S.R. 1979.
"Sex ratio as a function of size in hippa Pacifica Dana (Crustacea; Ancmura, Hippidae): a test of the sex reversal and differential growth rate Hypotheses".
Am. Nat. 113:391-397.

00519 Charnov, E.I.; Bull, J. 1977.
"When is sex environment determined
Nature 266:828-830.

00520 Fricke, H., Fricke, S. 1977.
"Monogamy and sex change by aggressive dominance
in coral reef fish".
Nature 266:830-832.

00521 Leigh, E.G.; Charnov, E.R.; Warner R.R. 1976.
"Sex ratio, sex change, and natural selection".
Proc, Natl, Acad, Sci. U.S.A., 73: (10) 3656-3660.

00522 Robertson, D.T. 1972.
Social control of sex reversal in a coral reef
fish.
Science, 177: 1007-1009.

00523 Sherman, A.D.; Petty, F. 1982.
"Additivity of Neurochemical changes
in Learned helplessness and imipramie"
Behavioral and Neural Biology, 35: 344-353.

00524 Burden T.W. 1954.
"Fishing methods of singapore"
Royal asiatic Society 27:29.

00525 Andreson W.W. 1956.
Observations upon the Biology, Ecology and
life history of the common shrimp,
pemaeus setiferus (Linnaus) along the south
Atlantic and gulf coasts of the United States".
Pro. Indo. Pacific Fish. Council, 6(2+3) : 339-403

00526 Furness, H,D.; Bresn; C.M. 1980.
The vegetation of the seasonally flooded areas of
the Pongolo river floodplain ,
Bothalia, 13:217-230

00527 Hudinaga, M. 1942.
"Reproduction development and rearing of penaeus
Japonicus Bate
Jap. Journ. Zool. 10(2): 305-393.

00528 Youngbluth, M.J. 1980.
"Daily seasonal and annual fluactuations among
Zooplankton populations in an unpolluted Tropical
Embayment."
Estuarine and coastal Marine Science 10:265-287.

00529 Eccles, D.H. 1974
"An outline of the physical limnology of lake Malawi; (L. Nyasa)".
Limnol. Oceanogr. 19(5): 730-742.

00530 Darlington, J.P.E.C. 1977.
"Temporal and spatial variation in the Benthic Invertebrate Fauna of Lake George Uganda."
J. Zool. Lond. 181: 95-111.

00531 Gaigher, I. G. 1970.
"Ecology of the tiger-fish (Hdrocynus Vittatus) in the Incomati River System, South Africa."
Zoologica Africana. 5 (2) : 211-227

00532 Morrisson, P.R.; Edsall, J.T.; Miller S.G. 1948.
"Preparation and properties of scrum and plasma proteins XVIII. The separation of purified fibrinogen from fraction I of human plasma."
J. Amer. Chem. Soc. 70: 3103-3108.

00533 Pearlstein,E. 1976.
"Plasma membrane Glycoprotein which mediates adhesion of fibrolasts to collagen"
Nature 262: 497-499.

00534 Mosher, D.F. 1975.
"Cross-linking of cold-Insoluble Globulin by fibrin-stabilizing factor".
J. Biol. Chem. 250: 6614-6621.

00535 Espersen, F.; Clemmesen, I. 1982.
"Isolation of a fibronectin-Binding protein from staphylococcus aureus".
Infect. lmm, 37(2): 526-531.

00536 Vuento, M. ; Salonen, E. ; Osterlund, K.; Stenman, U. 1982.
"Essential charged amino acid in the binding of fibronectin to gelatin."
Biochem. J. 201: 1-8.

00537 Boughton, B.J. ; Simpson, A.W. 1984
"The Biochemical and functional Heterogeneity of circulation Human Plasma Fibronectin".
Biochem. Biophys. Res. Commun. 119 (3): 1174-1180.

00538 Bruce, J.A. 1974.
Auophryxus Malindiae gen. nov., Sp. nov.
A Hemiarthrinid bopyrid parasitic upon the pontoniinid shrimp corlliocaris superba (Dana)".
Parasitology. 68: 127-134.

00539 Yamada, K. M.; Olden, K. 1978.
"Fibronectins-Adhesive glycoproteins of cell surface and blood."
Nature, 275:179-184.

00540 Rosenberg G.G. 1980.
Filmed observations of filter feeding in the marine planktonic copepod Acartia clausii
: Limnol. Oceanogr. 25(4) 738-142.

00541 Zooplankton sheets. Copenhague
Coaseil International pour Exploration Dela Mer. 119:57-1983. 212p.

00542 Fretter, V. 1970.
"Prosobranchin: vellgev larvae of Taerioglossa and s stecioglossa",
Fich. Ident. Zooplakton. 129/132. 6p.

00543 Wells, J.B. 1970.
Fich. Ident. Zooplakton, 133: 7p.

00544 Morrow, J.E. 1954.
Fishes from East Africa with new records and descriptions of two new species".
Ann. Mag. Nat. Hist. (12) 7: 797-820.

00545 Dales, R.P. 1963.
"Pelagic polychaetes from waters off the coasts of Kenya and Tanganyika."
Ann. Mag. Nat. Hist. (13) 6: 501-503.

00546 Sims, H.W. 1965.
"Notes on the Occurence of prenaupliosoma larvae of spiny lobsters in the plankton".
Bull. Mar. Sci. 15(1): 223-227.

00547 Wood, E.J.F. 1965.
"Protoplankton of the Benguela Guinea current region.
Bull. Mar. Sci. 15(2): 475-479.

00548 Nielsen, C. 1965.
"Four new species of pogonophora from the Atlantic Ocean off Southern Florida".
Bull. Mar. Sci. Vol. 15(4): 964-986.

00549 Job, T.J.; Pantulu, V.R. 1953.
Fish trapping in India.
J. Asiatic. Soc. Sci. XIX (2): 175-196.

00550 Longhurst, A.R. 1975.
The food of the demersal fish of a west African estuary.
J. Anim. Ecol. 26: 369-387.

00551 Crass, R.S. 1969.
The effects of land use on freshwater fish in south Africa, with particular reference to Natal
Hydrobiologia, 34(1): 38-56.

00552 Chutter, F.M. 1969.
The effects of silt and sand on the invertebrate fauna of stream and Rivers.
Hydrobiologia, 34(1)L 57-76.

00553 Crass, R.S. 1969.
The effects of land use on freshwater fish in south Africa, with particular reference to Natal.
Hydrobiol. 34(1): 38-56.

00554 Edwards, D. 1969.
Some effects of siltation upon aquatic macropyte vegetation in Revers.
Hydrobiol. 34 (1): 29-37.

00555 Roberts, D. 1975.
Differential uptake of endosulfan by the tissue of mytilus idulis.
Bull. Environ. Contam. Toxicol., 13(2): 170-176

00556 Koeman, J.H.; Rijksen, H.D.; Smies, M. 1971.
Faunal changes in a swamp habbitant in Nigeria sprayed with insecticide to exterminate glossina. Netherlands Journal of Zoology.
21 (4): 434-463.

00557 Kabarova, Y.G. 1968.
Primary production of northern part of the Indian Ocean. Oceanology, 8: 214 -255.

00558 Aquatic, Science Abstacts-Prints Summary. 20p.

00559 Walter, H.; Steiner, M. 1936.
Die okologie der ost- Afrikanischen mangroven zeitschrift for Botnik, Bd. 30 64-193.
Translation: The elocogy of the East-African mangroves.

00560 De Vlaming, V.L. 1972.
Environmental control of taleost reproductive cycles: a brief review. I Fish biol., 4: 131-140.

00561 Warner, R.R. 1978.
Sexual patterns in the labroid fishes of the western caribbean, 1: The wrasses (Labridae). Smithson contribution to zoology, 254: 1-27

00562 Haury, L.R., Wiebe, P.H., Orr, M.H., Briscoe, M.G. 1983.
Tidally generated high frequency internal wave packets and their effects on plankton in massachutts Bay.
J. Mar. Res., 41: 65-112.

00564 Philander, S.G.H., Delecluse, P. 1983.
Coastal currents in low latitudes with application to the Somali and El Nino currents. Deep sea Res. 30(8): 887-902.

00565 Morgans, G.R., Phillips, B.F., Jall, L.M. 1982.
Stock and recruitment relation-ships in Panulirus cygnus, the commercial rock (spiny) lobster on western Australia.
Fish. Bull. 80 (3): 475-486.

00566 Copra, B. 1923.
Bopyrid Isopods parasitic on Indian decapoda Macrura.
Rec. of the Ind. Museum. XXV: 411-550.
P/S.XI-XXI (1923).

00567 Chopra, B. 1930.
Further notes on bopyrid Isopods parasitic on Indian decopoda macrura. Rec.
Rec. Ind. Mus. XXXII: 113-147.

00568 Koeman, J.K., Pennings, J.H. 1970.
An orientational survey on the side effects and environmental distribution of insecticides used in tsetse-control in Africa.
Bull. Environ. Contam. Toxicol. (U.S.A.) 5 (2): 164-170

00569 Crocos, P.J., Kerr, J.D. 1983.
Maturation and spawning of the banana prawn penaeus Merguiensis de man (Crustacea Penaeidae) in the gulf of Carpentaria, Australia.
J. Exp. Mar. Biol. Ecol. 69:37-59.

00570 Alvarino, A. 1965.
Chaetognaths.
Oceanogr. Mar. Biol. Ann. Rev. 3:115-194.

00571 Achutha Kutty, C.T., Nair, Madhupratap. M., Nair, V.R., Nair, S.R.S., Rao, T.S.S. 1980.
Zooplankton biomass and composition in the western Bay of Bengal during late S.W. Monsoon.
Indian J. Mar. Sce. 9:201-206.

00572 Dussart, B.H. 1984.
Some crustacea copepods from Venezuela.
Hydrobiol. 113: 25-67.

00573 Dussart, B.H., Fenando, C.H., Matsumura-Tundisi, T., Siel, R.J. 1984.
A review of systematics, distribution and ecology of tropical freshwater zooplankton.
Hydrobiol. 113: 77-91.

00574 Zalkina, A.V. 1970.
Vertical distribution and diurnal migration of some cyclopoida (Copepoda) in the tropical region of the Pacific Ocean.
Mar. Biol. 5: 575-282.

00575 Jacobs, J. 1968.
Animal behaviour and water movement as co-determinates of plankton distribution in a tidal system.
Sarsia, 34: 355-369.

00576 Sameoto, D.D. 1975.
Tidal and diurnal effects of zooplankton sample variability in a near shore marine environment.
J. Fish. Res. Biol. Canada, 32: 347-366.

00577 Hairston, N.G. Jr. 1981.
The interaction of salinity, predators, light and copepoda cobor.
Hydrobiol. 81: 151-158.

00578 Miller, C.B. 1970.
Some environmental consequences of vertical migration in Marine Zooplankton.
Limnol. Oceanogr. 15: 727-741.

00579 Williams, R.; Conway, D.V.P. 1980.
Vertical distribution of calnus firmarchivus and helgolandicus (Crustacea).
Mar. Biol. 60: 57-61.

00580 Tanaka, O. 1956.
The pelagic copepods of the Izn region middle Japan: systematic account 1-11.
Publ. Seto. Mar. Biol. Lab. V(2&3)

00581 Gagnon, M. ; Lacroix, G. 1981.
Zooplankton sample variability in a tidal estuary: an interpretative model.
Limnol. Oceanogr. 26(3): 401-413.

00582 Rogers, H.M. 1940.
Occurence and retention of plankton within an estuary.
J. Fish. Res. Bd. Can: 5: 164-171.

00583 Wiebe, P.H. 1971.
A computer model of zooplankton patchiness and effe... ects on sampling error.
Limnol. Oceanogr. 16(1): 29-37.

00584 Wiebe, P.H. 1972.
A field investigation of the relationship between length of tow, size of net, and sampling error.
J. Cons. Int. Explor. Mer. 34(2): 268-275.

00585 Rippingale, R.J. 1981.
The ecology of plankton fauna in saline river pools. Hydrobiol. 82: 223-231.

00586 Walker, L.M. 1981.
Reproductive biology and development of a a marine harpacicoid copepod. reared in the laboratory.
J. Crust. Biol. 1(3): 376-388.

00587 Runge, J.A. 1980.
Effects of hunger and season on the feeking behavior of Calanus pacificus.
Limnol. Oceangr. 25(1): 134-145.

00588 Checkley, D.M. Jr. 1980.
The egg production of a marine planktonic copepod in relation to its food supply: laboratory studies.
Limnol. Oceanogr. 25(3): 430-440.

00589 Lance, J. 1963.
The salinity tolerance of some estuarine planktonic copepods.
Limnol. Oceanogr. 8: 440-449.

00590 Ketchum, B.H. 1954.
Relation between circulation and plankton populations in estuaries.
Ecol. 35(2): 191-200.

00591 Mullin, M.M. 1969.
Production of zooplankton in the ocean.
Oceanogr. Mar. Biol. Ann. Rev., 7: 293-314.

00592 Verheye, H.M., Dumont, H.J. 1984.
The calanoid copepods of the nile system.
Hydrobiologia, 110: 191-212. Keywords: Sudan: Calanoida: Copepoda: taxonomy biogeography: Africa, Nile.

00593 Tande, K.S., Gronvik, S. 1983.
Ecological investigations on the zooplankton community of Balsfforden, northern Norway, sex ratio and gonad maturation cycle in the copepoda metridia longa (lubbock).
J. Exp. Mar. Biol. Ecol. 71: 45-54

00594 Uye, S. 1982.
Seasonal cycles in abundance of major holozooplankton in the innermost part of onagawa Bay Northeast Japan.
J. Fac. Appl. Biol. Sci. Hiroshima Urino 21: 1-10

00595 Uye, S., Iwa, Y., Kasahara, S. 1983.
Growth and production of the inshore marine Copepod psedodiaptomus marinus in the central part of the Inland sea of Japan.
Mar. Biol. 73: 91-98.

00596 Thorrington-Smith, M. 1970.
Some new and little known phytoplankton forms from the west Indian Ocean.
Br. Phycol. J. 5(1): 51-56.

00597 Rippingale, R.J. 1981.
The ecology of plankton fauna in Saline river pools.
Hydrobiologia, 82: 223-231.

00598 Williams, R., Conway, D.V.P. 1984.
Vertical distribution, and Seasonal and diurnal migration of colanus helgolandicus in the ceotic sea.
Mar. Biol. 79: 63-73.

00599 Achuthankutty, C.T., Madhupratap, M., Nair, V.R., Nair, S.R.S., Rao, T.S.S.
Zooplankton biomass and composition in the western Bay of Bengal during late S.W. monsoon Indian .
J. Mar. Sci. 9: 201-206.

00600 Youngbluth, M.J. 1980.
Daily seasonal and annual fluctuation among zooplankton population in an unpolluted tropical embyment.
Estuarine and coastal Marine Science 10: 265-287

00601 Ferrar., F.D., Bowman, T.E. 1980.
Pelagic copepods of the family Oithonidae (cycloroida) from the east coast of central and South America.
Smithsonian Contribution to Zoology no. 312: 1-27

00602 Soltanpour- Gorgar., A., Hellershaus, S, 1984.
Eurytemora affinis the estuarine plankton copepod in the weser. Veroff Inst.
Meeresforsch. Brmerh, 20: 103-117.

00603 Fernando, C.H., Rajapaksa, O. 1983.
Some remarks on long-term on long-term and seasonal changes in the zoo lankton of Parakrama Samudra. In. Limnology of Parakrama Samudra- Sri-lanka (edited by F. Schiemd).
The Hague, Dr. W. Junk Publishers: 77-84

00604 Malone, B.J., Mcqueen, D.J. 1983.
Horizontal patchiness in zooplankton populations in two ontario kettle lakes.
Hydrobiologia, 99: 101-124.

00605 Thorrington-Smith, M. 1970.
Some new and little known phytoplankton forms from the west Indian Ocean.
Br. phcol. 5: 51-56.

00606 Krishnamoorth , Abdullah. H.K. Gadkari, A. 1978.
Biological Indicaters of pollution.
Pro. Indian natn. Sci. Acad. Vol. 44, Part B, 98-110.

00607 Huytley, ., Strong, K.W., Dengler, A.T. 1983
Dynamics and community structure of zooplankton in the Davis strait and northern labrador sea.
Arctic 36 (2): 143-161.

00608 Turner, J.T. 1982.
The annual cycle of zooplankton in a long Island estuary.
Estuarine 5(4): 261-274.

00609 Wyngaard, G.A., Elmore, J.L., Cowell, B.C. 1982.
Dynamics of a subropical plankton community with emphasis on the copepod mesocyclops edax.
Hydrobiologia, 89: 39-48.

00610 Sale, P.F., Mcwilliam, P.S., Anderson 1976.
Composition of the near-feef zooplankton at Heron Reef, Great Barrier Reef.
Mar. Biol. 34: 59-66.

00611 Blinova, Y.I. 1968.
Species composition and vertical distribution of seaweeds in penzhinsaya Guba the sea of (Okhotsk).
Oceanology, 8: 225-231.

00612 Geynrikh, A.K. 1968.
Seasonal phenomena in the plankton of the northeast Pacific ocean.
Oceanology, 8: 231-255.

00613 Aquatic Sciences and Fisheries Abstracts;
Part 1 Biological sciences and Living resources;
Volume 15 number 1 1985.
Abstracts 1-2500.

00614 Lehri, G.K. 1969.
Cyclical changes in the ovary of the catfish Clarias batrachus (Linn.).
Acta. Anat., 69: 105-124.

00615 Mackinnon, J.C. 1972.
Summer storage of energy and its use for winter metabolism and gonad maturation in American plaice (Hippoglossoides platessoides).
J. Fish. Res. Bd. Canada 29: 1749-1759.

00616 Wootton, R.J. 1974.
The inter-spawning interval of the female three-spined stickleback, Gasterosteus aculeatus
Zool., Lond. 172:331-342.

00616 Griffiths, C.L., King, J.A. 1979.
Energy expended on growth and gonad output in the Ribbed mussel anlacomya ater.
Mar. Biol. 53: 217-222.

00618 Payne, A.I. 1975.
The reproduction cycle condition and feeding in Barbus liberiensis atropical stream-dwelling cyprinid.
J. Zool., Lond. 176: 247-269.

00619 Van Handel, E. 1965.
Estimation of glycogen in small amounts of tissue.
Anal. Biochem. 11: 256-265.

00620 Cassie, R.M. 1968.
Sample design, Zooplankton sampling.
Mon. Oceanogr. Method. UNESCO.(Idris) 2: 105-121

00621 Danse, F. 1964.
On the vertical distribution of zooplankton in the sea.
Preg. Oceanogra. 2: 55-125.

00622 Platt, T., Brawn, V.M., Irwin, B. 1969.
Caloric and carbon equivalents of zooplankton biomass.
J. Fish. Res. Bd. Canada 26(9): 2345-2349.

00623 Rothlisberg, P.C., Jackson, C.J. 1982
Temporal and spatial Variation of plankton abundance in the Gulf of carpentaria Australia 1975-1977.
J. Plankton Res. 4(1): 19-40.

00624 Goswami, S.C., Singbal , S.Y.S. 1974.
Ecology of Mandovi and Zuari estuaries: plankton community in relation to hydrographic conditions during monsoon months, 1972. Indian J. Mar. Sci,. 3:51-57.

00625 Kimor, B., Wood, E.J.F. 1975.
A plankton study in the eastern mediterranean sea.
Mar. Biol. 29: 321-333.

00626 Emery, A. R. 1968.
Preminary observations on coral reef plankton
Limnol. Oceanog. 13:293-303.

00627 Carpenter, E.J.; Anderson, S.J.; Pedk, B.B. 1974.
Copepod and chlorophyll a concentrations in receiving waters of a nucle r power station and problems associated with their measurement.
Esturine and Coastal Marine Science 2:83-88.

00628 Reeve, M.R. 1970.
Seasonal changes in the zooplankton of South Biscayne Bay and some problems of assessing the effects on the zooplankton of natural and artificial thermal and other fluctuations.
Bull. Mar. Sci. 20(4):894-921.

00629 Sournia, A. 1970.
A checklist of planktonic diatonis and dinoflagellates from the mozambique channel.
Bull. Mar. Sci. 20(3): 678-696.

00630 Jeffries, H.P. 1964.
Comparative studies on estuarine zooplankton.
Limnol. and Oceanogr. 9:348-358.

00631 Humphreys, W.F. 1979.
Production and respiration in animal populations.
J. Animal Ecol. 48: 427-453.

00632 Dunbar, M.J. 1960.
The evolution of stability in marine environments natural selection Amer. Natur. XCIV (875):129-136.

00633 Mann, K. H. 1965.
Energy transformations by a population of fish in the River Thames. J. Animal Ecol. 34:253-275.

00634 Alverson, D.L.; Longhurst, A.R.; Gulland, J.A. 1970.
How much food from the sea. Science 168: 503-505.

00635 McLaren, I.A.; 1974.
Demographic strategy of vertival migration by a marine copepod.
Amer. Natur. 108:91-102.

00636 Mclaren, I.A. 1974.
Demographic strategy of vertical migration by a marine copepod.
Amer. Natur. 108: 91-102.

00637 Bryan, J.R., Riley, J.P., Williams, P.J. LeB. 1976.
A winkler procedure for making precise measurements of oxygen concentration for productivity and related studies.
J. exp. Mar. Biol. Ecol. 21: 191-197.

00638 Vinogradov, M.E., Krapivin, V.F., Menshutkin, V.V., Fleyshman, B.S., Shushkina, E.A. 1973.
Mathematical model of the functions of the pelagial ecosystem in tropical regions (from the 50th Voyage of the R/V).
Vityaz. Oceanology 13: 704-717.

00639 Schaefer, M.B. 1965.
The potential harvest of the sea.
Trans Amer. Fish. Soc. 94(2): 123-128.

00640 Welch, E.B., Isaac, G.W. 1967.
Chlorophyll variation with tide and with plankton productivity in an estuary.
J. Water Poll. Cont. Fed. 39: 360-366.

00641 Webb, K.L., D'Elia, C.F. 1980.
Nutrient and oxygen redistribution during a spring neap tidal cycle in a temperature estuary.
Science. 207: 983-985.

00642 Ryther, J.H. 1969.
Photosynthesis and fish production in the sea, the production of organic matter and its conversion to higher forms of life vary throughout the world ocean.
Science 166: 72-76.

00643 Laws, E.A. 1975.
The importance of respiration losses in controlling the size distribution of marine phytoplankton.
Ecology 56: 419-426.

00644 Mann, K.H. 1969.
The dynamics of aquatic ecosystems.
Adv. Ecol. Res. 6: 1-81.

00645 Gnaiger, E, ; Gluth, G., Wieser, W. 1978.
pH fluctuation in an intertidal beach in Bermunda.
Limnol. Oceanogr. 23(5): 851-857.

00646 Banse, K. ; Mosher, S. 1980.
Adult body mass and annual production/biomass relationships of field populations.
Ecol. Monogr., 50(3): 355-379.

00647 Newell, R.I.E.; Jordan, S.J. 1983.
Preferential ingestion of organic material by the American oyster crssostrea virginica. Mar. Ecol. Prog. ser., 13:47-53.

00648 Conley, R.F. ; Bundy, W.M. 1958.
Mechanism of gypsification.
Geochimica Cosmochimica Acta, 15: 57-72.

00649 Bunge, C.A. 1984.
Potential and reality at the reference desk: reflections on a return to the field.
Journal of Academic Librarianship. 10(3): 128-133

00650 Bonn, G.S. 1974.
Evaluation of the collection.
Library Trends, 22(3): 265-304.

00651 Cheng, C-C. 1974.
How do scientists meet their information needs? Special Libraries 65(7): 272-280.

00652 Piermalti, P.A. ; Bolles, S.W. 1980.
Planning online search service in a state university.
Science & Technology Libraries, 1(1): 47-50

00653 Tregouboff, G.; Rose. M. 1957.
Manuel de Planctonogie Mediterraneenne. Paris.
Centre National de la Recherche Scientifique
2 Vols. 805pp.

FROM: Librarian　　　　TO: Prof. Polk - Director KBP

REF: KMF/PUB/13/119　　　　DATE: 29th July 1986.

SUBJECT: LITERATURE RECEIVED UNDER THE AVSPICES OF KBP

Attached is a list of literature we have received between March and July 1986 from L.U.C. and Free University of Brussels in Belgium. A total of 139 (2785 pages) articles have been received.

JKMwobobia

J.K. Mwobobia

Librarian .

JK/et.

00654 Teas, H.J. ed. 1984.
Physiology and management of Mangroves. The Haque
W. Junk, 106p.

00655 Por, F.D., Dor, I. ed. 1984.
Hydrobiology of the mangal: the ecosystem of the
mangroves forests. The Hague; W. Junk, 264p.

00656. Ditlev, H. 1980.
A field - guide to the reef-building corals of
the Indo-Pacific.
Rotterdam: D.W. Backhuys, 291.p.

00657 Marrow, J.E. 1954.
Data on Dolphin, Yellow fin tuna and little tuna
from East Africa. Copeia (1): 14 - 16.

00658 Hatchell, G.W. 1954.
Sea-fishing on the Tanganyika Coast. Tanganyika
notes and Records: 37: 1-39.

00659 Williams, F. 1970.
The sport fishery for sail fish at Malindi, Kenya,
1958-1968; with some Biological notes.
Bull. Mar, Sci. 20: 830-852.

00660 Merrett, N.R. 1970.
Gonad development in billfish (Istiophoridae)
from the India Ocean.
J. Zool., Lond., 160: 355 - 370.

00661 Williams, F. 1959.
Marlins in British East African Waters.
Nature: 183: 762 - 763.

00662 Bulow, F.J. 1971.
Selection of suitable Tissues for use in the
RNA - DNA ration technique of assessing recent
growth rate of a fish.
Iowa state Journal of Science 46(1): 71 - 78.

00663 Heidinger, R.C., Crawford, S.D. 1977.
Effects of Temperature and feeding rate on the
livr - somatic index of the largemouth Bass,
micropterus salmoides.
J. Fish. Res. Board.Can. 34: 633-638.

00664 Bulow, F.S. 1970.
RNA - DNA ratios as indicators of recent growth rate
rates of a fish.
J. Fish. Res. Board Can. 27: 2345-2349.

00665 Haines, T.A. 1973.
An evaluation of RDA-DNA ratio as a measure of long-term growth in fish populations.
J. Fish. Res. Board Can. 30: 195 - 199.

00666 Gorbunova, N.N. 1969.
Breeding grounds and food of the larvae of sword fish (XIPHIAS GLAIUS Linne)
Probl Yehrhyoe (Voprosy lehriol) 9: 375-387.

00667 Cadwallader, P.L. 1975.
The food of the New Zealand common River Galaxias, Galaxias Vulgaris stokell (Pisces: Solmoniformes)
Aust. J. freshw. Res. 26: 15-30.

00668 Morgans, J.F.C. 1962.
Ecological Aspects of Demersal Tropical fishes off East Africa. Nature: 193- 86-87.

00669 Mclaren, L.A. 1963.
Effects of temperature on growth of zooplankton and the adaptive value of vertical migration.
J. Fish. Res. Bd. Canada, 20: 685-727.

00670 Allen, K.R. 1971.
Relation between production and Biomass.
J. Fish. Res. Bd. Can. 28: 1573-1589.

00671 Barnes, H. 1956.
BALANUS BALANOIDES (L)
In the development and Annual variation of the larval population, and the causative factors.
J. Anim. Ecol. 25: 72 - 84.

00672 Black Burn, M., Laurs, R.M., Owen R.W., Zeitzschel, B. 1970.
"Seasonal and areal changes in standing stocks of phytoplankton, Zooplankton and Micronekton in the eastern tropical pacific".
Mar. Biol. 7: 14 - 31.

00673 Kuttyamma, V.J.,,Kurian, C.V. 1982.
Distribution of post larvae of marine prawns in the southwest coast of India.
Indian J. Mar. Sci. 11: 270 - 272.

00674 Hassan, H. 1974.
"A generic Key to the Penaied Larvae of Pakistan.
Agri. Pak. 25: 227-236.

00675 Vinogradov, M.E.; Gitelzon, I,I; Sorokin, Y.I. 1970.
"The vertical structure of a pelagic community in the tropical Ocean".
Mar. Biol. 6: 187-194.

00676 Mullin, M.M.; Brooks, E.R., 1970.
Growth and metabolism of two planktonic, marine copepods as influenced by temperature and type of food. In Marine food chains; ed. J. H. Steele, Oliver and Boyd, Edinburgh P. 74 - 95.

00677 Parsons, T.R., Lebrasseur. R.J. 1970.
The availability of food to different trophic levels in the Marine food chain. In Marine Food chains, ed. J.H. Steele, Oliver & Boyd, Edinburgh, P. 325 - 343.

00678 Hale, H.M. 1952.
"Notes on distribution and night collecting with artificial light".
Trans. Roy. Soc. S. Aust. 76: 70 - 76.

00679 Walsh, J.J. 1971.
"Relative importance of habitat variables in Predicting the distribution of phytoplankton at the ecotone of the Antarctie upwelling ecosytem".
Ecol. Monogr. 41 (4): 291 - 309.

00680 Parsons, T.R., Lebrasseur, R.J., Fulton J.D. Kennedy, O.D. 1969.
"Production studies in the strait of George.
Part II. Secondary production under the Fraser River plume; February to May, 1967."
J. exp. Mar. Biol. Ecol. 3: 39 - 50.

00681 Patten, B.C. 1962.
"Improved method for estimating stability in plankton"
Limnol. Oceangr. 7(6): 266 - 268.

00682 Sheard. K. 1941.
"Improved methods of collecting Marine organisms".
Rec. S. Aust. Mus. 7: 11 - 14

00683 Mullin, M.M., Brooks, E.R. 1967.
"Laboratory culture, growth rate, and feeding behaviour of A planktonic marine copepod"
Limnol. Oceanogr. 12: 657 - 666.

00684 Cook, H.L. 1966.
"A generic key to the protozoean, mysis and post-larval stages of the littoral Penaeidae of the Northwestern Gulf of Mexico".
Fish. Bull. 65(2): 437 - 447.

00685 Macarthur, R.H. 1969.
"Patterns of communities in the tropies".
Biol. J. Linn. Soc. 1: 19-30.

00686 Rothlisberg, P.C. 1982.
Vertical migration and its effect on dispersal of penaeid shrimp in the Gulf of Carpentaria, Australia.
Fish. Bull. 80 (3): 541 - 554.

00687 Voytou, V.I., Dement'yeva, M.G. 1970.
"The Relative Transparency of the Indian Ocean water".
Oceanology 10 (1): 35 - 36

00688 Ganapati, P.N., Radhakrishna, Y. 1958.
"Studies on the polychaete larvae in the plankton off Waitair Coast".
Andhra Univ. Memoirs Oceanogr. 2: 210 - 237.

00689 Braley, R.D. 1984.
"Mariculture potential of introduced oysters saccostrea cucullata tuberculata and Crassostrea eehinata, and a Histological study of Reproduction of C. echinata".
Aust. J. Mar. Freshw. Res. 35: 129 - 141.

00690 Mustafa., S. 1977.
Influence of maturation on the concentrations of RNA and DNA in the flesh of the Catfish. Clarias batrachus.
Trans. Am. Fish. Soc. 106: 449 - 451.

00691 Doodson, A.T. 1954.
"The harmonic development of the tide-generating potential".
Int. Hyd. Review, 31: 37 - 61.

00692 Durako, M.J., Goddard, R.H., Hoffman, W., Lawrence, J.M. 1979.
"Malate and Lactate Dehydrogenase Activities in the pyloric, caeca of Luidia Clathrata (Echinodermata: Asteroidea)".
Comp. Biochem. Physiol. 62B: 127-129.

00693 Zetler, B.D., Cummings, R.A. 1967.
"A Harmonic method for predicting shallow-water t tides".
J. Mar. Res., 25: 103 - 114.

00694 Franco, A.D.S. 1963.
"Harmonic Analysis of the tide by the semi-graphic method".
Int. Hdr. Rewiew, 40(2): 69-97

00695 France, A.D.S. 1965.
Harmaonic Analysis of tides through linear combinations of ordinates.
Int. Hyd. Review, 42(1): 83 - 94..

00696 Horn, W. 1960.
"Some recent appreaches to tidal problems".
Int. Hydr. Review, 37(2): 65 - 88.

00697 Aragnol, A. 1953.
The use of algebraic methods in the harmonic analysis of analysis of tidal observations.
Int. Hydr. Review, 30(2): 103 - 109.

00698 Cartwright, D.E., Catton, D.E. 1963.
"On the fourir analysis of tidal observations".
Int. Hydr. Review, 40(1): 113 - 125.

00699 Doodson, A.T. 1957.
"The analysis and prediction of tides in shallow water".
Int. Hydr. Review, 33: 85 - 126.

00700 France, A.D.S.M. 1964.
"Harmonic analysis of tides for 7 days of hourly observations".
Int. Hydr. Review, 41(2): 109 - 142.

00701 Cartwright, D.E. 1968.
"Aunified analysis of tides and surges round north and East Britain.
Phil. Trans. Ray. Soc. 263A: 1-55.

00702 MacDonald, G.J.F. 1953.
"Anhydrite - Gypsum Equlibrium Relations.
Amer. J. Sci. 251: 884 - 899

00703 Raup, O.B. 1982.
"Gypsum precipitation by mixing seawater Brines".
The American Association of petroleum Geologists Bulletin. 66(3): 363 - 367.

00704 Thayer, G.W., Wissiams, R.B., Prile, J.P. Colby, D.R.
1975. Alarge corev for guantitatively sampling benthos Limnol. Oceanogr. 20: 474 - 480.

00705 Tundisi, J., Tundisi, T.M., Kutner, M.B. 1973.
"Plankton studies in a mangrove Environment".
Int. Rev. Ges. Hydrobiol. 58(6): 925 - 940.

00706 Malley, D.F. 1978.
Degradetion of mangrove leaf litter by the tropical

tropical sesarmid crab.
Mar. Biol. 49: 377 - 386.

00707 Ellington, W.R. 1976.
Lactace dehydrogenase in the longitudinal musele of the sea cucumber.
Mar. Biol. 36: 31-36.

00708 Klinkhammer, G.P., Bender, M.L. 1981.
"Trace metal distributions in the Hudson River estuary".
Estr. Coastl. & Shelf Ser. 12: 629-643.

00709 Farmer, J.G. 1983.
"Metal pollution in marine sediment cores from the west coast of Scotland".
Mar. Envie. Res. 8: 1-28.

00710 Danielsson, L., Magnusson, B.
Westerlund, S. Zhang, K. 1983.
"Trace metal in the Gota River estuary".
Estuarine, coastal & Shelf Sci. 17: 73 - 85.

00711 Teraoka, H., Ogawa, M. 1984.
"Behavior of elements in the Takahashi Japan River Basin".
J. Environ. Qual. 13(3): 453-459.

00712 Somashekar, R.K., Ramaswamy, S.N. 1982.
Research Report.
"Trace metal concentration in the water of River cauvery, Karnataka, India"
Intern. J. Environ. Studies 18: 243-244

*00713 Somashekar, R.K., Ramaswamy, S.N. Arpkal, G.D. 1982.
"Research Report trace metal concentrations of the waters of a south Indian River".
Intern. J. Environ. studies 20: 63-65.

00714 Teraoka, H., Kobayashi, J. 1980.
"Concentration of 21 metals in the suspended solids collected from the principal 166 rivers and 3 lakes in Japan".
Geochem. Jour. 14: 203 - 226.

00715 Presley, B.J., Trefry, J.H., Eshokes, R.F. 1980.
"Heavy metal inputs to Mississippi delta sediments".
Water, Air. & Soil Pollution 13: 481-494.

00716 Norris, R.H., Swain, R., Lake, P.S. 1981.
"Ecological effects of mine effluents on the south Esk River, North-Estern Tasmania".
Aust. J. Mar. freshwater. 32L 165-173.

00717 Lieder, U. 1963. Trace clements in inland waterways
and their significance for inland fisheries.
Deutsense fisheries - zeituria, Raaebeul, 10:106-109.

00718 Ellaway, M. Tart, B.T., Beckett, R. 1982.
"Trace metals in sediments from the Yarra River"
Aust. J. Mar. Freshw. Res. 33: 761 - 778.

00719 Sinex, S.A., Cantillo, A.Y., Heinz, G.R. 1980.
Accuracy of Acid extaction methods for trace
metals in sediments".
Anal. Chem. 52: 2342 - 2346.

00720 Sholkovitz, E.R., Copland, D. 1980.
"The coagulation, solubility and adsorption
properties of Fe, Mn, Cu, Ni, Cd, Co and humic
acids in a river water".
Geochem. et. Cosmochemics 45: 181-189.

00721 White, K.D., LittleBaum, M.E. 1984.
"Statistical comparison of heavy metal concentrations in various Louisiana sediments".
Environ. Monitoring & Assessment 4: 163 - 170.

00722 Lan, T.J. 1982.
"Applications of endrocrinology to fish culture"
Can. J. Fish. Aquat. Sci. 39: 111-137.

00723 Coulter, G.W. 1977.
"Approaches to estimating fish biomass and
potential yield in lake Tanganyika".
J. Fish. Biol. 11: 398 - 408.

00724 Bishai, R.M. 1981.
"Age, growth and maturity of the Nile perch in
Jebel aulyia Reservoir (Sudan)".
Bull. Zool. Soc. Egypt, 30: 15-28

00725 Bishai, R.M. 1975.
"Food and feeding habits of the nile-perch at
Aulyia Reservoir Sudan".
Bull. Zool. Soc. Egypt. 27: 90-97.

00726 Chillappa , S. Chellappa, N.T. 1982.
"Induced breeding of Indian major Carps By
Hypophysation Technique".
Ciencia Cultura 34(3): 354 - 358.

00727 Bertran, K., Bertran, C. 1971.
"The decline of the Dugong".
Aust. Nat. Hist. 146-147.

00728 Tisdell, A.C. 1983.
"Conserving living Resources in third world
countries: Economic and social issues".
Int. J. Environmental. Stud. 22: 11-24.

00729 Lipkin, Y. 1975.
"Food of the Red sea Dugong from Sinai".

Ise. J. Zool. 24(3-4): 81-98.

00730 Marsh, H., Gardner, B.R., Heinsohn, E.G. 1981.
"Present-Day Hunting and distribution of Dugongs in the Welteslay Islands (Queensland) Implications for conservation"
Biol. Conserv. 19(4): 255 - 267.

00731 Marsh, H., Anderson, K.P. 1983.
"Probable susceptibility of Dugongs to capture stress".
Biol. Conserv. 25: 1-3.

00732 Marsh, H., Heinsohn, G.E., Marsh, L.M. 1984.
"Breeding cycle, life history and population Dynamics of the Dugong".
Aust. J. Zool. 32: 767 - 788

00733 Heinsohn, G.E. 1972.
"A study of Dugongs in Northern Queensland, Australia".
Biol. Conserv. 4(3): 205 - 213.

00734 Best, R.C. 1982.
"Seasonal breeding in the Amazonian manatee".
Biotropica 14(1): 76 - 78.

00735 Gallagher, M.D. 1976.
"The Dugong at Bahrain persian (Arabian) Gulf".
J. Bombay. Nat. Hist. Soc. 73(1): 211-212.

00736 Hughes, G.R., Oxley - Oxland, R. 1971.
"A survey of Dugong in and around Antonid Enes Northern Mozambique"
Biol. Consev. 3(4): 299 - 301.

00737 Robineau, R., Rose, J-M. 1982.
"Le Dugong Sivenia En republique de Djibouti".
Biol. Conserv. 24(3): 233 - 238.

00738 Heinsohn, G.E. , Wake, J., Marsh, H., Spain, A.V. 1977.
"The Dugong in the seagrass system".
Aquaculture. 12(3): 235 - 248.

00739 Vermeij, G.J. 1973.
"West Indian molluscan communities in the rocky Intertidal zone: A morphological Approach".
Bull. Mar. Sci. 23(2): 351 - 386.

00740 Icely, J.D., Jones, D.A. 1978.
"Factors Affecting the distribution of the Genus Uca on an East African shore".
Estuar. Coast. Mar. Sci. 6(3): 315-325.

00741 Bruce, N.L. 1981.
"New records of cirolanidae from the Tanzania coast of East Africa".
J. Crustacean. Biol. 1(3): 457-460.

00741 Bruce, N.L. 1981.
"New records of cirolamdae from the Tanzania coast of East Africa".
J. Crustacean. Biol. 1(3): 457 - 460.

00742 Rudman, W.B. 1978.
"A new species and genus of the Aglajide and the evolution of the philinacean opisthobranch molluscs".
Zool. J. Linn. Soc. 62(1): 59-88.

00743 Siebert, M. 1961.
"Atmospheric tide".
Advances in Geopysics.
7: 105-187.

00744 Dixon, A.Y. 1944.
"Notes on certain aspects of the biology of cunopsis and some other cumaceans in the relation to their environment".
J. Mar. Biol. Assoc. U.K. 26: 61-71.

00745 Russell, F.S. 1931.
"The vertical distribution of marine macroplankton."
J. Mar. Biol. Assoc. U.K. 17: 767-784.

00746 Wallace, J.H. 1975.
"The estuarine fishes of the East coast of South Africa".
S.A. Assoc. Mar. Biol. Res. no. 40.

00747 Wallace, J.H., Elst Van der, R.P. 1975.
"The Estuarine fishes of the East coast of south Africa".
S.A. Assoc. Mar. Biol. Res. no.42.

00748 Vinogradou, M.E., Gitelzon, I.I., Sorokin, Y.I. 1970.
"The vertical structure of a pelagic community in the tropical Ocean."
Mar. Biol. 6: 187-194.

00749 Nakamura, R. 1985.
"Aquaculture development in India: A model."
Bioscience 35(2): 96-100.

00750 Sarig, S., David, N. 1984.
"Trends in the Israel Aquaculture".
Eur. Maricult. Soc. Spec. Publ.8:1-6,

00751 Utting, S.D., Helm, M.M. 1985.
"Improvement of sea water quality by physical and chemical pre-treatment in a Bivalve Hatchery."
Aquaculture 44: 133-144.

00752 Hall, G.E. 1985.
"Reservoir fishery research needs and priorities".
Fish. Bull. 10(2): 3-5.

00753 Kron, M.D., Grayer, S., Davidson, A. 1985.
"An Automated method of Ammonia determination for use in Mariculture."
Aquaculture. 44(2): 153 - 160.

00754 Msiska, O.V. Cantrell, M.A. 1985.
"Influency of poultry manure".
Aquaculture 44(1): 67 - 73.

00755 Watson, N.R. 1985.
"Processed piggery waste as a feed material".
Aquaculture 44(3): 167 - 176.

00756 Lam, T.J., Sharma, R. 1985.
"Effects of salinity and thyroxine on larval survival growth and development in the carp".
Aquaculture. 44(3): 201 - 212.

00757 Barker, S.B., Summerson, W.H. 1941.
The colorimetric determination of latic acid in Biological material.
J. Bio. Chem. 138: 535 - 554.

00758 Ellington, W.R., Lawrence, J.M. 1973.
Malic and lactic dehydrogenate activities and rations in regular and irregular echinoids.
Comp. Biochem. Physiol. 45(B): 727 - 730.

00759 Van Isacker, J. 1961.
Generalized harmonic analysis.
Adv. Geophy. 7: 189 - 214.

00760 Taylor, G.I. 1920.
Tidal oscillations in Gulf and rectangular basins.
Phil. Trans. 220: 148 - 181.

00761 Elmgren, R. 1973.
Methods of sampling sublittoral soft bottom microfauna.
Oikos supplement 24: 112 - 120.

00762 Juario, J.V., Duray, M.N., Nacario, J.F.
Almonds, J.M.E. 1984.
Induced breeding and larval rearing experiments with milkfish in the phillippines.
Aquaculture 36: 61 - 70.

00763 Okera, W. 1974.
Morphometrics, condition and gonad developments of E. Africa Bleeker and valencrennes.
J. Fish. Biol. 6: 801 - 812.

00764 Mann, R.H.K. 1973.
Observations on the age, growth reproduction and food of the roach in two rivers in southern England.
J. Fish. Biol. 5: 707 - 736.

00765 De Sylve, S.S. 1973.
Aspects of the reproductive biology of the sprat, in inshore waters of the west coast of Scotland.
J. Fish. Biol. 5: 689 - 705.

00766 Marsh, H., Channells, P.W., Heinsohn, G.E., Mornssey, J.
1982.
Analysis of stomach contents of Dugongs from Querensland.
Aust. Wildl. Res. 9: 55 - 67.

00767 Heinsohn, G.E., Mars, H. , Spain, D.V. 1976.
Extreme risk of mortality to Dugongs from netting operations.
Aust. J. Wildl. Res. 3: 117 - 121.

00768 Anderson, P.K., Birtles, A. 1978.
Behaviour and ecology of the Dugongs, Observation in shoal water and cleveland Bays Queensland.
Aust. Wildl. Res. 5: 1- 23.

00769 Anderson, P.K. 1982.
Studies of Dugongs at shark bay western Australia surface and subsurface observations.
Aust. Wildl. Res. 9: 85 - 99.

00770 Anderson, P.K. 1982.
Studies of Dugongs at shark Bay Western Australia.
Aust. Wildl. Res. 9: 69-84.

00771: Moore, H.B. 1931
The specific identitication of faecal pellets.
J. Mar. Biol. Ass. UK. 17: 359 - 365.

00772 Delsman, H.C. 1926.
Fish eggs and larvae from the Java sea.
Treubia 8: (199 - 211) (395 - 400).

00773 Delsman, H.C. 1930.
Fish eggs and larvae from the Java sea.
Treubia 9: 275 - 286.

00774 Wells, A.L. 1938.
Some notes on the plankton of the thames estuary
J. Anim. Ecol. 7: 105 - 124.

00775 Ventilla, R.F.
Recent development in the Japanese oyster culture Industry.
Adv. Mar. Biol 21: 1- 57.

00776 Ivaneukov, V.N., Gubin, F.A. 1960.
Water masses and hydrochem. of water & south parts.
Trudy. Norsk Gidrofix Just. 22: 27 - 99.

00777 Bertram, G.C.L., Bertram, C.K.R. 1973.
The modern Sivenia: their distribution and status.
Biol. J. Linm. Soc. 5: 297 - 338.

00778 Anderson, P.K. 1981.
The behaviour of the dugong (Dugong Dugon) in Relation to conservation and Management.
Bull. Mar. Sci. 31(3): 640 - 647.

00779 Hudson, B.E.T. 1981.
Interview and aerial survey data in relation to resource Management of the Dugong in Manus province, papua New Guinea.
Bull. Mar. Sci. 31(3): 662 - 672.

00780 Johnstone, I.M., Hudson, B.E.T. 1981.
The Dugong diet: mouth sample analysis.
Bull. Mar. Sci. 31(3): 681 - 690.

00781 Sarig, S. 1984.
Fisheries and fish culture in Israel in 1983.
Bamidgeh 36(4): 95 - 108.

00782 Degani, G.; Dosoretzic, C.; Levanon, D. 1984.
The influence of cow manure on growth rates Oreochromis Aureus and Clarias Lazera.
In Israel small october tanks.
Bamidgeh 36(4): 114 - 120.

00783 Van Ette, A.C.M. ; Shoemaker, H.J. 1966.
Harmonic analyses of tides essential features and disturbing Influences. Special publication no. 2 to Vol. 1 of hydrographic. Newsletter, published by the Netherlands Hydrographer. 39p

00784 Cyrus, D.P.; Blaber, S.J.M. 1983.
The food and feeding ecology of Gerreidae, Bleeker 1859, in the estuaries of natel.
J. Fish. Biol. 22: 373 - 393.

00785 Cyrus, D.P.; Blaber, S.J.M. 1984.
The reproductive biology of Gerrel in Natal estuaries.
J.Fish. Biol. 24: 491 - 504.

00786 Srinivasan, M. 1984.
Biology of chaetognaths of the Estuarine waters of India.
J. Mar. biol. Assoc. India 13(2): 173 - 181.

00787 Chanberlain, R.G.E. 1983.
Somalia development of the national fish factory at Kismayu: a report prepared for the fisheries Development and Training Project (Phase 2). FAO FI: DP/50M/75/008-Field. Doc. 3. -36p. Doc. 3. 36p.

00788 FAO/UNEP 1980.
Report of the adhoc working on Aktisanal fisheries in W.Africa. International Fisheries Development and Management Program Cecaf/Tech/80/28 (En). 11p.

00789 Husan, S.L. 1975.
Fishery statistics of the United States 1975. Fish. Wildl. Serv. 4: 1-30.

00790 Heimsohn, G.E.; Lear, R.L.; Bryden, M.M.; Marsh, H.; Gardener, B.R. 1978.
Discovery of a large population of Dugongs off Brishsue, Australia.
Environmental Conservation 5(2): 91 - 92.

00791 Sewell, R.B.S. 1940.
Copepoda, Harpacticoida.
Brit. Mus. Natr. Hist. The John Murray Exped. 1933 - 34. Sci. Rep., VII(2): 117 - 382 p

00792 De Schepper, L. 1985.
Besctirijving Van de Databank Wetenschappelijke Informatie. Van de Onderzaeksgroep Materiae ifysiku (Description of the Data-base scientific information of the research-group "Material physics"). 152p.

00793 Roberts, J.
Internal gravity waves in the Ocean.
Mar. Sci. 2: 1-31.

Annex 4

Visit of Mr. Beck, Head of the Development / Co-operation Section at the Belgian Embassy in Nairobi, to the "Kenyan - Belgium Cooperation in Marine Sciences" project in Mombasa from December 9 to 13, 1985. K.M.F.R.I.

Proposed Agenda

Monday December 9:	- Arrival 9:35 a.m. - Hotel - 2 p.m. : discussion agenda
Tuesday December 10:	- Trip to Gazi - Discussion on the Oyster culture Departure time will depent on the tides.
Wednesday December 11:	- Trip to Kanamai - Discussion on Seepage Departure time will depent on the tides.
Thursday December 12	- Seminaries on the Kenyan-Belgian Project done by the Kenyan counterparts. - 2:30 p.m. Visit to the Laboratory, the Documentation Centre and the Store room at K.M.F.R.I.
Friday December 13:	- Discussion on the present situation and the perspectives of the project with Mr. Allela, Director K.M.F.R.I.

A. Research

- Regional Centre - Documentation Centre
- Pollution heavy metals
- Mangrove Project
- Algae culture
- Oyster culture
- Project Primary Production (Ms. De Souza)
- Project Secondary Production (Mr. Okemwa - Mrs. Kimaro)
- Project Coral Ecology (Ms. Muthiga)
- Project Seepage (Prof. Van Der Beken)
- Project Geology (Prof. Paepe)
- Diving Centre

B. International Contacts

- State of affairs in the contacts with EEC, UNEP, FAO, UNESCO, Ministry of Wildlife

C. Infrastructure

- Regional Centre - Buildings

D. Varia

- State of affairs in relation to the exhibition on "Oceanography" organised by the French Embassy.

SEMINARS GIVEN BY THE KENYAN COUNTERPARTS ON DECEMBER 11, 19

Library KMFRI, 9:15 a.m.

TOPIC	PRESENTED BY
1. Introductory speech	The Director, Mr.S.O. Allela
2. Literature retrieval	Mrs. Mwobobia
3. Computerisation	Ms. W. Ogaye
4. Effects of seepage on distribution of mangroves and oyster culture	Mr. R. Ruwa
5. Distribution of Macro-algae	Mrs. H. Oyieke
6. Primary Production in creeks	Ms. De Souza
Tea break	
7. Coral reef ecology and importance of creating a diving centre	Ms. N. Muthiga
8. Relevance of short term fellowships	Mr. J. Kazunga
9. Aspects of biology of <u>Siganus</u>	Mr. M. Ntiba
10. Ecology of copepods	Mr. E. Okemwa
11. Biology of zooplankton in Tudor creek	Mrs. M. Kimaro *
12. Conclusion	Prof. Dr. P. Polk

* is on leave, the topic will be presented by Prof. Dr. Polk

ANNEX 5 : INTERNATIONAL CONGRESS ON TROPICAL AQUATIC ECOSYSTEMS

UNESCO 1986

Afternoon Session: Contributed Papers on Current Research 4/10/85

02.00 - 02.20 X

The Dynamic Zonation of Three Neritid Rocky Shore Prosobranchs at the Kenya Coast.

R.K. Ruwa and Victor Jaccarini.
Kenya Marine and Fisheries Research Institute
Mombasa, Kenya.

and

Department of Zoology
University of Nairobi, Nairobi, Kenya.

02.20 - 02.40 X

Changes in the Population Sttucture of a Sea Urchin (Echinometra Mathaei de Blainville) on an Exploited Fringing Reef at Diani Reef, Mombasa.

Nyawira Muthiga and Tim R. Mcclanahan
Kenya Marine and Fisheries Research Institute
Mombasa, Kenya.

and

Friends World College,
Machakos, Kenya.

02.40 - 03.20

Abundance and Exploitation of Small Pelagic Fish in Marine and Fresh Waters of Tanzania.

L.B. Nhwani and D.B.R. Chitamwebwa,
Tanzania Fisheries Research Institute
Dar Es Salaam, Tanzania.

03.00 - 03.20

Massive Fish Kills within the Nyanza Gulf of Lake Victoria, Kenya.

Peter B.P. Ochumba
Kenya Marine and Fisheries Research Institute
Kisumu, Kenya.

03.20 - 03.40

Distribution, Biology and Fishery of the Introduced Fish Procambarus ClarkII Girrard in Lake Naivasha, Kenya.

A. Olouch and M. Litterick
Department of Zoology
University of Nairobi, Nairobi, Kenya.

03.40 - 04.00 X

Fish Yield of Kilifi Coral Reef in Kenya.

Raphael M. Nzioka
Kenya Marine and Fisheries Research Institute
Mombasa, Kenya

04.00 - 5.00 Discussion of Future Aquatic Research Priorities for East Africa.

05.00 Closing Remarks and Adjournment.

THE DYNAMIC ZONATION OF THREE NERITID ROCKY SHORE PROSOBRANCHS AT THE KENYA COAST

by

R. K. Ruwa and V. Jaccarini

Kenya Marine & Fisheries Research Institute, P.O. Box 81651, Mombasa

and

Dept. of Zoology, University of Nairobi, P.O. Box 30197, Nairobi, Kenya

Abstract

The rocky shore Indo-Pacific prosobranch Nerita undata is shown to have a dynamic zonation similar to that of its two co-occurring congeners, N. plicata and N. textilis, and the zonation of the three species is analysed quantitatively. The mean vertical resting position of all three species exhibits a spring-neap cycle, with the animals resting at higher levels (P 0.001) around spring tide days than around neaps. These spring-neap migrations are of larger amplitude during the rough southeast monsoon (SEM) and in exposed situations, than during the calmer northeast monsoon (NEM) and in sheltered situations. N. textilis always rests at a significantly lower position (P 0.001) than the other two species and lies within the upper eulittoral. Though there is always some overlap between the populations of the two higher level species, N. undata and N. plicata, which is more extensive around spring tide days, the mean resting position of N. undata is higher (P 0.001) than that of N. plicata during the SEM. During the NEM they occupy the same zone. These two species exhibit in addition a seasonal monsoon cycle superimposed on the spring-neap movements with the animals resting higher (P 0.001) during the SEM than during the NEM. In more exposed shores all three species exhibit the usual uplift of zonation as compared to more sheltered situations. This uplift is seen only during the rough SEM. Within each species the vertical zonation is related to the size of individuals but in different ways. Downward feeding migrations take place during night ebb tide. Most of the above features can be interpreted as a response to the degree of wave energy.

CHANGES IN THE POPULATION STRUCTURE OF A SEA URCHIN (ECHINOMETRA MATHAE DE BLAINVILLE) ON AN EXPLOITED FRINGING REEF AT DIANI BEACH, KENYA

BY

NYAWIRA A. MUTHIGA AND TIM R. MCCLANAHAN
KENYA MARINE & FISHERIES RESEARCH INSTITUTE,
P. O. BOX 81651, MOMBASA, KENYA
AND
FRIENDS WORLD COLLEGE, P. O. BOX 526, MACHAKOS, KENYA

ABSTRACT

A COMPARISON OF E. MATHAEI DENSITY AND SIZES WAS MADE ON AN INNER REEF LAGOON AND AN OUTER REEF EDGE AT DIANI BEACH, KENYA. E. MATHAEI DENSITY AND AVERAGE LENGTHS WERE SIGNIFICANTLY HIGHER (P < 0.01) IN THE INNER REEF LAGOON (X = 14.2/M2 + 15.8, N = 90; X = 40.8 MM + 7.4; N = 14 RESPECTIVELY) THAN IN THE OUTER REEF EDGE (X = 1.7 + 1.0/M2, N = 60; X = 31.2 MM + 6.7; N = 68, RESPECTIVELY). A COMPARISON WITH DENSITIES AND AVERAGE LENGTHS MEASURED 15 YEARS PREVIOUSLY (KHAMALLA, 1971) SHOWED INCREASES IN THE NUMBERS AND AVERAGE LENGTHS (AVERAGE LENGTH; P < 0.05) E. MATHAEI IN THE INNER REEF AND A DECREASE IN AVERAGE LENGTHS (P < 0.05 IN THE OUTER REEF EDGE. A CORRELATION OF AVERAGE LENGTHS VERSUS WEIGHT = 2.1 X 10-3 Y2.64, R = 0.96; N = 144) INDICATED AN INCREASE IN BIOMASS 424 G/M2 ON THE INNER REEF AND A DECREASE OF 81 G/M2 ON THE OUTER REEF. THE DISTRIBUTION OF E. MATHAEI ALONG THE TRANSECTS CORRELATED SIGNIFICANTLY (R = 0.69; F = 82.2, P < 0.01) WITH PERCENT HARD SUBSTRATE ON THE INNER REEF LAGOON WHERE THE AVERAGE DENSITY OF HARD SUBSTRATE WAS 41% AND NOT ON THE OUTER REEF EDGE WHERE THE HARD SUBSTRATE DENSITY WAS MUCH HIGHER (83%). IT IS SUGGESTED THAT THE POPULATION OF SEA URCHINS I THE INNER REEF LAGOON IS REGULATED PRIMARILY BY BIOTIC INTERACTIONS (COMPETITION AND PREDATION) AND BY PHYSICAL FACTORS (WAVES AND TIDES) IN THE OUTER REEF EDGE. WE ATTRIBUTE THE INCREASED BIOMASSES OF SEA URCHIN IN THE INNER REEF LAGOON TO INCREASED FISHING AND SHELLING WHICH REDUCES COMPETITORS AND PREDATORS OF THE SEA URCHIN.

FISH YIELD OF KILIFI CORAL REEF IN KENYA

BY

RAPHAEL M. NZIOKA

THE FISH YIELD OF KILIFI REEF, WHICH IS ABOUT 4.0 KM2, WAS ESTIMAT FOR THREE YEARS. IT WAS FOUND THAT THE YIELD ON THE REEF RANGED FROM ABOUT 5.07 T/KM2/YEAR TO 12.9 T/KM2/YEAR, WITH A MEAN OF 8.8 T/KM2/YEAR. THE MAJOR GROUPS OF FISH CAUGHT WERE MOSTLY SIGANIDAE, SCARIDAE, LUTJANIDAE, SERRANIDAE, CARANGIDAE, PLECTORHYCHIDAE, SCOMBRIDAE, SPHYREANIDAE AND CAESIODIDAE. THERE WERE MORE FISH CAUGHT DURING THE NORTHEAST MONSOON WHEN THE SEA WAS CALM THAN DURING THE SOUTHEAST MONSOO WHEN THE SEA WAS ROUGH.

Annex 6

NUTRIENTS AND PARTICULATE ORGANIC CARBON STUDY

FREE UNIVERSITY OF BRUSSELS

SEPTEMBER-DECEMBER
1985

JOHNSON M.KAZUNGU

CONTENTS

DETERMINATION OF AMMONIA IN SEAWATER (BERTHELOT REACTION)

A. INTRODUCTION

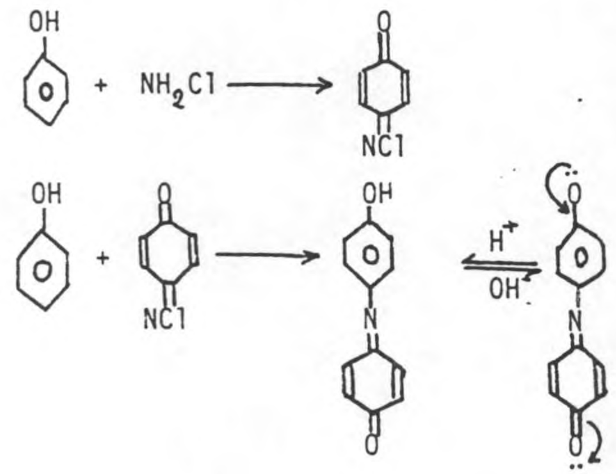
The Berthelot reaction is the name given to the reaction of Ammonium ions and Phenol, wich, under suitable oxidizing conditions, results in the formation of an Indophenol dye. These dyes are highly conjugated and absorb between 620 and 720 nm.

Nature of reaction. (reaction mechanism)

(1) $NH_3 + OCl^- \longrightarrow NH_2Cl$

(2)

(3)



YELLOW BLUE

Reagents.

PHENOLS :

Phenols that undergo the Berthelot reaction normally have an unsubstituted para-position although some Phenols with vacant para-positions may not react if there is steric hindrance from adjacent groups. Other phenolic compounds are sometime used in place o Phenol. However , only Thymol and Sodium salicylate have been found to give somewhat good results comparable to Phenol.

HYPOHALITE SOURCE :

The formation of Monochloramine as the first stage (see the reaction mechanism) is usually achieved in the presence of Hypochlorite.

CATALYSTS :

Sodium nitroprusside is used as a catalyst because it provides a more rapid colour development and a stable colour.

B. ORDER OF ADDITION OF REAGENTS

In most methods the Phenol is added prior to the Hypochlorite and at high concentrati of Hypochlorite, little or no Indophenol is produced if the Hypochlorite is addedfirs At lower concentrations the Hypochlorite can be added first with no loss of sensitivi and this order of reagent addition fits the proposed reaction sequence.

C. REAGENTS PREPARATION

1. De-ionized water.
   Distilled water is passed trough a cation exchange column in the hydrogen form (30 cm. long, 1-2 cm. wide). This water should be prepared fresh for use

2. Phenol-alcohol reagent.
   Dissolve 20 g. of analytical grade Phenol in 200 ml. of 95% v/v Ethyl alcohol.

3. Sodium nitroprusside solution.
   Dissolve 1,0 g. of Sodium nitroprusside; $Na_2[Fe(CN)_5NO]2H_2O$, in 200 ml. of de-ionized water. Strore in a darik glass bottle; the solution is stable for at leas a month.

4. Alkaline reagent.
   Dissolve 100gr. of Sodium citrate and 5 gr. of Sodium hydroxide in 500 ml. of de-ionized water. The solution is stable indefinitely.

5. Sodium hypochlorite solution.
   Use commercially availeble Hypochlorite (e.g." Chlorox") wich should be about 1.

6. Oxidizing solution.
   Mix 100 ml. of reagent 4 and 25 ml. of reagent 5. Keep stoppered while not in use and prepare fresh every day.

D. EXPERIMENTAL PROCEDURE

1. Add 50 ml. of seawater to an erlemeyer flask from a 50 ml. measuring cylinder. Add 2ml. of phenol solution, swirl to mix, and then add in sequence 2 ml. of Nitro-prusside and 5 ml. of oxidizing solution; mix after each addition by swirling the flask.
2. Allow the flask to stand at room temperature (20-27°C) for one hour. The top of the flask should be covered with parafilm during this period. The colour is stabl for about 24 hours after the reaction period.

3. Read the extinction (absorbance) at 640 nm. in a spectrophotometer using a 10 c[m]
(or 1 cm.) cell length.
4. Correct the measured extinction for the reagent blank and calculate Ammonia-nitro[gen]
from a prepared standard calibration graph.

E. DETERMINATION OF BLANK

Carry out the method exactly as derscibed in sections D1 to D3 above using 50 ml. of de-ionized water. Blank extinction, should not exceed about 0.075 on a 10 cm. cell (0.0075 on a 1 cm. cell).

F. CALIBRATION

1. Carry out the calibration with filtered seawater in which the concentration of Ammonia has been reduced by boiling.

2. Dissolve 0.1 g. of a.g. ($NH_4)_2SO_4$ in 1000ml. of de-ionized water . Add 1ml. of Chloroform as a preservative and store in a refrigerator. The solution is stable for many months if well stoppered.

   Concentration = 1500 μg.-at N / L

   For calibration purposes, dilute this stock solution .(using Ammonium-free seawate[r] and prepare working standards with the following concentrations :

   1 μg.-at N/L , 5 μg.-at N/L , 7 μg.-at N/L , 10 μg.-at N/L , 15 μg.-at N/L
   20 μg.-at N/L , 25 μg.-at N/L , 35 μg.-at N/L , 45 μg.-at N/L ,
   55 μg.-at N/L .

RESULTS

CONCENTRATION	ABSORBANCE (ABS)	(ABS - BLANK ABS)
Blank	0.006	
1 μg.-at N/L	0.015	0.009
5 "	0.047	0.041
7 "	0.073	0.067
10 "	0.146	0.144
15 "	0.240	0.234
20 "	0.331	0.325
25 "	0.410	0.404
35 "	0.593	0.587
45 "	0.761	0.755
55 "	0.840	0.834

Figure 1 shows a graph of Absorbance v/s Concentration. It is clearly indicated that the maximum concentration value which obeys Beer's law is 47.50 μg.-at N/L. From the graph, the linear regression equation is :

$$y = 0.01667\,x - 0.0265$$

This implies that

$$\text{ABSORBANCE} = 0.01667\ \text{CONCENTRATION} - 0.0265 \qquad (\text{I})$$

$$\therefore\ \text{CONCENTRATION} = \frac{\text{ABS} + 0.0265}{0.01667} \qquad (\text{II})$$

Accuracy calculation

Absorbance for the 10 μg.-at N/L solution was 0.140

$$\therefore\ \text{Concentration} = \frac{\text{ABS} + 0.0265}{0.01667}$$

$$= \frac{0.140 + 0.0265}{0.01667}$$

$$= 9.988\ \mu\text{g.-at N/L}$$

$$\text{Accuracy} = \frac{10 - 9.988}{10} \times 100\ \%$$
$$= 0.12\ \%$$

Detection limit calculation

For detection limit calculation, prepare 10 blank samples and run them. Then using the absorbance values, calculate the standard deviation σ. Then multiply the standard deviation by 3. Insert the value 3σ as absorbance in equation (II) and get the corresponding concentration value. This value is the detection limit.

SALINITY EFFECT

To check whether the Berthelot reaction method could be applied in estuary conditions a standard sample of 5 µg.-at N/L was prepared by diluting 1 ml. of the stock solution to 300ml. with artificial seawater of different salinities.

Results :

Concentration	Salinity	Absorbance
1. 5 µg.-at N/L	5‰	0.038
2. "	10‰	0.038
3. "	20‰	0.039
4. "	25‰	0.038
5. "	30‰	0.040
6. "	35‰	0.041
7. "	40‰	0.041

From our results, it appears that salinity difference does not affect our ABSORBANCE values very much. This implies that "salinity effect" can be neglected for Ammonia measurements in estuaries.

SAMPLE STORAGE

It is important that samples for Ammonia determination should be analysed immediatly after collection and stored in glass bottles.

DETERMINATION OF NITRATE

A. Introduction

Nitrate in seawater is reduced almost quantitatively to Nitrite when a sample is run trough a column containing Cadmiun filings coated with metallic Copper. The Nitrite produced is then determined by diazotizing with Sulfanilamide and coupling with N-(I-naphtyl)-ethylenediamine to form a highly coloured azo dye which can be measurec spectrophotometrically. Any Nitrite initially present in the sample must be correcte for.

Possible suggested equations for the diazotization and coupling of the reaction.

$$NH_2SO_2C_6H_4NH_2{\cdot}HCl \; + \; HNO_2 \longrightarrow NH_2SO_2C_6H_4N{\equiv}NCl \; + \; 2H_2O \qquad (I)$$

$$NH_2SO_2C_6H_4N{\equiv}NCl \; + \; C_{10}H_7NHCH_2CH_2NH_2.2HCl \longrightarrow \qquad (2)$$
$$NH_2SO_2C_6H_4N{=}NNHCH_2CH_2NH(C_{10}H_7).2HCl \; + \; HCl$$

$$NH_2SO_2C_6H_4N{\equiv}NCl \; + \; C_{10}H_7NHCH_2CH_2NH_2.2HCl \longrightarrow \qquad (2a)$$
$$NH_2SO_2C_6H_4N{=}NC_{10}H_6NHCH_2CH_2NH_2.2HCl \; + \; HCl$$

note : The product of the coupling reaction is not definitely known but equations (2) and (2a) represent possibilities.

Interferences (Reductor column)

The mechanism of reduction must involve the oxidation of Cadmium metal as given in th redox reactions (3) and (4) ;

$$NO^- \; + \; 2H^+ \; + \; 2e^- \; = \; NO_2^- \; + \; H_2O \qquad (3)$$

$$Cd \; = \; Cd^{2+} \; + \; 2e^- \qquad (4)$$

Anything that can change the ultimate rate of electron transfer or the redox potentia of reaction (4) can possibly interfere with the analytical method. Other metal ions and ligands can change the redox potential of (4) and hence possibly decrease or incr the electron availability which could show up as a positive or negative interference in the method. Alternatively inorganic or organic complexing agents can interfere by associating with Cadmium ions formed at al the metal surface, so providing a block to most active reducing sites.

B. METHODOLOGY

For the experimental procedure, refer " A manuel of Chemical and Biological Methods for Seawater Analysis ". By Timothy R. Parsons, Yoshiaki Maita and Carol M. Lalli.

C. RESULTS

Figure 2 shows the calibration graph obtained by plotting concentrations values (µg.-at N/L) of a set of standard Nitrate samples against their absobance values after being reduced in the column. The linearity conforms with Beer's law

D. EFFICIENCY OF THE REDUCTION COLUMN

To check the efficiency of the reduction column, two sets of standard samples (one prepared from Potassium nitrate (KNO_3) and the other from potassium nitrite (KNO_2) both containing the same concentration of nitrogen atom per liter (say 6 µg.-at N/L are made. Since the determination of Nitrate follows the procedure as the determinati of Nitrite once the Nitrate has been reduced. Comparison of the absorbances obtained from the 6 µg.-at $N\text{-}NO_3$/L with those obtained from the 6 µg.-at $N\text{-}NO_2$/L will help one calculate efficienty.

Results :

For the NO_2^-, the mean absorbance for the 6 µg.-at N-NO /L was 0.283.
For the NO_3^-, the absorbance for the 6 µg.-at N-NO /L were;

	Absorbance	% Efficiency	
1.	0.275	97.2%	
2.	0.280	99.0%	
3.	0.273	96.5%	
4.	0.276	97.5%	
5.	0.276	97.5%	96.5%
6.	0.274	96.8%	
7.	0.263	93.0%	
8.	0.277	97.9%	
9.	0.265	93.6%	
10.	0.271	95.8%	

From the above figures, the mean efficiency of the reductor column is found to be about 97%.

E. SAMPLE STORAGE

Samples should be analysed immediately after collection. In case this is difficult, 40 mg./L Mercuric chloride should be used as a preservative. If the preservative is used, then the sample should be analysed with in the first eight hours.

DETERMINATION OF PHOSPHATE

A. Introduction

The concentration of Phosphorus as Phosphate in seawater may range from less than abo 0.01 ùg.-at P/L in surface waters to over 3 µg.-at P/L in deep water. In the upper layers of the sea, the concentration rarely exceeds 1.0 µg.-at P/L and it is in these layers that Phosphate is taken up by the phytoplancton and enters the marine food cha Changes in the Phosphorus content of the seawater may be used as indicators of the water movement and as an index of plant growth and productivity.

In the following Phosphate determination method, the seawater sample is allowed to react with a composite reagent containing Molybdic acid, Ascorbic acid and trivalent Antimony. The resulting complex is reduced to give a blue solution which is measured at 885 nm.

B. SPECIAL REAGENTS

1. Ammonium Molybdate solution.
   Dissolve 15 gr. of analytical reagent grade Ammonium paramolybdate $(NH_4)_6Mo_7O_{24}.4H_2($ in 500 ml. of distilled water. Store in plastic bottle away from direct sunlight. The solution is stable.
2. Sulfure Acid solution.
   Add 140 ml. of concentrated (sp. gr. 1.82) analytical reagent quality Sulfuric acid to 900 ml. of distilled water. Allow the solution to cool and store it in a glass bottle.
3. Ascorbic Acid solution.
   Dissolve 27 gr. of Ascorbic acid in 500 ml. of distilled water. Store the solutio in a plastic bottle frozen solid in the freezer. The solution is stable for many months but should not be kept at room temperature for more than one week.

4. Potassium Antimonyl-Tartrate solution.

Dissolve 0.34 gr. of Potassium antimonyl-tartrate (tartar emetic) in 250 ml. of water, warming if necessary. Store in a glass or plastic bottle. The solution is stable for many months.

5. Mixed Reagent.

Mix together 100 ml. Ammonium molybdate, 250 ml. Sulfuric acid, 100 ml. Ascorbic a and 50 ml. of Potassium Antimonyl-tartrate solution. Prepare this reagent when needed and discard any excess.

C. EXPERIMENTAL PROCEDURE

1. Warm the samples to room temperature (15-30°C). Measure the turbidity of a samp at 885 nm. ; if this value is greater than 0.01, a correction should be applied to the final extinction value (step 4).
2. To a 100 ml. sample, add 10 ml. of mixed reagent using a syringe- type pipette and mix at once.
3. After 5 min. and preferably within the first 2-3 hours, measure the extinction in a 1 cm. cell against distilled water at 885 nm.
4. Correct the extinction with the reagent blank (and turbidity blank if necessary) and get the corresponding Phosphate concentration from a standard calibration grapł (see below).

D. DETERMINATION OF BLANK

Use distilled water in place of a sample and carry out steps 1-3 above to obtain the extinction of the reagent blank. Reagent blanks should be less than 0.002 on a 1 cm. cell.

E. CALIBRATION

Dissolve 0.136 gr. of anhydrous potassium dihydrogen Phosphate, KH_2PO_4, in 1 L of distilled water. Store in dark bottle with 1 ml. of Chloroform ; the solution is stable for many months.

$$\text{Concentration} = 1000\ \mu\text{g-at P/L}$$

From this stock solution prepare standard working samples of 1 µg.-at P/L, 3 µg.-at P/ 5 µg.-at P/L, 7 µg.-at P/L and 10 µg.-at P/L.

With each sample, repeat steps 1-3 of section C. After correction fot the blank reag plot a graph of Absorbance against Concentration (in µg.-at P/L).

Figure 3 shows the calibration graph obtained. Note the linear relationship between the absorbance and the concentration as expected in the Beer's law. By preparing many standards, the linearity range may be found.

F. STORAGE OF SAMPLES

Samples should be analyzed immediately after collection otherwise preserved with Chloroform.

DETERMINATION OF SILICATE

A. Introduction

Many natural waters contain less than 10 mg./L Silica, though some may approach 60 mg./L. A Silica cycle occurs in many bodies of water containing organisms such as diatoms that utilize Silica in their skeletal structure. The Silica removed from the water may be slowly returned by re-solution of dead organisms.
Though there are quite a number of methods for the determination of Silica in seawate the Heteropoly blue method seems to be used the most. In this method, the seawater sample is allowed to react with Molybdate under conditions which result in the formation of Silicomolybdate, Phosphomolybdate and Arsenomolybdate complexes. A reducing solution, containing Ascorbic acid, is than added which reduces the Silicomolybdate complex to give a blue colourand simultaneously decomposes any Phosphomolybdate or Arsenomolybdate. The resulting extinction is measured using a 1 cm. cuvette.

B. SPECIAL REAGENTS

1. Molybdate reagent.
   Dissolve 4.0 g. of analytical reagent quality Ammonium paramolybdate, $(NH_4)_6 Mo_7 O_{24}$ $4H_2O$, in about 300 ml. of distilled water. Add 12 ml. of concentrated Hydrochloric acid (12 N), mix and make to volume of 500 ml. with distilled water. Store the solution in a polyethylene bottle and keep out of direct sunlight.
2. Ascorbic acid.
   Dissolve 17.6 g. of reagent grade quality Ascorbic acid in 500 ml. of distilled water containing 50 ml. of Acetone. Mix and dilute to 1 L. with ditilled water.

3. Oxalic acid solution.

   Prepared saturated Oxalic acid by shaking 50 g. of analytical reagent quality Oxalic acid dihydrate, $(COOH)_2.2H_2O$, with 500ml. of distilled water. Decant the solution from the crystals for use; the solution may be stored in a glass bottle and is stable indefinitely.

4. Sulfuric acid solution 50 % v/v.

   Pour 250 ml. of concentrated Sulfuric acid (sp. gr 1.82) into 250 ml. of distilled water. Cool to room temperature and make the volume to 500 ml. with a little extra water.

5. Reducing reagent.

   Mix 100 ml. of the Ascorbic acid with 60 ml. of Oxalic acid solution. Add slowly with mixing, 60 ml. of the 50 % Sulfuric acid solution and make the mixture up to 300ml. with distilled water. The solution should be prepared each time for immedia use.

C. EXPERIMENTAL PROCEDURE

1. Samples should be at room temperature (18-25°C). Add 10 ml. of Molybdate solutio to a dry 50 ml. graduated cylinder fitted with a glass stopper. Pipette 25 ml. of the seawater sample into the cylinder, stopper and mix by inverting; allow to stand for 10 min. , but not for more than 30 min.
2. Add the reducing reagent rapidly to make 50 ml. and mix immediatly.
3. Allows the solution to stand for 2-3 hours to complete the reaction. Measure the extinction for the blank and read the corresponding Silicate concentration from the standard calibration graph (see below).

D. DETERMINATION OF BLANK

Use distilled water, which has been collected in a polyethylene container, in place of seawater and carry out steps 1 to 3 in section C.

E. CALIBRATION

Standard Silica Solution (Stock Solution)

Weight 1.44 g. of Sodium metasilicate monohydrate, $Na_2SiO_3.9H_2O$, and dissolve in 100 m of distilled water. Dilute to exactly 1000 ml.,mix, and transfer the solution to a polyethylene container for storage. The solution is stable and consist of ;

1 ml. = 5 µg.-at Si

By diluting certain quantities of the stock solution, prepare the working standards of concentrations : 1 µg.-at Si/L , 5 µg.-at Si/L , 10 µg.-at Si/L , 50 µg.-at Si/L and 100 µg.-at Si/L.

Using these working standards, instead of the seawater, repeat steps 1 to 3 of section C. After correcting for the blank reagent plot a graph of absorbance vs. concentratio Figure 4 shows the calibration graph obtained using the above working standard.

DETERMINATION OF PARTICULATE ORGANIC CARBON

A. OUTLINE OF METHOD

The method described is essentially for analysing organic Carbon in sediments. A certain amount of the particulate matter is weighed and put into a 30 ml. beaker. Carbon is then determined by " wet-ashing " with Dichromate and concentrated Sulfuric acid. The decrease in extinction of the yellow Dichromate solution is taken as a measure of the oxidable Carbon.

Range : 10 to 4000 µg.-at C/L

B. SPECIAL REAGENTS

I. Sulfuric acid-dichromate oxidant.

Dissolve 4.84 g. of Potassium dichromate , $K_2Cr_2O_7$, in 20 ml. of distilled water. Add this solution a little at a time to about 500 ml. of concentrated Sulfuric acid (analytical quality grade) in a 1000 ml. volumetric flask. Cool the mixture to room temperature and make to volume with more concentrated Sulfuric acid. Store in a glass-stoppered bottle protected from dust; the solution is stable indefinitely.

2. Phosphoric acid.
   Analytical reagent grade (70%) Phosphoric acid.

C. EXPERIMENTAL PROCEDURE

1. Weigh out about 250 mg. (0.25 g.) of the sample and put it into a 30 ml. beaker.
2. Add 1.0 ml. of Phosphoric acid and 1.0 ml. of distilled water. Mix and place in a block heater at 100-110°C for 30 min., cover with a water glass during this period.
3. Then, add 10 ml. of Sulfuric acid-dichromate oxidant and 4.0 ml. distilled water.
4. Mix by swirling and place a cover glass over each beaker Heat for 60 min. at 100-110°C.
5. Cool the mixture and transfer the solution to a 50 ml. volumetric flask. Rinse the sides of the beaker with distilled water and make the flask up to volume with distilled water. Stopper and mix by inverting; allow to stand at room temperature to cool
6. Measure the extinction of a blank solution against the sample at 440 nm. using a 1-cm. cuvette.
7. Correct the resulting extinction for the absorbance of trivalent Chromium by the expression :

   $E = 1.1\, E_F$, where E_F is the extinction found by difference in 6 above.

   Calculate the particulate Carbon in µg.C/g from the expression :

   $$\mu g\ C/g = \frac{E \times F \times v}{W}$$

   where W is the weight of sample used in grams,
   v is the volume of oxidant used (10 ml.)
   F is the factor as described below.

D. BLANK DETERMINATION

Blank determinations should be carried out exactly as described in steps 2 to 5 above, using 1 ml. of Phosphoric acid , 10 ml. of oxidant and 4 ml. of distilled water. The blank extinction measured against distilled water should be between 1 and 1.1 . The blank should than be used in step 6 , section C above.

E. CALIBRATION

1. Standard Glucose solution.
   Dissolve 7.50 g. of pure glucose and a few crystals of mercuric Chloride, HgCl ,
   in distilled water and fill up to a volume of 100 ml. The solution is stable for many months in the refrigerator but should be discarded if any turbity develops. Dilute 10 ml. of the concentrated solution to 1 L with distilled water.

   1ml. = 300 μg of Carbon

2. Procedure.
   Put 1 ml. of Phosphoric acid into a beaker. Then add 10 ml. of oxidant and 4 ml. of diluted Glucose solution to the beaker. Continue the method as in section C, steps 4 to 7. Calculate the factor F as

   $$F = \frac{120}{Es}$$

   where Es is the average of three standard extinctions corrected for the trivalent Chromium absorption at 440 nm.

F. RESULTS

The following is the result of organic Carbon measurement for a sediment sample coll[illegible]ted near the Kenya Meat Commission (K.M.C.) in the Tudor creek. The core sample w[illegible] sectioned into nine parts and marked A1 to A9. The results are expressed in mg. C p[illegible] gram of sample analysed, (mg.C/g).

CORE SECTION		DEPTH (cm)	CORRECTED ABS	mgC/g
A1	A1	0 - 3.0	0.252	32.58
A2	A2	3.0 - 5.5	0.272	35.17
A3	A3	5.5 - 8.0	0.209	27.07
A4	A4	8.0 - 10.5	0.266	34.39
A5	A5	10.5 - 12.0	0.185	23.92
A6	A6	12.0 - 13.0	0.059	7.63
A7	A7	13.0 - 14.0	0.111	14.35
A8	A8	14.0 - 15.0	0.156	20.17
A9	A9	15.0 - 16.0	0.150	19.40

Average Es = 0.3375

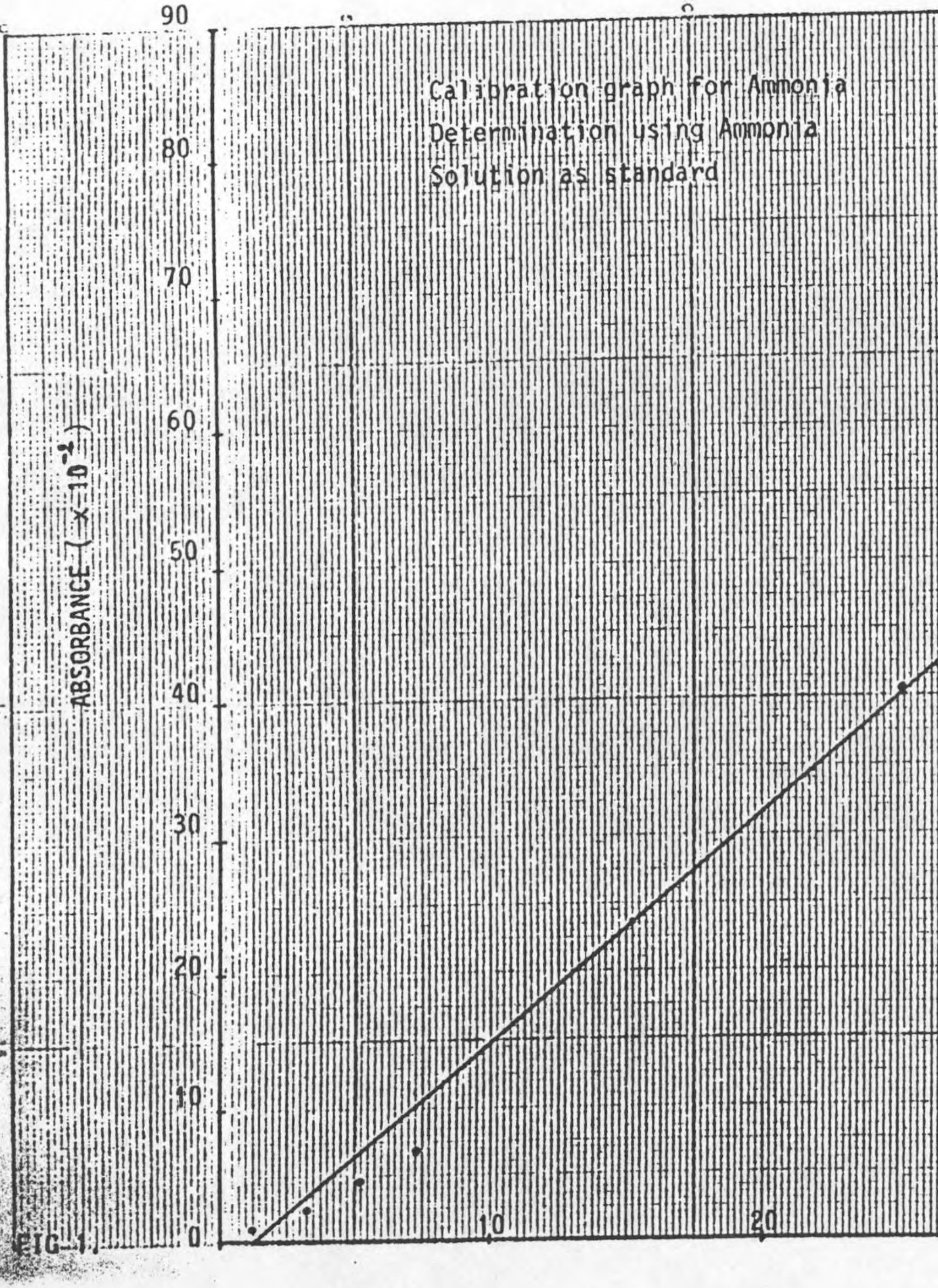
Absorption of blank against distilled water was 0.999

From the results obtained we observe a general decrease with depth of the organic Carbon content. This decrease is mainly due to bacterial degradation.

CONCLUSION

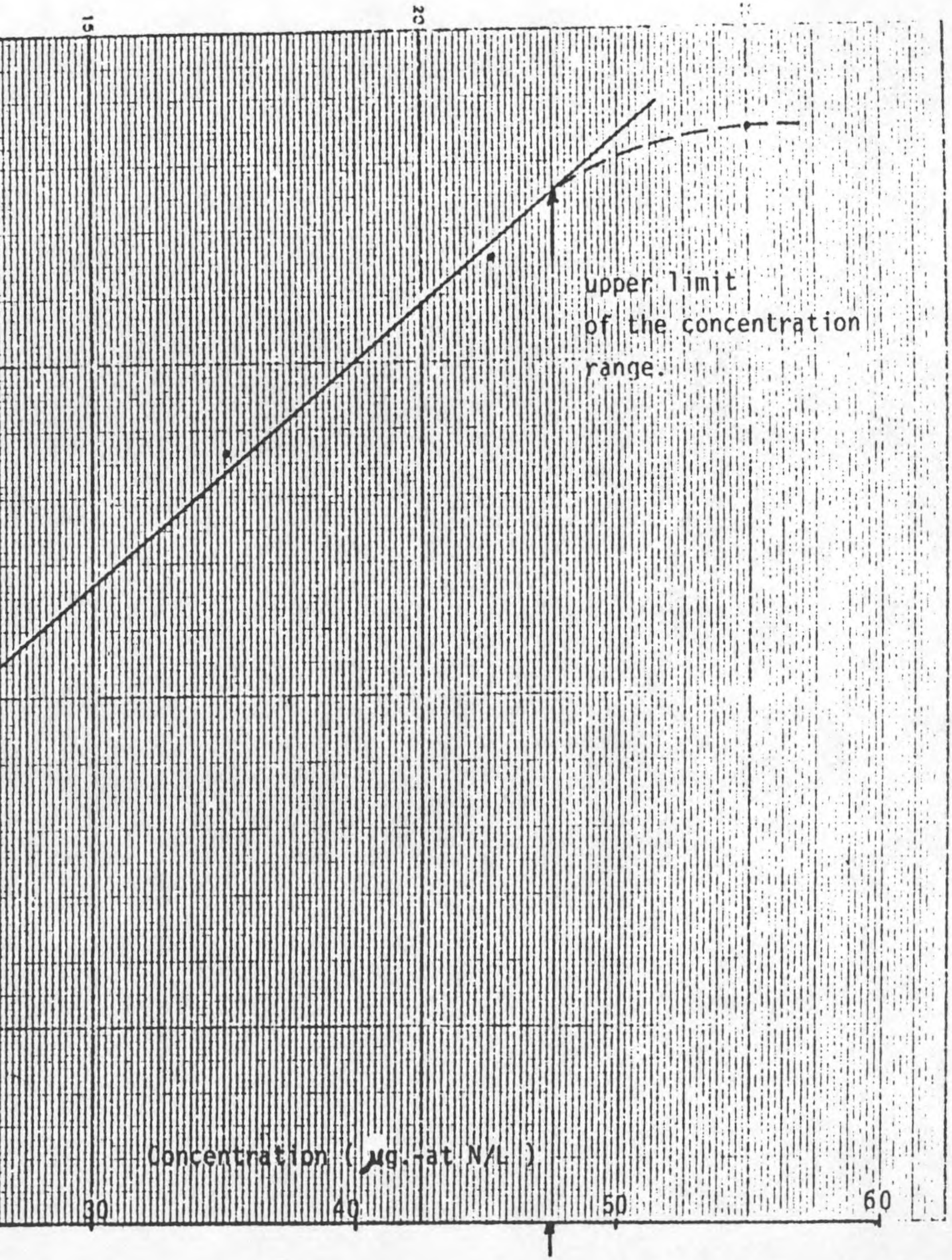
For nutrients analysis, the most difficult part is with sample storage prior to analysis. In most cases samples have to be analysed immediatly after collection. This is usualy difficult due to the number of samples often collected. Freezing of the samples immediately after collection has been found to be the best way for preservir the samples. Sample poisoning is also another way of preserving samples for nutrier analysis. For Ammonia determination, it is recommended that samples should be treat with a 0.49 100 ml^{-1} of Phenol immediately after collection. Samples for Nitrate-Nit determination should be preserved with 40 mg/L mercuric Chloride. Fot Phosphate anc Silicate determinations samples should be preserved with Chloroform and stored in plastic bottles. For proper Nitrate analysis, it is quite important that the effici cy of the reduction column is always above 95%. In case it falls below 95%, then th Cadmium-Copper reductor should be re-activated. For Ammonia determination, we have established that the "salt -effect" is negligible. This implies that the determinat method can also be applied for estuary studies. However for Nitrate-Nitrite determi nations, it is essential that the standard calibration is done, using prepared artif cial seawater.

For the determination of particulate organic Carbon, the most difficult part is the heating stage. A proper temperature of 100°C should be maintained for all the sampl to be analysed. Slight changes of temperature affect very much the colour intensity of the solution making one record wrong absorbance values.



Calibration graph for Ammonia
Determination using Ammonia
Solution as standard
ABSORBANCE (x 10^{-2})
90
80
70
60
50
40
30
20
10
0
10
20

FIG 1.


15
20
upper limit
of the concentration
range.
Concentration (µg.-at N/L)
30
40
50
60

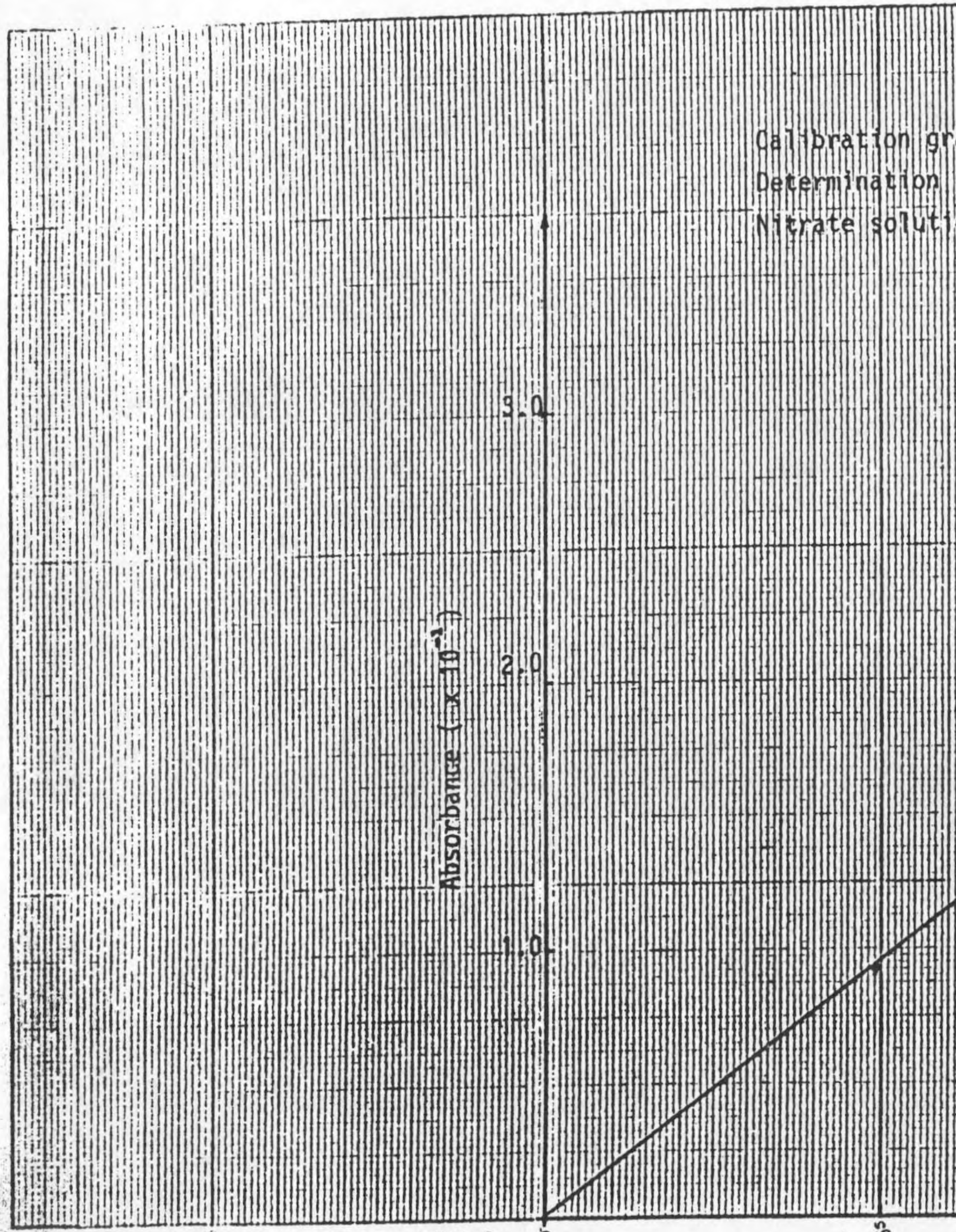
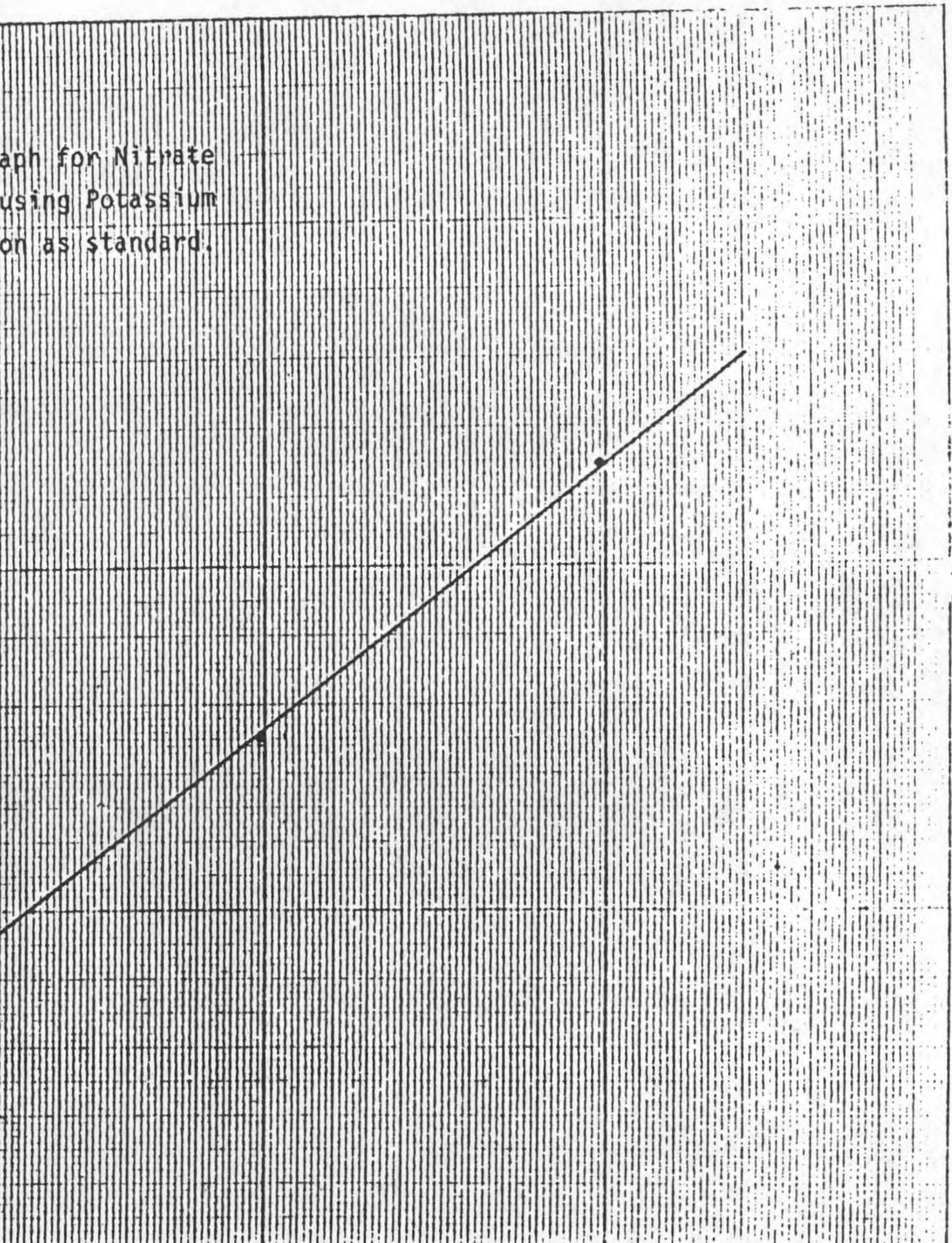
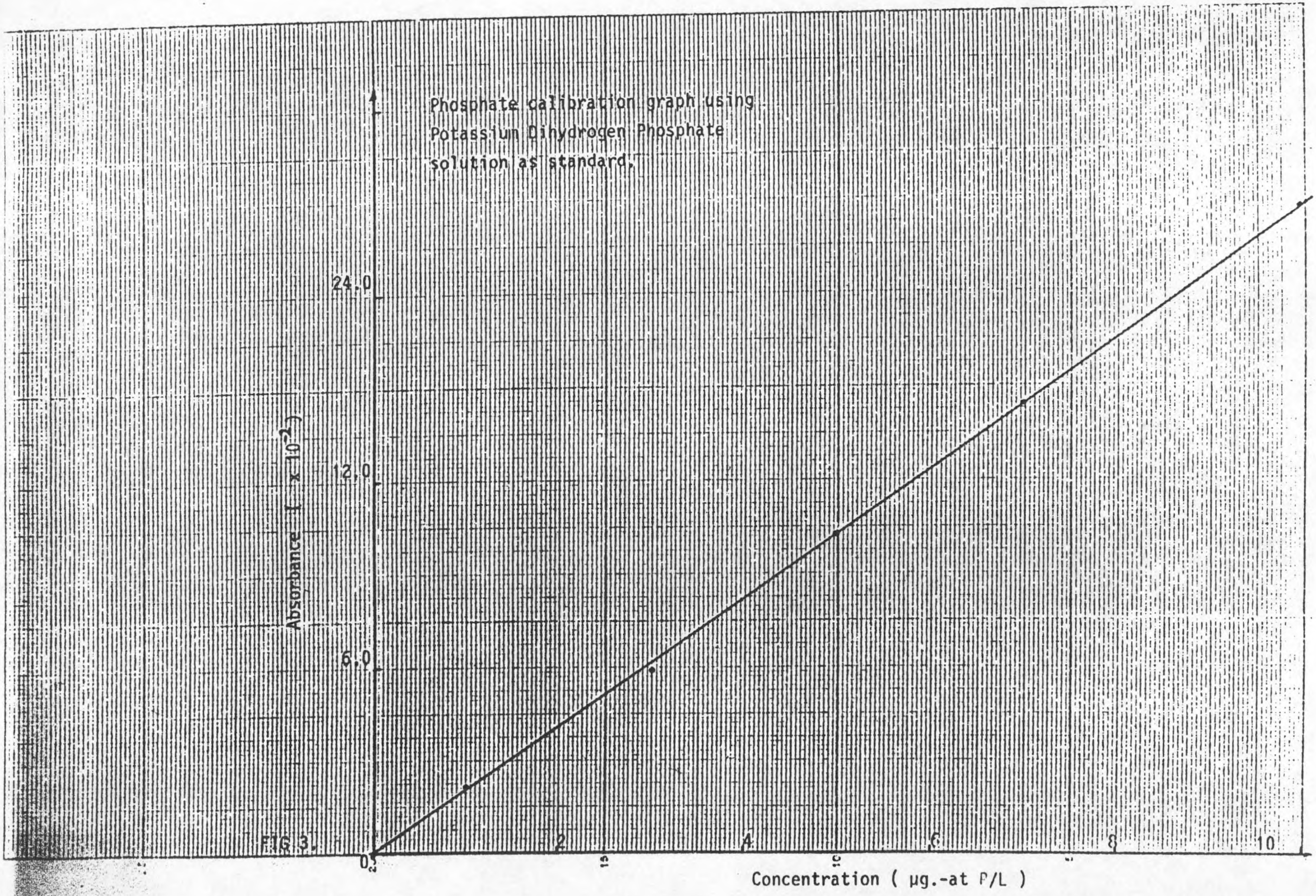

Calibration gr
Determination
Nitrate soluti
Absorbance (x 10^{-1})
3.0
2.0
1.0
0
2

FIG 2.


aph for Nitrate
using Potassium
on as standard.
4
6



Phosphate calibration graph using
Potassium Dihydrogen Phosphate
solution as standard.
Absorbance (x 10^-2)
24.0
12.0
6.0
0
2
4
6
8
10
Concentration (µg.-at P/L)

FIG 3.

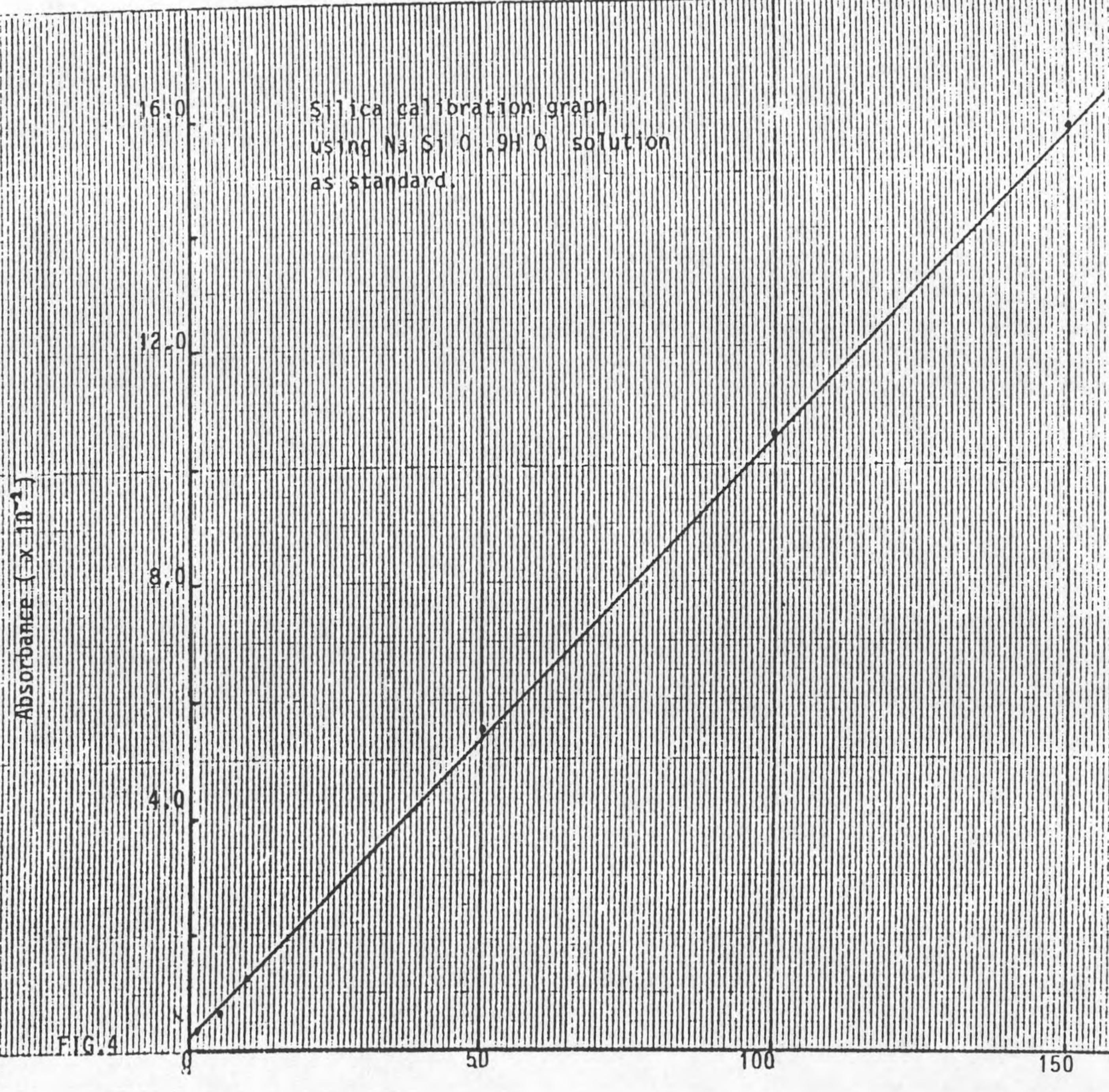

Silica calibration graph
using Na Si O .9H O solution
as standard.
Absorbance (x 10^-1)
16.0
12.0
8.0
4.0
0
50
100
150

FIG.4

ANNEX 7

KENYA - BELGIUM CO-OPERATION PROJECT

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

```
*******************************************
*                                         *
*           PROGRAMME PAYROLL             *
*                                         *
*                                         *
*        U S E R ' S  M A N U A L         *
*        ========================         *
*                                         *
*******************************************
```

copyright 1986 by

Pissierssens P, KMFRI , MOMBASA KENYA
Onyango B.A.H , KMFRI , MOMBASA KENYA

Introduction :

The Program 'Payroll' was written for the Kenya Marine and Fisheries Research Institute staff payroll. It can be used with the following dimensions :

- maximum nr of employees (per disk) : 300
- maximum nr of deductions : 40
- maximum nr of deductions per employee : 15
- maximum nr of banks : 60
- maximum nr of +deductions : 10
- maximum nr of insurance policy per employee : 3
- maximum nr of Insurance companies : 20

P A R T - I

CHAPTER I : **Initiating the program**

After inserting the payroll disk and switching the computer , the program must be initiated : first, the date of the payroll must be entered , (this date can differ from the current date !) followed by the month (in letters), and the name of the station. (Not necessary for Hard Disk version). See fig.1 for the procedure.

```
------------------------------------------------------------
 I N I T I A T E                        ____________STATION
------------------------------------------------------------


 DATE OF PAYROLL (MMDDYY) : ? _______
 MONTH OF PAYROLL (LETTERS) : ? __________
 STATION : ? ________________





____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.1

Note : A part from the bottom line, the _____ indicate where to enter a variable. The next question only appears after the previous variable has been entered, followed by a RETURN.

After entering this information and RETURN, the first menu will appear on the screen (fig 2.) You can choose between 2 options :

1/ Input
2/ Output

- Input contains all the routines which will change the records of the employee, whereas output includes all the reports, payroll and other print-outs.
- If you choose to quit, then the program will be terminated.

Enter the choice as a number from 1 to 3 and press RETURN.

```
-----------------------------------------------------------------
 PAYROLL  M E N U                    SANGORO STATION
-----------------------------------------------------------------



          Make your choice :

                    1/ Input    : Modify variables
                    2/ Output   : Reports and payroll

                    3/ Quit



                    Choice ? : ? _

----MENU---PRINT---------------CHANGE-------------KALKUL--DO--
```

Fig.2

Exercise : enter 1 , then RETURN

Note : Some screens will not be illustrated becaause they are just slight variations of the ones illustrated. After a little practice, you will be at home with them .

CHAPTER II : **Modify**

2.1 Menu

After entering 1, the Modify menu will appear (fig.3). Here you have 11 options :

1/ Update paysheets : to change the information which will be used to calculate the salary .
2/ Update personnel sheets : to change the personal information of the employeee.
3/ Update deductions : to change the label information of the used deductions.
4/ Process records : this will update the unused values in the records . This procedure will be used after the last print-out , every month or before the first updating the following month .
5/ Reset unused values to 0 : this can be used to reset the values of unused to 0 .
6/ Add employee : to add an employee to the file .
7/ Kill employee : to remove an employee from the file .
8/ Transfer employee : to transfer an employee to another station (file) .
9/ Modify salary scales : to change the salary scales .
10/ Modify tax table : to change the tax rates .
11/ Return to main menu : to return to menu (fig.2) .

Enter your choice as a nr from 1 to 11 , and press RETURN .

Exercise : Enter 6 ,then RETURN .

```
 ------------------------------------------------------------
  Modify  M E N U                     SANGORO STATION
 ------------------------------------------------------------

      Make your choice :

          1/ Update paysheets
          2/ Update personnel sheets
          3/ Update deduction variables

          4/ Process records (use before PAYROLL or OPTIONS)
          5/ Reset unused values to 0

          6/ Add employee
          7/ Kill employee
          8/ Transfer employee

          9/ Modify salary scales
         10/ Modify tax table

         11/ Return to main menu
                                                Choice ? : ? _
____MENU___PRINT_____________CHANGE____________KALKUL__DO__
```

Fig.3

2.2 Starting or Adding a file

If starting a file, then adding an employee will be the first instruction . After entering 6 in menu (fig.3) you will then get screen (fig.4) .

```
-----------------------------------------------------------
 A D D  employee                     SANGORO STATION
-----------------------------------------------------------

 Employee nr :  69                   Name :  .

 Personnel nr    :  .

 Job group       :  .                First D.O.A    :  .
 Job     :  .                        T.O.E          :  .




                                     Bank :  .
                                     Bank acc. nr :  .

CHANGE(F6),CONTINUE(F10)

____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.4

'Employee nr' gives the number at which the new employee's details will be stored (this nr will further be called the Payroll nr). At the bottom of the screen you can see the choices for the function keys : 'CHANGE(F6) , CONTINUE(F10) '. The F6 corresponds with the function key (top row on th keyboard) F6 , the F10 with the corresponding function key F10 .

As you wish to change the values for this employee (it is now an empty record) , press F6. Now , for every variable to enter, limiters '<<' will appear (fig.5) :these indicate the maximum length of that variable . If you make the 'word' longer then the extra characters or numbers will be left out (ignored).

After the entry of each variable , push RETURN . Fig.5 also shows a finished screen.

```
------------------------------------------------------------------
A D D  employee                      SANGORO STATION
------------------------------------------------------------------

Employee nr :  69                    Name  : ? OWIDI C.A.    <<

Personnel nr : ? 446    <<

Job group       : ? B<<              First D.O.A  : ? 090983<<
Job   : ? AUX.STAFF          <<      T.O.E         : ? PF <<



                                     Bank : ? CASH             <<
                                     Bank acc. nr : ? ---


CHANGE(F6),SAVE(F10)

____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.5

The option line now gives 'CHANGE(F6) , SAVE(F10)' : 'change 'for more changes ,'save' to store the record as you have now entered it. If you think the record is now OK, push F10 . You will see the little red light on Disk drive 2 come on and hear the disk turn. After this, the option line shows 'CONTINUE(F10)' . It is only one option, so press it.

You can continue the above procedure for all employees .

>>**Important** : Always make sure you have entered the job group. Omitting this information will give problems when you try to update the paysheet later (ERROR !!).

2.3 Update Personnel Sheets

If you want to change the personal information after adding the employee , you must use 'Update personnel sheets' to do this. Choice nr 2 of the modify menu.

After entering this option , enter the payroll nr of the employee you want to change . See 'Add employee' for further instructions.

2.4 Update Paysheets

Fig.6 gives the update paysheets screen.

```
------------------------------------------------------------
 UPDATE PAYSHEETS                  SANGORO STATION
------------------------------------------------------------


      Make your choice :

              1/ Selected sheet
              2/ More sheets
              3/ Return to menu


                         Choice ? : ? _

____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.6

Choices are 'Selected sheet' or 'More sheets'. Whereas for 'selected sheet' after the updating is finished, you will return to the menu, 'more sheets' will return you, after updating, to the next screen (fig.7).

```
------------------------------------------------------------
 Update More sheets                SANGORO STATION
------------------------------------------------------------

    Current number of entries = 68


    Payroll number of employee ? : ? ____




____MENU___PRINT______________CHANGE____________KALKUL__DO__
```

Fig.7

If your choice is 'selected sheet' then push 1 followed by RETURN.

This screen (fig.8) gives you the information which will be used to generate the payslip later.

All variables which were not entered in the 'Add' routine should be 0 (zero). If not ,then there was still information left from a previous file, which had not been erased. This will not interfere with your new file, but may sometimes have strange effects.

The bottom (option) line gives 'MENU(F2), PRINT(F3), CHANGE(F6), and CONTINUE(F10)'

>>**Important** : For unused you can see a highlighted nr and a normal video nr. The highlighted nr is the value now stored on the disk , while the other one is the currently calculated unused (= old val. + new unused or - used)

If you push F2 you will be returned to the 'Modify menu' (fig.3)

- F3 will give a print-out copy of the screen, and

- F6 will enable you to update this record :
Push F6 : a '?' will appear after the D.O.A (Date of appointment) ; it asks for the last date of job-group change.

```
========================================================================

Payroll sheet nr : 1    Name : OWIDI C.A.     D.O.A : 090983  D: 063086
                                              First date : 090983
Personnel nr : 446      Bank : CASH
Terms of emplm : PF     Bank Account : ---

Earnings :              Tax calculation :          Deductions :

Job group :    B          Round down  :   45.00    +NSSF           45.00
Basic Pay     725.00        .              .          .              .
  .             .           .              .          .              .
  .
  .
  .
GROSS PAY :  1000.00
                          Tax deduc.      00.00

   Net Pay :  700                                     Tot ded. :  300.00

MENU(F2),PRINT(F3),CHANGE(F6),CONTINUE(F10)

     ____MENU___PRINT_____________CHANGE_____________KALKUL__DO__

========================================================================
```

Fig.8

If the employee was given 'increments', this date must be decremented by a number of years equal to the number of increments. Alternatively, if the employee was demoted, this date must be incremented by the number of years of decrement.

>>**Important** : If the D.O.A exceeds the current date, then the Basic Pay will be zero (0).

After entering the D.O.A , press RETURN . You will notice that not every variable can be changed. Some variables on personal information can only be changed through the 'Update personnel sheets' routine, whereas others cannot be changed by you because they are calculated by the computer.

Remark : Deductions are updated in the next screen (fig.9)

After entering all variables the bottom line gives the following options : CHANGE(F6), CALCULATE(F9), SAVE(F10)

Use F6 if you want to make more changes,
- F9 if you want to calculate the salary with the updated variables, and
- F10 to save the updated values.

```
---------------------------------------------------------------------------
  D E D U C T I O N S         OWIDI C.A.      Paynr:  1    # Ded.: 4
---------------------------------------------------------------------------
+NSSF:                         45.00      Petty cash:
+NHIF:                                    Thabiti loan:
+H.PUR.(Woodventure):                     +S.A.Y.E:
+H.PUR.(Argos):                           House mortg.loan:
+H.PUR.(Bic.KNTC):                          .
  .
  .
  .
  .

Harambe loan/inter:                       Miscallenous 2:          10.00
CHANGE(F6),CONTINUE(F10)
                                          SUBTOTAL DEDUCTIONS :   274.80
     ____MENU__PRINT_____________CHANGE______________KALKUL__DO__
```

Fig.9

Remark :

1/ This F10 here , will only save the personal information , plus entered information : deductions and calculations are not saved.

2/ If you 'changed' and 'calculated' several times, you will have to 'save' several times as well. Changing and calculating more than five times may cause problems. Avoid it !

2.5 Deduction Screen

After 'saving' you will get the 'Deductions' screen (fig.9). The top line gives you the employee's name, payroll nr, and current nr of deductions, while the bottom line gives you the choice between CHANGEing(F6) or CONTINUEing(F10) :

- F10 will continue back to the menu so you can do something else,

- F6 will allow you to make any changes in the deductions :
On pushing F6 , a '?' will appear next to +NSSF. If you don't want to change the value which is there , then push RETURN; if you want to change the value, enter the new value followed by a RETURN. Continue this until the last deduction.

The option line gives the options to CHANGE(F6) again , or SAVE(F10) this information.

Remark : Several deductions have a '+' as the first character. This indicates that these deductions are 'labelled' : other information is attached to them. See 2.6 for further information.

>>**Important** : It is possible to redefine the names of the deductions. Refer to the Appendix for more information.

Now, if your choice at screen (fig.6) was 'Selected sheet', then F10 will return you to the menu. If , however , tour choice was 'More sheets' then after F10 a new option line will appear : MENU(F2), and RETURN TO PAYSCREEN(F10).

Pushing F10 will enable you to check the salary , calculated with the changed deductions. Onthis screen it is again possible to make change. Entering F10 after this will return you to the 'Number of employee ?' screen (fig.7).
Note : Subsequent deduction screens are similar to fig.9

2.6 Update Deduction Variables

After entering all records, you can update the deduction variables for the '+' deductions. This will enable you later to use the 'Split Deductions' routine in the output section. Now enter choice 3 in the 'Modify' menu (fig.3). This gives screen (fig.10).

```
-------------------------------------------------------------
 U P D A T E  deduction variables  SANGORO STATION
-------------------------------------------------------------


           Current number of entries : 68

           Payroll nr of employee ? : ? ___


____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.10

Enter the payroll nr of the employee to update. This gives screen (fig.11).

-In the top line, you will find the Payroll nr, Name and Personnel nr,
-Line 2 gives the nr of deduction inthe payslip and the name of the deduction,
then :
- Variable 1 : this , depending on the deduction, can be a PLC nr or an Insurance policy nr.
- Variable 2 : this, depending on the deduction, can be an Account nr, NSSF nr, NHIF nr or Insurance Company name.

If you want to change the current info, then push F6. Else pushing F10 will advance you to the next +deduction or, if there are no other +deductions, to the next screen.

Push F6 : now, the limiters appear. Enter the new info. If you don't want to change , just push RETURN.

Remark : For variable 1 ,the range is 10 characters, and for variable 2, 20 characters. However, if necessary, the length of variable can exceed 10 to be 20. This, however might result in problems in the output routines. Therefore, it is advisable not to exceed 10.

```
-------------------------------------------------------------
U P D A T E deduction variables   SANGORO STATION   CHANGE
-------------------------------------------------------------

     Payroll nr  1    OWIDI C.A.          Pers.nr : 446


Ded.nr :  1             +NSSF


      Variable 1 (PLC nr )     : ?                  <<
                 (Insur.pol.nr)

      Variable 2 (Account nr ) : ?                      <<
                 (NSSF nr )
                 (NHIF nr )
                 (Insurance cy )


____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.11

After Add employee, Update Paysheets and Update Deductions, you should be ready to proceed to the output routines. Sometimes, however, more changes are necessary : Remove employee or Transfer employee. If you don't need these, you can proceed to PART II.

P A R T - I I

This part deals with the second option of the 'payroll menu' (fig.2)

CHAPTER III: **Payroll Options**

On entering choice 2 followed by a RETURN, the 'payroll options' menu will appear on the screen (fig.36).There are 9 possibilities here

1/ Generate payroll (+ report)
2/ Report (without generating payroll)
3/ Paylist (bank or cash)
4/ Split bank payments
5/ Split deductions
6/ Personnel list
7/ Check deduction variables
8/ Tax deduction card for current year , and
9/ Return to payroll menu

Select and enter your choice as a nr from 1 to 9, and press RETURN

```
-----------------------------------------------------------
 PAYROLL O P T I O N S             SANGORO STATION
-----------------------------------------------------------

          Make your choice :

                   1/ Generate payroll (+ report )
                   2/ Report ( without generating payroll )
                   3/ Paylist ( bank or cash )
                   4/ Split bank payments
                   5/ Split deductions
                   6/ Personnel list
                   7/ Check  deduction variables
                   8/ Tax deduction card for current year

                   9/ Return to main menu

                          Choice ? : ? _

____MENU___PRINT_____________CHANGE_____________KALKUL__DO__
```

Fig.12

Choice 9 will return you to the 'payroll menu' (fig.2)

Note : all choices are followed by a RETURN ; thus 'entering' hereafter means " typing your choice, followed by a RETURN "

3.1 Generate payroll (+ report)

This choice will generate the payslips for the employees. On entering this choice you will get screen (fig.13). Here again there is a choice between generating the whole payroll (plus a full report) - choice 1, or generating part of the payroll (plus a report on that part of the payroll) - choice 2.

```
------------------------------------------------------------
  Generate payroll                SANGORO STATION
------------------------------------------------------------

       Number of entries : 68


       Make your choice :

                 1/ All
                 2/ Partly

                             Choice ? : ? _

----MENU---PRINT--------------CHANGE------------KALKUL--DO--
```

Fig.13

'Generate all' (choice 1) will commence the generation of the whole payroll, printing payslips (fig.14) for all employees in the station - either 'bank' or ' cash' as the case may be. After the completion of the printing of the payslips, you will be prompted to 'Adjust paper and push any key'. This allows you to adjust the printer paper to top of page if it had gone below.

```
======================================================================
            KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
                          SANGORO STATION

  Salary for JUNE 1986
                                            Name : OWIDI C.A.

  Personnel nr : 446                     Bank : CASH
  Terms of employment : PF               B.acc.: ---


                       - same as fig.8 -


        Net pay : 725.00               Total deductions : 275.00

           Payroll nr : 1          Payroll sheet nr : 4
======================================================================
```

Fig.14

After adjusting the paper and pushing any key, a report will be generated. This report will comprise :

i. breakdown of all payments to all employees, and
ii. breakdown of all deductions from all employees.

The options line gives 'STOP PRINT F(2)'. Pushing F(2) will halt printing and return you to 'payroll options' menu. Otherwise the generation continues.

'Generate part' (choice 2) will give the 'Generate part' screen . You have the choice of generating payslips for individual employees, each at a time, or a few at a time.

To generate for an individual, enter the individual's payroll nr at the 'First nr :' prompt, and also at the 'Second nr :' prompt.

Enter appropriate payroll numbers at both prompts to generate payslips for a few employees.

Remark : A report is generated after every 'generate' has been effectuated.

Note : - that the current nr of entries is indicated,
- that before printing starts, you are asked to 'Activate printer !'. Make sure you do if the printer wasn't, otherwise you may be forced to start running the program a fresh !

3.2 Report (without generating payroll)

Choice 2 of the payroll options will give the 'Report without generating payroll' screen . The report is generated without the payslips being printed.In the mid-section of the screen the current number of record being processed is indicated until the last record. After all the records are processed,the report is printed out.

Remark:The time taken to produce the report without generating payroll is about the same as the time taken to produce the report with the payroll (3.1).

3.3 Paylist

Normally a paylist is required for a quick check of errors,and for record.On choosing 3, the 'Paylist' screen will appear.This gives you 3 choices:

1- Paylist for record
2- Paylist for cash payments (signature column) ,and
3- return to main menu.

-Choice 3 returns you to 'main menu'
-Choice 1 gives a paylist for 'Bank' or 'Cash'.For cash payroll this choice doesn't give a column for signatures of the payees: this signature column is given by
-Choice 2,which gives only a paylist for 'cash' in which is also included the cash breakdown for each payee,to facilitate easy payment by the cashier.

After a paylist for cash with signature column has been produced,a "Certificate of Paying Officer"is generated followed by a "Totals of cash breakdown".This cash breakdown helps the cashier when withdrawing from the bank to know how much of 100's,50's, etc. notes or coins to take.

Remark: The paylists are arranged according to the order of sorting e.g. Name,Personel number etc (see 3.6 for details on sorting).

3.4 Split Bank Payments

This option works only with bank payments.It breaks down the payees to their banks and then makes paysheets for the banks,plus by a voucher for recommendation and approval.The voucher also has spaces for 'voucher number' and 'cheque number'. Also, verification and examination are done on these paysheets (as is done on all paysheets).

- on entering this choice,a sorting of the banks is done ,and shown on the screen.The option line gives "MENU F(2), HARD COPY (F3) and CONTINUE (F10)
- F(2) returns you to the 'payroll options'menu.
- F(3) gives a print-out of the sorted list of banks,after which the option line gives the same options.
- F(10) will enhance the splitting of the bank payments and print-out of bank lists detailing name, payroll nr, personnel nr, bank, bank account and net pay.

Note: If you want a sorted list of banks,press F(3) before 'continuing'.

3.5 Split Deductions

This choice does essentially the same thing as the split bank payments except here the split is according to the different deductions. The print-outs are lists of all deductions with all the employees contributing to each. The format is the same.

- On entering this choice ,the screen of all deductions appears.The option line gives F(2),F(3) and F(10).

- F(2) returns you to payroll options menu.
- F(3) gives a print-out of the deductions,yielding same options again.
- F(10) allows you to continue with the splitting.

Note : If you want a print-out of the deductions,press F(3) before F(10).

On pushing F10 to continue, the option line gives 'SPLIT SELECTED(F6), SPLIT ALL(F10)'.

You have a choice of splitting all the deductions one after the other automatically (F10), or splitting (a) selected deduction(s) one at a time (F6).On pushing F6 to split a selected deduction, the option line will ask you 'Which number (1-38) ?' : you will enter your choice as a nr from 1 to 38 as on the deductions screen .

After entering your choice, the deduction you have chosen will be highlighted on the screen which also informs you about current nr of entries. Splitting will commence , giving a print-out similar to that one of 'bank split'. The main difference will be the deduction name in place of the bank name, and of course the differences in personal details.

After finishing, the option line will give MENU(F2),HARD COPY(F3), and CONTINUE(F10) on screen .

You can opt to quit by going back to menu (F2), make a hard copy (print-out) of the screen (F3), or continue (F10) which will allow you to choose between selected split or split all again.You can do this until all the deductions you wanted split are finished.

3.6 Personnel List

This choice 6 of the payroll options will generate two types of personnel lists :

i - the list of employees who have their salaries paid to their banks : this list details for each such employee, list nr, (bank) payroll nr, name, personnel nr, bankers and bank accout nr,and

ii - the list of employees who are paid in cash, detailing their list nrs, (cash) payroll nrs, name, and personnel nrs .

These are just routine lists for checking details on both types of payroll. On entering this option, a screen giving total nr of entries, and the order to which the Personnel list will be sorted : this can be name, peronnel nr, date of appointment,payroll nr, first date of appointment, terms of employment, job group or bank (for bank payroll only).The option line gives you 'CHANGE SORT(F6), and CONTINUE(F10)' :

- Change sort (F6) will allow you to change the order to which the list is sorted (as given on the screen).If you push F6 you will be prompted to choose the sorter option among those 8 above or to go back to the Personnel list menu. Choose the order to which you want the list sorted and enter. The sorting will be done and you will be returned to the Personnel list menu. From here you can now

- Continue (F10) to print a list sorted according to last order of sorting.The date of printing as well as the station (and bank or cash) also appear on the list for reference.

3.7 Check Deduction Variables

This option is something between a 'Deduction split' and a 'Personnel list'. It works only with the +deductions, and gives splits for these deductions detailing employees' (contributors') name, PLC nr,(or insurance policy nr), and Account nr,(or Insurance company name).

These lists are merely for checking if the details are correct for the contributors before generating the payroll and the reports to accompany such contributions to the companies concerned.

On entering this choice, before the printing of the lists, you will have the choice of returning to the menu without the lists (F2), making a hard copy of the +deductions which will appear on screen (F3), or continuing (F10). F(10) will allow the lists to be printed.

On pushing F10 you will have a list on screen, of all the +deductions and a prompt for the +deduction you have chosen to split.After finishing splitting one +deduction, you will have the choice to go back to 'MENU(F2)' or 'SPLIT ANOTHER DEDUCTION(F10).

You can get all the splits for all the +deductions in the same manner , and quit by 'MENU(F2)'.

Details on Insurance Premuim splitting will be appended.

3.8 Tax Deduction Card for the current year

This option will produce, for every employee on an annual basis, a card detailing all his/her taxation records for the year.

Again as you will have realised by now, the program is very easy to use i.e user friendly, since you are aided by suggesting prompts at every stage.

You can try this option as an exercise to see if you have mastered the procedures. You can also try out the other options not covered in both parts e.g Kill employee, Transfer employee etc etc.

G O O D L U C K

First Edition - July 1986

copyright by Pissierssens P. \
Onyango B.A.H / mombasa, kenya

Annex 8

TO: ALL RESEARCH OFFICERS &
TECHNICIANS.

30TH MAY, 1986

SEMINAR MEETING.

This is to inform you that there will be a seminar meeting on Friday, 13th June, 1986 in the library as from 9.00 am.

The following officers will deliver a speech for between 15 - 20 minutes on the topics shown against their names:-

1.	Dr. Tackx Hickey:	Overiew of the research in oceanography.
2.	Mr. Okemwa:	Plankton Ecology (Copepods)
3.	Mrs. Kimaro:	Zooplankton (Fish eggs & Larvae)
4.	Mr. Kazungu:	Marine Chemistry (Nutrients, POC, Salinity, Oxygen in Tudor Creek)
5.	Mrs. Oyieke:	Phycology
6.	Mr. Wakwabi:	Population Dynamics of Penacid Shrimps in Tudor Creek.
7.	Mr. Nzioka:	Research on fishes.
8.	Mr. Oduor:	Fish quality Control.
9.	Mr. Ruwa:	Mangrove Ecology.
10.	Ms. Muthiga:	Coral Reef Ecology.
11.	Miss Abubaker:	Nutritive Value of Oysters.

P.O. NDONGA
AG: DIRECTOR

KENYAN/BELGIAN BIOLOGICAL OCEANOGRAPHY PROJECT.

EZEKIEL OKEMWA

ZOOPLANKTON RESEARCH

1.1 ZOOPLANKTON STUDY FROM LIKONI FERRY

Data are drawn from six 24-hours samplings taken in a serie once a month and every after two months for a year starting i April, 1985 to February, 1986.

Zooplankton samples were collected from a car ferry using th clarke-Bumpus high speed sampler having a month area of 0.017 Tows were conducted every two hours for the duration of the crossing (about 4 minutes) by the car ferry with a 480 hp die power engine.

Total zooplankton abundance averaged $2000/m^3$. The magnitude annual changes was small. Calanoid increased five fold in th South-East monsoon than North-East. The copepoda were clearl the dominant taxa throughout the six 24-hours cycles.

In the evening there is a sudden increase which holds on duri the night. In the morning there is a sudden drop. We can attribute this to vertical migration of copepoda and some oth taxa.

However, the magnitude of the difference and the pattern of catch-rates over 24 hours varied on each of the six occasions. Some of the variability appeared to be linked to the high-low tidal cycle (see Annex).

1.2 COPEPODA STUDY FROM TUDOR CREEK

Fifty-two free swimming planktonic copepod species were identified from the samples collected from three stations in Tudor Creek between 1984 and 1985. This appears to be the first systematic account of copepods reported from the coasta and inshore waters of Kenya (see Annex12)

.../

2.1 RESPIRATION EXPERIMENT

The aim is to measure the amount of food required by an animal for maintenance. Further it is also a rough method to sketch the kind of food web we are dealing with in Tudor Creek.

Zooplankton samples were collected on four occasions (12th February, 19th March, 2nd May, and 6th June, 1986) from Fort Jesus near Mombasa. Zooplankto were selected for respiration experiment Respiration rates were measured usir Winkler method, and related to dry-weight of the animals.

The respiration rate for the Zooplankton ranged from 0.57 μg O_2/12 hours/ animal to 130.2 μg O_2/12 hours/Animal with a mean value of 13.6 μg O_2/12 hrs/ animal (see Table 1).

All these respiration results show different features: Most of the species have a much higher respiration rate at night than at day. We can conclude that zooplankton are much more active at night than at day.

Table 1. Respiration of zooplankton from Fort Jesus expressed in μgO_2/12 hrs/ Animal.

	DATE	February 12th, 1986		March 19th, 1986		May 3rd, 1986		June 6th, 198	
	PERIOD	Day	Night	Day	Night	Day	Night	Day	ni
SPECIES									
Temora turbinata		3.07	11.25	2.69	13.47	3.33	10.47		
Centropages orsinii		2.4				3.15	8.07		
Acartia sp.		0.57							
Acartia sp_2		2.79	11.25	3.42	6.69	1.5	8.16		
Eucalanus sp		5.61	34.98	3.12	25.8	5.07	24.33		
Macrosetella		3.06		2.91	8.82	3.6	18.36		
Crab larvae		0.78	3.12						2[illegible]
Acrocalanus			28.74			3.39	21.63	~~[illegible]~~	6.
Decapod larvae			25.41						
Calanopia elliptica				2.85	9.27				8.
Oncaea sp						2.79			
Sygnathus cynospilus									45.
Hemisiriella									31
Ostracod									2[illegible]
Undinula vulgaris								130.2	

An attempt was made to estimate the organic carbon weight of the animal and respiration expressed as a function of the unit weight/day; and carbon respiration as a function of carbon weight. Table 2 lists the dry weight in µg per animal, Respirat in µg carbon and percentage of body carbon weight used by respiration.

Carbon losses were expressed by reppiration as a function of the body carbon and we find that there are higher losses for the herbivores (30-49%) than for the carnivores (20%) (Table 2).

Table 2:

Respiration and dry weight of zooplankton from Fort Jesus expressed as a function of the unit weight/day; and carbo respiration as a function of carbon weight.

Date: 12.2.1986

Species	Dry weight in µg	Respiration in µg C	% of body carbon weight used by respiration.
Temora	28.9	4.47	34
Eucalanus	74.7	12.68	38
Crab larvae	13.4	1.22	20
Acartia sp_2.	22.5	4.39	43
Date: 19.3.1986			
Species			
Eucalanus	55.8	9.04	37
Calanopia	27.58	3.79	31
Date: 3.5.1986			
Species			
Temora	28.9	4.31	33
Centropages	23.8	3.51	33
Date: 6.6.1986			
Species			
Acrocalanus	10.03	2.23	49

2.2 COPEPODS' WEIGHTS AND LENGTHS MEASUREMENTS

Table 3 shows the mean weight per individual animal and the corresponding mean length per individual for the copepods on each planchet from the three stations in Tudor Creek.

Estimation of biomass is going to be made after more data has been acquired.

For accurate analysis it is better to work on formalized samples. So a serie of measurements is being carried out on individual species to know the weight loosed in formaline

Table 3. Mean dry weight and mean length of Groups of copepods from Tudor Creek.

Species	Location/Dateoof collection	Number of animals	Mean lenght (mm)	Mean weigh (µg)
Undinula vulgaris	Stn 1/27.8.1985	10	1.81 ± 0.11	90.94
Undinula vulgaris	"	10	2.23 ± 0.08	151.33
Undinula vulgaris	"	10	1.92 ± 0.08	114.82
Calanopia elliptica	stn 1/27.8.1985	10	1.11 ± 0.12	42.24
Centropages furcatus	"	10	1.10 ± 0.11	20.34
Centropages orsinii	"	10	1.11 ± 0.05	14.28
Temora turbinata	stn 1/4.3.86	9	0.81 ± 0.09	11.66
Temora turbinata	"	9	0.73 ± 0.08	11.97
Acartia	"	10	0.93 ± 0.07	10.89
Centropages orsinii	stn 1/27.8.85	10	1.05 ± 0.05	5.03
Acrocalanus	stn 2/12.2.1986	10	0.82 ± 0.08	8.7
Calanopia elliptica	stn 2/27.8.85	24	1.35 ± 0.05	33.0
Temora turbinata	"	14	0.73 ± 0.02	9.2
Canthacalanus pauper	"	11	1.05 ± 0.02	19.8
Undinula vulgaris	"	5	1.92 ± 0.03	94.6
Undinula vulgaris	"	7	2.23 ± 0.13	111.4
Calanopia minor	"	7	1.21 ± 0.06	25.8
Calanopia minor	"	10	1.19 ± 0.08	24.7
Centropages orsinii	"	15	1.05 ± 0.03	13.1
Centropages orsinii	"	15	1.13 ± 0.04	15.2
Calanopia elliptica	"	33	1.27 ± 0.03	42.43
Centropages orsinii	"	18	1.07 ± 0.05	14.12
Canthocalanus pauper	stn 3/27.8.1985	35	1.04 ± 0.05	18.36
Temora turbinata	"	64	0.74 ± 0.04	8.93
Temora turbinata	"	39	0.77 ± 0.05	9.35
Undinula vulgaris	"	9	1.75 ± 0.09	64.20
Calanopia elliptica	"	10	1.10 ± 0.15	28.85
Calanopia minor	"	13	0.86 ± 0.02	10.70

2.3: ZOOPLANKTON COUNTINGS

A vertical net haul is being taken twice a month at Fort Jesus (station one on Tudor Creek for identification of the most important zooplankton species.

Regular sampling of zooplankton is carried out on Tudor Creek on 5 stations Gazi Creek, and at English Point(near KMFRI).

2.4: STUDIES ON OYSTERS

Plankton sampling at ENGLISH POINT and Gazi are carried out twice every weel and oyster larvae are observed and enumerated in the laboratory.

2.5 WATER CHEMISTRY

A monitoring programme on water chemistry has been set out, one sampling station at English Point, is carried out daily, and 5 stations on Tudor Creek are sampled four times monthly.

Salinity and Temperature are measured daily during working days in a week at English Point. Dissolved Oxygen, PH, Sio_2 are also measured twice a week at English Point. All the parameters mentioned above are measured twice monthl during day and night of one spring and one neap tides respectively.

In addition to the monitoring programme, nutrient analysis are carried out on the 5 stations on Tudor Creek by Mr. Kazungu.

2.6 Algae and Primary Production

Samples for algal species composition, biomass, chlorophyll analysis and Primary Production measurements are planned on a monthly basis on the 5 stations on Tudor Creek.

Annex 8/2

THE COMPOSITION, DISTRIBUTION AND ABUNDANCE OF NEAR SURFACE ZOOPLANKTON IN TUDOR CREEK, MOMBASA, KENYA.

BY

Mercy Mghoi Kimaro

Abstract of a thesis to be submitted in part fulfilment for the degree of Master of Science, University of Nairobi.

University of Nairobi,
1986

The composition , distribution and abundance of near-surface zooplankton throughout a one year cycle (November 1984-October 1985) was studied by the analysis of monthly samples taken at three fixed stations in Tudor Creek , Mombasa. The biomass was measured by displacement volume of fixed material . The numerical abundance of selected groups was determined by counting using a Bogorov tray under a Wild (Heerbrugg) M3C stereomicroscope . The selected groups were chaetognaths,copepods,molluscan larvae,crustacean decapod larvae (excluding brachyuran larvae) ,brachyuran larvae , fish eggs and fish larvae.Station 1 was located at the mouth of the creek ,station 2 was about 2 km from station 1 in the middle reaches of the creek and station 3 was about 2 km from station 2 in the upper reaches of the creek .

Zooplankton sampling was carried out by horizontal tows with a plankton net of 335 micron mesh size at an approximate depth of 1.3 m . Surface water temperature , surface water salinity and turbidity were measured at the same time as the zooplankton was being collected . On two occasions (24th-25th June , 1985 and 23rd-24th September , 1985). 24 h sampling was carried out at two hourly intervals at a fixed station (English point) in Tudor Creek , in order to determine the diel cycle of near-surface abundance of the selected groups .

The composition , distribution and abundance of zooplankton and the hydrographic parameters monitored , showed seasonal changes closely related with the two monsoon seasons (northeast monsoon season : November-March ; southeast monsoon season : May-September;intermonsoon periods : April and October) . The surface water temperature was high during the northeast monsoon with a maximum value of 29.0 °C recorded from January to March at all stations . During the southeast monsoon , the surface water temperature declined reaching a minimum value of 26.0 °C at station 1 from July to september and the same minimum at stations 2 and 3 in October . The annual range of surface water temperature at the tree stations was therefore small (3 °C) characteristic of tropical waters . The surface water salinity was 35 %. at all stations throughout the northeast monsoon except in February when the maximum value of 36 %. was recorded at all stations .

During the southeast monsoon the surface water salinity declined reaching minimum values in May at all stations coinciding with a peak in rainfall . The minimum value differed between stations : 33 %. at station 1, 31 %. at station 2 and 30 %. at station 3 . Station 1 experienced the least annual salinity change (3 %.) whereas stations 2 and 3 experienced the largest (5 %. and 6 %. respectively) as would be expected from their locations in the creek . The largest Secchi disc readings were recorded at station 1 and ranged from 12.3 m in December to 2.3 m in June . At station 2 smaller Secchi disc readings were recorded at station 3 which ranged from 3.3 m in January to 1.5 m in October . Station 1 had the least amount of suspended particulate matter as shown by the large Secchi disc readings and station 3 had the most as shown by the small Secchi disc readings . Station 2 had intermediate amounts . The Secchi disc readings recorded at all stations during the northeast monsoon were larger than those recorded during the southeast monsoon . Therefore there was less suspended particulate matter during the northeast monsoon than during the southeast monsoon .

The selected groups of zooplankton showed different patterns of near-surface abundance in different months whereas in the diel cycle , most of the selected groups showed a similar pattern of near-surface abundance .

The chaetognaths occurred at all stations during the study period and showed maximum abundance during the northeast monsoon . The mean monthly abundance during the northeast monsoon was 10 / cub.meter (± 3.67 SE) at station 1 , 8 / cub. meter (± 2.53 SE) at station 2 and 9 / cub.meter (± 3.96 SE) at station 3 and during the southeast monsoon the values were 3 / cub.meter (± 0.65 SE) at station 1 , 2/ cub.meter (± 0.20 SE) at station 2 and 3/ cub.meter (± 0.49 SE) at station 3 .

Copepods were an important component of the zooplankton especially in samples collected from station 1 . Copepods reached maximum abundance during the northeast monsoon . The mean monthly abundance of copepods was 154 / cub.meter (± 44.42 SE) at station 1 , 66 / cub.meter (± 22.78 SE) at station 2 and 90 / cub.meter (± 60.17 SE) at station 3 during the northeast monsoon and 22 / cub.meter (± 5.55 SE) at station 1 , 16 / cub.meter (± 2.04 SE) at station 2 and 28 / cub.meter (± 14.17 SE) at station 3 during the southeast monsoon .

The crustacean decapod larvae (excluding brachyuran larvae showed maximum abundance during the northeast monsoon . The mean monthly abundance was 12 / cub.meter (± 2.53 SE) at station 1 , 142 / cub.meter (± 100.79 SE) at station 2 and 221 / cub.meter (± 167.91 SE) at station 3 during the northeast monsoon and 18 / cub.meter (± 2.12 SE) at station 1 , 23 / cub.meter (± 4.44 SE) at station 2 and 22 / cub.meter (± 6.40 SE) at station 3 during the southeast monsoon .

The brachyuran larvae showed a mean monthly abundance of 27 / cub.meter (± 6.78 SE) at station 1 , 292 / cub.meter (± 103.65 SE) at station 2 and 328 / cub.meter (± 127.90 SE) at station 3 during the northeast monsoon and 186 / cub.meter (± 112.22 SE) at station 1 , 180 / cub.meter (± 107.77 SE) at station 2 and 155 / cub.meter (± 72.14 SE) at station 3 during the southeast monsoon .

Fish larvae were more abundant at station 2 and 3 than at station 1 . The mean monthly abundance of fish larvae was 2 / cub.meter (± 0.61 SE) at station 1 , 6 / cub.meter (± 3.31 SE) at station 2 and 3 / cub.meter (± 1.02 SE) at station 3 during the northeast monsoon and 1 / cub.meter (± 0.40 SE) at station 1 , 2 / cub.meter (± 0.33 SE) at station 2 and 1 / cub.meter (± 0.40 SE) at station 3 during the southeast monsoon .

Fish eggs were more abundant at station 1 than at stations 2 and 3 . Station 1 had an equal value of mean monthly abundance in both seasons : 4 / cub.meter (± 0.78 SE) during the northeast monsoon and 4 / cub.meter (± 0.73 SE) during the southeast monsoon . Stations 2 and 3 had low numbers of fish eggs during the northeast monsoon with a mean monthly abundance of 1 / cub.meter (± 0.20 SE) at station 2 and 1 / cub.meter (± 0.69 SE) at station 3 . The number of fish eggs at stations 2 and 3 increased during the souteast monsoon with a mean monthly abundance of 6 / cub.meter (± 3.84 SE) at station 2 and 3 / cub.meter (± 0.69 SE) at station 3 .

The molluscan larvae were more abundant during the southeast monsoon than during the northeast monsoon . The mean monthly abundance was 4 / cub.meter (± 1.30 SE) at station 1 , 3 / cub.meter (± 1.02 SE) at station 2 and 1 / cub.meter (± 0.32 SE) at station 3 during the southeast monsoon and 1 / cub.meter (± 0.98 SE) at station 1 , 1 / cub.meter (± 0.53 SE) at station 2 and more at station 3 .

Thus all the selected groups of zooplankton except molluscan larvae showed maximum abundance during the northeast monsoon .

The biomass and numbers exhibited a seasonal cycle closely related to the rainfall pattern . Major peaks in numbers occured in December , April and a minor peak in July/August at all stations . The peaks in December occured a month after the short rains in November . The peaks in April occured a month after the onset of the long rains in March . The peak in numbers in June occured a month after peak rainfall in May . Probably , the increased nutrient input into the creek during the heavy rains enhances phytoplankton growth which inturn leads to higher biomass and numbers of zooplankton in the peaks that we see . The lag time between heavy rainfall and zooplankton abundance was about two to four weeks . The biomass and numbers of zooplankton reached the lowest values during the dry months of both monsoons : January-February in the northeast monsoon and September-October in the southeast monsoon.

The diel variations in the hydrographic parameters monitored were small . The diel range of surface water temperature was 2 C in June and 1.5 C in September . The lowest surface water temperatures were recorded at night and the highest during the day on both occasions . The diel range of surface water salinity was 1 ‰ on both occasions . However , the instrument used (a refractometer with 1 ‰ graduations) was not precise enough in order to measure small subtle but significant differences in the diel cycle of surface water salinity .

The values of the silica content of the water were higher in June (0.08 - 0.2 ppm) than in September (0.06 - 0.10 ppm) . The pH values ranged from 8.05 (07.30 h) to 8.31 (11.30 h) in June and 8.30 (07.30 h) to 8.60 (11.30 h) in September . The lowest and the highest pH values on both occasions occured at the same time in the diel cycle . The pH values recorded in June were lower than those recorded in September .

There was less zooplankton caught near the surface during the day than during the night on both occasions . Most of the selected groups of zooplankton showed maximum heat-surface abundance at night between 19.30 h and 23.30 h on both occasions . The pattern observed was accounted for by the classical pattern of vertical migration . The results point firstly to light as the the major timing factor and secondly , that the tidal cycle has no discernable effect on the diel cycle of near -surface abundance .

Annex 8/3

THE DISTRIBUTION OF GRACILARIA AROUND MOMBASA AND THEIR OPTIMAL PERIOD OF GROWTH.

Mrs.Oyieke.

A study on the Phycology of the Kenyan Coast is being carried out in which 5 sampling stations have been selected around Mombasa:Mackenzie Point, Kanamai Beach, Shelly Beach, Tiwi Beach and Bamburi Beach (Reef Hotel). From the five stations all the *Gracilaria* species are to be identified and their different habitats described. Transects will be taken from the intertidal to the sublittoral zone, and any other algae that grow together with the *Gracilaria* will be identified.

A biomass study has to be done for every *Gracilaria* identified so as to find out: which of the *Gracilaria* species occurs in economically harvestable quantities, which is the regeneration time for each *Gracilaria* species, when it is the best moment to harvest them with respect to dry or rain season, and which is the best method for harvesting with the "holdfast" or just above it.

The extraction of agar will be done for the different *Gracilaria* species in order to establish which of them is richest in agar, when it is best to harvest for agar, and whether the habitat has any influence on the quantities of agar produced.

So far the work has been confined to Mackenzie Point (due to availability of transport to go to outer stations...).

At Mackenzie Point the following work has been going on for the past 3 months (February, March, April 1986):

1. A transect study has been done, the dominant *Gracilaria* species is *G.salicornia*. Its habitat as well as of all the other algae in the transect have been recorded. The sampling of this transect is done once a month.
2. Sites for biomass study have been located and biometric observations have been made. The initial biomass of *G.salicornia* was taken and the regeneration time is being monitored.
3. At each sampling specimens have been used for agar extraction.

The transect under investigation is located at a place where the land ends in a cliff. The cliff gives way to a sandy beach which stretches for about 10 m, then followed by rocky pools of various sizes whose bottoms consist of sand. The pools stretch for about 30 m before reaching the low water line. The area is sheltered from surf activities.

February 1986.

Zone	Remarks on *Gracilaria*.	Remarks on other common algae.
1.This zone consists of shallow rock pools with sandy bottoms . The pools are 5-10 cm deep	*G.salicornia* is the main *Gracilaria* species. is the most abundant algae growing on the edges of the pools. The thallus are about 3 cm high and are cushion forming.	*Enteromorpha kylinii* is quite common on exposed surfaces of rocks .*Lyngbya* sp. is very common in the pools.
2.The rock pools here ar 10-15 cm deep.	*G.salicornia* is still the most abundant algae growing on the edges of the pools. The thallus size is about 3 cm forming cushions.	*E.kylinii* is still common on the rocky surfaces.*Lyngby* sp. is common in the pools and *Laurentia venusta* occurs in thick cushions on the edges of the pools.
3.The rock pools here are deepest: 15-20 cm deep.	*G.salicornia* is still most abundant on the edges as well as on the bottom of the pools. The thallus of those in the pools are 10-15 cm high.	The common algae occuring here are *Boodlea composita* (on edges of pools), *Cystoseira myrica* (in pools) and *Laurencia papillosa* (in pools).
4.This is a flat surface without pools. The substrate is rock covered with little sand.	*G.salicornia* still dominates but growing in very small forms in cushions of about 1 cm high	Other common algae are: *Acrocystis nana*, *Ulva pestusa*, *Centocerus clavulatum*, *Laurencia venusta*.
5.This is a sublittoral zone. The height of waterlevel at low spring tide is about 1 m.	*G.salicornia* grows in patches scattered all over. The thallus cushions are about 2 cm high on rocky surfaces and on sandy areas up to 5 cm high.	*Thalassia hemprichii* (sea grass) is abundant.*Centrocerus clavulatum* is also common.

March 1986

Zone 1	Remarks as in February	Remarks as in February
Zone 2	Idem	Other common algae are Chaetomorpha crassa and E.kylinii.
Zone 3	Idem	Other algae commonly found are C.crassa and E.kylinii.
Zone 4	Idem	Other common algae areBoodlea composita, E.kylinii and Hypnea pannosa.
Zone 5	Idem	Other algae occuring: Thalassia hemprichii and Centroceras clavulatum.

April 1986

Zone 1	As in March	As in March
Zone 2	As in March	As in March
Zone 3	The thallus size of G.salicornia is slightly smaller: about 7-10 cm high.	As in March
Zone 4	As in March	As in March
Zone 5	As in March	As in March

May 1986

Zone 1	There is no *Gracilaria* in this zone	*E.kylinii* is the most common algae on the rocky surfaces. *Monostroma* sp. also occurs frequently.
Zone 2	*G.salicornia* occur in patches here but are not the most abundant algae. They grow in cushions, about 2 cm high.	*Padina boriana* is very common in the pools and *Laurencia papillosa* occurs on the edges. *Hypnea nidulans* and *E.ramulosa* are also quite common.
Zone 3	*G.salicornia* occur only in dispersed patches, are not the most abundant algae. Thallus size about 4-6 cm high.	Pools dominated by *Ulva reticulata* and *E.ramulosa*.
Zone 4	Cushions of *G.salicornia* dominate the platform. The thallus are about 1 cm high.	*Centroceras clavulatum* are very common together with *U.pertusa*.
Zone 5	*G.salicornia* occur in cushions on the rocky surfaces.	Sea grass *Thalassia hempirchii* is most abundant.

Biometric studies at Mackenzie Point

This is a study on the regeneration period of G.salicornia . There are 4 one metre quadrats . Quadrat 1 and 2 had G.salicornia removed with the holdfast. Quadrats 3 and 4 had G.salicornia removed above the holdfast.

Quadr. nr.	Date	Wet wt(kg)	Dry wt(g)	% Cover	Agar	Remarks
1	24-2-86	0.945	75	58	trace	Experiment
2	24-2-86	0.88	80	50	trace	set on.
3	24-2-86	1.225	105	63	trace	Thallus
4	24-2-86	1.26	110	68	trace	size 10-15 cm high.
1	25-3-86	Not ready for harvest		5		New growth has
2				5		already started
3				10		Thallus size
4				8		1-2 cm high.
1	24-4-86	Not ready for harvest		15		Growth continues
2				13		Thallus size
3				30		2-5 cm high.
4				23		
1	23-5-86	Not ready for harvest		20		Growth continues
2				19		Thallus size
3				38		4-7 cm high
4				33		

WATER MASS ANALYSIS IN RELATION TO PRIMARY PRODUCTIVITY IN KILINDINI AND TUDOR ESTUARIES.

J.M.Kazungu.

Introduction

Kilindini and Tudor Estuaries form a very interesting area for Oceanographic study. As pointed out in my earlier research project proposal, it is not clear as to why Kilindini estuary- though not scientifically proven- has relatively more fish than the Tudor creek. This implies that primary productivity in Kilindini estuary is higher then that of Tudor creek.
The present study is therefore centered on the identification of various water types which might be existing within the estuaries and try to relate them to primary productivity.
To do this the study is divided into three sections, namelely:

1. Analysis of the nutrients (phosphates, silicates, nitrates, ammonia) distribution within the estuaries.
2. Analysis of particulate organic carbon (POC) distribution both within the estuaries water column and the bottom sediments.
3. Analysis of the salinity and oxygen distribution within the creeks.

Period of study.

This study is to be conducted in both the wet and the dry seasons. This would place us in a better position of understanding the effect of the monsoon rains on the river input of nutrients and organics in the creeks.

Discussion.

So far little can be said due to limited data. However, it is noticed that for the Tudor Creek, lowest concentrations of nitrate, phosphate and silicates were found at the mouth of the estuary near the open sea, whereas high concentrations were found upstream. Figs. 2 and 3 show representative graphs of nutrients concentration Vs sampling stations for the Tudor and Kilindini Estuaries respectively. As indicated in Fig.2 the highest nutrient concentrations for the Tudor Creek were found around station A6 near the river mouth, while the lowest were recorded at station A2 near the open sea. As expected, salinity concentrations decreased upstream. The highest silicate, nitrate and phosphate concentrations were 186.0 µg-atSi/$_l$ 28.50 µg-at N/$_l$, and 4.12 µg-at P/$_l$ respectively, while the lowest were 65.50 µg-at Si/$_l$, 5.20 µg-at N/$_l$ and 0.64 µg-atP/$_l$ respectively.
For Kilindini Estuary (Fig.3), the situation was different. Salinity and silicate concentrations behaved as expected, with salinity decreasing upstream and silicate increasing. However, it is surprising to find phosphate concentrations decreasing upstream. Nitrate concentrations oscillated between 0.2 and 0.5 µg-at N/$_l$ except station B1 which had 1.80 µg-at N/$_l$.
It is also surprising to discover that nutrients concentrations are higher in Tudor than in Kilindini Creek which is thought to be having a higher fish stock.

RESULTS FOR THE FIRST TWO MONTHS

Date: 08/04/86 Estuary:

STATION	NO_3^- µg-at N/l	NO_2^- µg-at N/l	NH_4^+ µg-at N/l
A1 (0m)	1.02	0	-
(5m)	1.56	-	-
A2 (0m)	2.98	0.05	-
A3 (0m)	1.78	0.05	-
A4 (0m)	1.70	0.05	-
A5 (0m)	2.05	0.02	-
(2.5m)	1.80		
A6 (0m)	6.80	0.15	-

Tudor

Si µg-at Si/l	PO_4^- µg-at P/l
6.0	0.35
	0.25
8.0	0.35
12.0	0.35
15.50	0.25
28.50	0
105.00	0.55

Date: 22/4/86 Estuary: Tudor

STATION	NO_3^- µg-at N/l	NO_2^- µg-at N/l	NH_4^+ µg-at N/l	Si µg-at Si/l	PO_4^- µg-at P/l	S o/oo
A1 (0m)	0.15	0	0	4.00	0.30	36.36
(5m)	0.37	0	-	3.50	0.50	36.36
A2 (0m)	1.60	0.04	0	5.00	0.70	36.26
A3 (0m)	3.10	0.06	2.65	13.40	0.70	34.09
A4 (0m)	3.40	0.08	2.70	20.00	0.95	32.25
A5 (0m)	9.25	0.24	8.50	70.00	1.20	12.41
(5m)	1.90	0.22		17.80	0.95	34.63
A6 (0m)	9.25	0.64	10.65	71.50	0.10	1.11

Date: 22/05/86

A1 (0m)	-	-	-	-	-	-
A2 (0m)	5.20	0.05	-	65.50	0.64	25.07
A3 (0m)	9.30	0.05	-	116.00	0.68	18.53
A4 (0m)	17.80	0.05	-	163.50	1.46	11.29
A5 (0m)	22.50	0.05	-	186.00	1.92	5.66
A6 (0m)	28.50	0.08	-	180.50	4.12	0.72

KENYAN/BELGIAN BIOLOGICAL OCEANOGRAPHY PROJECT
KENYA MARINE AND FISHERIES RESEARCH INSTITUTE,
P. O. BOX 81651,
MOMBASA.

WORK PLAN ON DAILY BASIS:

TIME	0630 ___ 1230	1230 - 1400	1400 ___ 1830
DAY / MONDAY	Collection of plankton (pass 200 lts of water through 55μm mesh - Net). Take measurements of physical and chemical parameters (PH, O_2, salinity, Temperature, secchi disk measurement, SiO_2, NH_4, No-.....) at English point (pool water Brackish water.	LUNCH	Oyster culture experiment in wet Lab and at the Jetty and at the Pillars on Mkomani Beach. Measure physical and chemical parameters at KMFRI and pool water and Brackish water. Collect plankton. Write labels and enter the findings.
TUESDAY	Collect oyster larvae during low and high tide at English point. Take measurements of physical and chemical parameters: O_2, pH, salinity, Temp., secchi disk measurement. Enter data in files.	LUNCH	Take measurements of physical and chemical parameters at English point during low and high tide. Data processing. Oyster experiment in the wet lab. and at English point and at the Pillars on Mkomani Beach.
WEDNESDAY	Take observations on water pool, pass 100 Lts of water through 55μm mesh. Net. Measure O_2, pH, NO_2, NO_3, NH_4, Sio, salinity, Temperature, Secchi disk. Oyster culture experiment in wet Lab. Data analysis.	LUNCH	Measure physical and chemical parameters at English point. Carry out Oyster experiment. Data analysis.

...../2

TIME	0630 ---- 1230	1230-1400	1400 --------- 1830
DAY THURSDAY	Oyster culture. Measure O_2Secchi disk, pH, salinity, No_3 Temperature ... etc. during low and high tides. Wash and prepare sample bottles. up data files, and note books.	LUNCH	carry out measurements of physical ar chemical parameters, at English point Data analysis.
FRIDAY	Take plankton samples from English point (pass 200Lts of sea water through 55μm mesh-Net). Measure and count oyster settlement on the control packets at Oyster platform A & B during low tide. Monitor O_2,pH, Salinity, Temp., Secchi disk measurement ... etc at English point. Oyster experiment in the Aquaria in wet Lab.	LUNCH	Take plankton samples at English point. Measure physical and chemical paramet also at English point. Oyster experiment at wet Lab. and English.
	PERSONNEL: 1. Mr. Stephen Muiru (Technician) 2. Mr. Jospha Kitonga " 3. Mr. Joseph Kilonzo "" 4. Mr. James Anunda " 5. Mr. Nicholas Maroko "		NOTE: The success of experiment calls foi the spirit of TEAM WORK.

Date: 06/05/86 Estuary: Kilindini

STATION	NO_3^- µg-at N/l	NO_2^- µg-at N/l	NH_4^+ µg-at N/l	Si µg-at Si/l	PO_4^- µg-at P/l	S o/oo
A1 (0m)	0.30	0.04	-	4.00	0.90	34.99
(5m)	0.30	0.04	-	4.00	0.56	35.53
B1 (0m)	1.80	0.00	-	6.70	0.66	34.45
(5m)	0.60			4.00	0.66	34.81
B2 (0m)	0.25	0.00	-	7.20	0.52	34.09
(5m)	0.50	0.04	-	5.70	0.48	34.99
B3 (0m)	0.53	0.05	-	8.30	0.56	34.27
(5m)	0.80	0.04	-	8.80	0.52	38.42
B4 (0m)	0.40	0.05	-	8.80	0.42	33.55
(5m)	0.80	0.10	-	11.80	0.71	33.91
B5 (0m)	0.55	0.07	-	24.00	0.38	31.17
(5m)	1.00	0.08	-	23.50	0.86	31.71
B6 (0m)	0.40	0.04	-	16.00	0.66	32.97
(5m)	0.75	0.13	-	14.00	0.86	33.33

DATA ANALYSIS : 1) Catch Sampling

Date	Gear	Total Catch (kgm)	Sample kgm (indiv.)	% Species Composition	Sex ratio F/M	Mean size ($\bar{x}$) (CL mm) ♀ , ♂	Maturity (♀)
1/1/86	castnet	1.8	1.8	1. 2% *P. indicus*	-	-	-
			(383)	2. 90% *P. monodon*	0.96	17.5, 17.4	Juveniles
				3. 6% *M. monoceros*			
				4. 2% others (non Penaeids)			
6/1/86	castnet	1.3	1.3	1. 4% *P. indicus*	0.70	12.4, 10.7	Juveniles
			(412)	2. 86% *P. monodon*	0.99	16.4, 16.2	Juveniles
				3. 8% *M. monoceros*			
				4. 2% (non penaeids)			
21/1/86	castnet	3.7	3.7	1. 18% *P. indicus*	0.94	14.3, 13.8	Juveniles
			(959)	2. 80% *P. monodon*	1.20	17.1, 16.2	Juveniles
				3. 2% *M. monoceros*			
23/2/86	castnet	10	1.6	1. 53% *P. indicus*	-	- -	-
			(402)	2. 39% *P. monodon*	1.24	20.6, 20.1	Juveniles
				3. 0.2% *M. monoceros*			
				4. 8% *P. semisulcatus*			
11/3/86	castnet	5.5	3.0	1. 58% *P. indicus*	1.18	13.6, 13.8	Juveniles
			(912)	2. 34% *P. monodon*	0.99	17.8, 17.9	Juveniles
				3. 3% *M. monoceros*			
				4. 4% *P. semisulcatus*			
11/4/86	castnet	4.0	2.5	1. 54% *P. indicus*	0.90	13.0, 12.6	Juveniles
			(337)	2. 43% *P. monodon*	1.20	23.2, 21.9	Sub-adults
				3. 3% *M. monoceros*			

Date	Gear	Total Catch (kgm)	Sample kgm (indiv.)	% Species Composition	Sex ratio F/M	Mean size ($\bar{x}$) (CL mm) ♀ , ♂	Maturity (♀)
28/4/86	castnet	10	4.7	1. 36% P. indicus	0.68	15.0, 13.4	Sub-adults
			(1111)	2. 39% P. monodon	0.84	21.3, 19.8	Sub-adults
				3. 21% M. monoceros			
				4. 0.3% P. semisulcatus			
				5. 2.7% non penaeids			
10/5/86	castnet	3.0	3.0	1. 58% P. indicus	0.73	13.4, 12.9	Juveniles
			(784)	2. 21% P. monodon	1.32	22.0, 22.0	Sub-adults
				3. 6.0% M. monoceros			
				4. 14% P. semisulcatus			
				5. 1% non penaeids			
12/5/86	castnet	2.1	2.1	1. 53% P. indicus	1.39	18.3, 18.8	Adults
			(355)	2. 32% P. monodon	0.79	21.5, 19.5	Sub-adults
				3. 8% M. monoceros			
				4. 4% P. semisulcatus			

2. Plankton, Beach seining : Hydrography

Date	Station	Gear type	T°c	S°/oo	pH
10/1/86	1	Plankton	28	35	7.82
	2	net	28	35	7.61
	3	"	29	35	7.48
	4	"	29	35	7.18
	5	"	29	30	7.07
	1	Beach seine	28.5	-	7.82
	2	Beach seine	29.5	30	7.61
	3	beach seine	30.5	25	7.48
28/1/86	1	Plankton	28	35	7.83
	2	net	28.5	36	7.72
	3	"	29	35	7.47
	4	"	29	35	7.32
	5	"	30	35	7.19
	2	Benthic trawl in 1-2m depth with 500 µm mesh 3 tows	-	-	-

Total catch	Species composition	Size range (mm)
No Penaeid larvae		
7	5 *P. semisulcatus*	3.20 - 8.25
	2 *Acetes* sp.	-
83	68 unidentified Penaeids	0.7 - 4.11
	5 Juveniles - 4 *P. latisulcatus*	11.2 - 22.0
	1 *M. monoceros*	6.7
	7 caridians	-
	3 *Acetes erythreus*	-
181	148 *P. semisulcatus*	0.5 - 15.7
	23 *P. latisulcatus*	0.8 - 4.7
	1 *P. monodon*	4.55
	6 *Acetes erythreus*	-
	3 Caridians	-
No Penaeids recorded		
110	78 *P. indicus*	1.4 - 3.5
	5 *P. monodon/semisulcatus*	1.3 - 3.5
	26 *M. monoceros*	1.0 - 3.8
	1 *Acetes erythreus*	4.0

Date	Station	Gear type	T°c	S°/₀₀ pH	
	3	Benthic trawl in 1-2m depth with 500 µm net 2 tows	31	35	7.69
10/3/86	2	Benthic trawl, 2 tows with 500 µm net	31	-	-
	3	Benthic trawl 3 tows	31.5	-	-
28/3/86	2	" 2 tows	-	-	-
	stream	Benthic trawl towed up & down stream 60 m one way	-	-	-
9/4/86	stream	" beach seine 0.5cm mesh+ benthic trawl 500 µm mesh combined	-	-	-

Total catch	Species Composition	Size range
8	6 *P. semisulcatus*	5.8 - 8.3
	1 *M. monoceros*	4.3
	2 *Acetes erythreus*	
15	8 *P. indicus*	8 - 32 (TL)
46	23 *P. semisulcatus/monodon*	12 - 23 (TL)
	23 *P. indicus*	9 -14 (TL)
66	*P. indicus*	-
	P. semisulcatus	-
	P. latisulcatus	-
508	91 *P. semisulcatus*	1.8 - 15.2 (CL)
	4 *P. monodon*	7.0 - 11.8 (CL)
	6 *M. monoceros*	5.1 - 19.4 (CL)
	349 *P. indicus*	2.0 - 10.0 (CL)
	58 non-identified	-
265	51 *P. semisulcatus*	6 - 17 CL (13)
	155 *P. monodon*	6 - 14 CL (10.9)
	26 *M. monoceros*	4 -16 CL (9.5)
	33 *P. indicus*	8 - 15 CL (11.6)

Date	Station	Gear type	T°c	S°/₀₀ pH		Total catch	Species composition	Size range
25/4/86	2	beach seine 0.5cm mesh one tow	-	34	7.88	1	1 P. latisulcatus (stocked)	-
	3	beach seine one tow	-	27	7.67	23	stocked	-
		benthic trawl- 1mm net		"	"	1	P. monodon	-
	stream	one tow 2mm benthic net	-	35	7.62	704	263 P. semisulcatus 65 P. monodon 6 M. monoceros 111 P. indicus 236 others (caridians)	5 - 20 (11.9) 5 - 14 (8) 9 - 14 (11) 5 - 11 (7) -
9/5/86	2	beach seine 4mm mesh	-	33	8.59	0		
	3	"	-	32	8.41	4	1 P. monodon juv. 2 P. latisulcatus 1 gravid Macrobrachium sp.	- -
	stream 60m	2mm mesh benthic trawl on rectangular mouth	-	33	8.33	1	M. monoceros sub-adult	

TL = total lenght
CL = carapax lenght

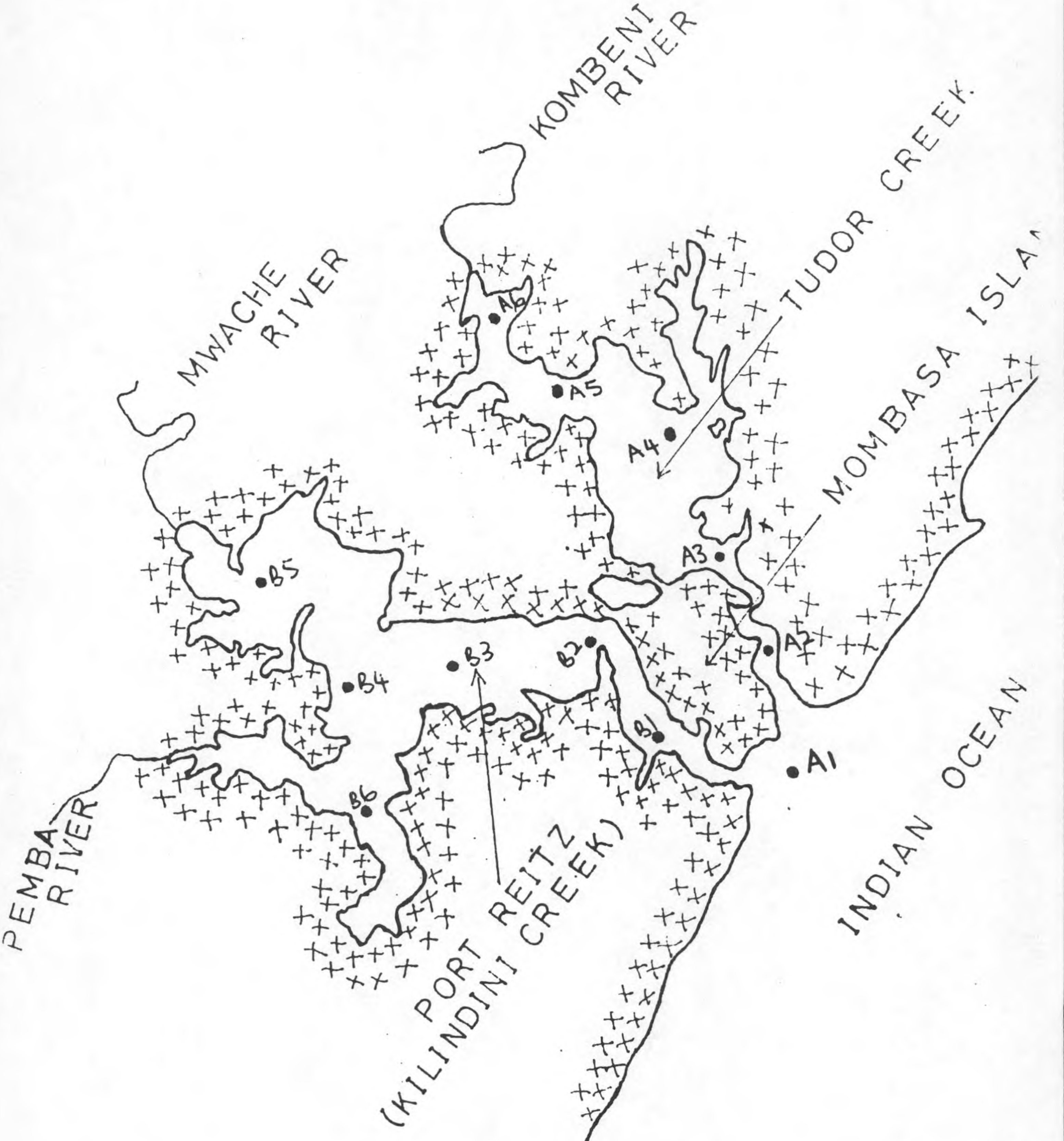


FIG. 1
A1 – A6 (TUDOR CREEK)
B1 – B6 (KILINDINI CREEK).

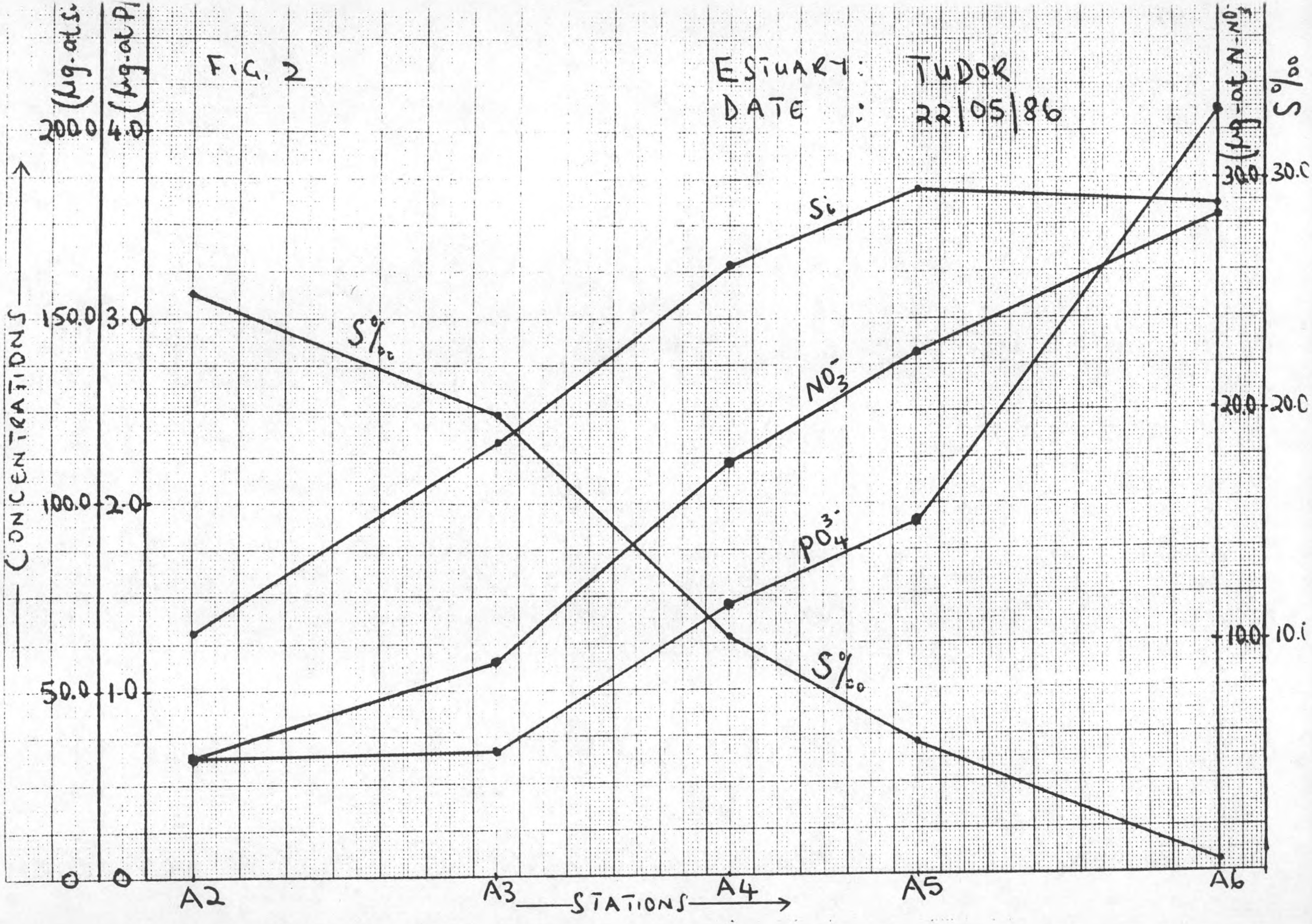


FIG. 2
ESTUARY : TUDOR
DATE : 22/05/86
CONCENTRATIONS
(μg-at Si)
(μg-at P)
(μg-at N-NO$_3^-$)
S‰
200.0
150.0
100.0
50.0
0
4.0
3.0
2.0
1.0
0
30.0
20.0
10.0
Si
NO$_3^-$
PO$_4^{3-}$
S‰
A2
A3
A4
A5
A6
STATIONS

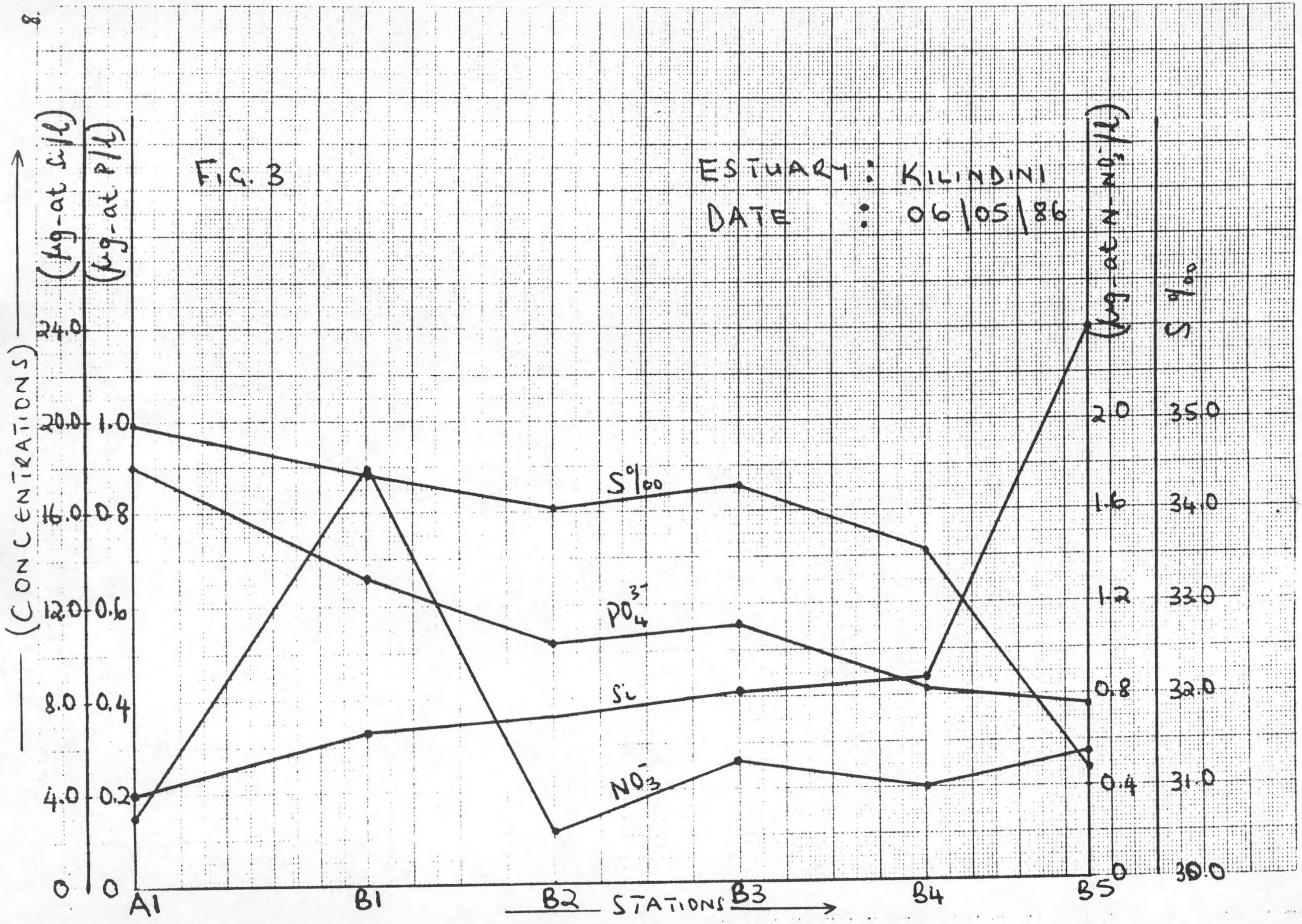


FIG. 3
ESTUARY : KILINDINI
DATE : 06/05/86
(CONCENTRATIONS) →
(μg-at Si/l)
(μg-at P/l)
(μg-at N-NO3-/l)
S ‰
S‰
PO4 3-
Si
NO3-
0
4.0
8.0
12.0
16.0
20.0
24.0
0.2
0.4
0.6
0.8
1.0
0.4
0.8
1.2
1.6
2.0
30.0
31.0
32.0
33.0
34.0
35.0
A1
B1
B2
B3
B4
B5
STATIONS →

POPULATION DYNAMICS MAJOR PENAEIDAE SHRIMPS SPECIES IN THE TUDOR CREEK

E.O. Wakwabi

Aims : (1) To study the life history with emphasis on documentation on larval stages of the major penaeids in inshore waters (case study area: Tudor Creek).

(2) To determine relative abundance, recruitment intensities, growth rates, reproduction and mortalities on the creek penaeids.

Introduction

In recent years, the prawn fishery has grown tremendously, due to the high market value. Such growth, if not based on sound understanding of the population, may result to resource depletion due to overfishing The Tudor Creek is likely playing a multiple role to the shrimp fishery i.e. offering nursery, feeding and spawning grounds; which must be understood in order to evaluate the actual fishing pressure the creek population can sustain.

Precise knowledge on life cycles through which the shrimp grows is necessary for understanding and executing management procedures. In a multispecies fishery, specific identity of the very young is important for designing sampling and fishing programmes.

Methods

1. Relative reqruitment into the backwaters i.e. the settling post-larvae in shallow (1m) waters where they assume benthic life, has to be followed by regularly sampling. Penaeids tend to migrate to the (offshore) sea waters where they mature and spawn. Samples from the principal gears used in the creek will be used in the shallow water fishery. Trawling in the deeper waters will afford data on the older and larger animals.

../1

2. The reproductive cycles can be studied by sampling ovarian development cycles, plankton for larvae and postlarvae and beachseining for postlarvae.

3. Reproductive potential - studies on the sex ratio, size at maturity and fecundity will provide information on the potential for the population to replanish itself. This kind of information is necessary for determining potential yields.

4. Histological preparations to confirm ovarian stages and fecundity counts.

5. Oceanographic parameters include water temperatures, salinities and pH.

Annex 8/6

THE ESTUARINE FISHES OF KENYA.

R.M.Nzioka.

The East African Coast supports an extremely diverse fish fauna which has been studied taxonomically in considerable details but only little in terms of its biology and ecology. The need for this type of research has developed progressively during the last decade due to decline in availability of certain species in response to commercial fishing and environmental degradation. Furthermore, concern over the state of the fauna and the lack of the research has been stimulated by an increasing awareness that it constitutes a valuable national asset. In view of the diversity of the fauna and its environment, great care had to be taken to set research priorities so as to investigate the most serious problems first. It was decided that priority should be given to fishes living in endangered and degraded habitats rather than to individual species subjected to heavy exploitation. This was based on the conviction that serious long-term and sometimes irremediable damage can result from the former, whereas exploited species have a natural ability to recover if fishing effort is reduced.
Primarily sampling was started in February 1985 and followed by intensive monthly sampling. This work is to continue for three years.

Sampling was concentrated in Port Reitz and Tudor Creeks.
The main fish groups were Leiognathidae, Scianidae, Mulidae, Pomadasydae, Sphyraenidae, Clupeidae, Lutjanidae, Carangidae, Drepanidae and Teraponidae. Numerous other species were present in small quantities.
In many species juveniles exceeded the number of adults. Examples are Scianidae, Joliniops dussumieri, J.sina; Gerridae, Gerres oyena, G.filamentosus; Pomadasydae, Pomadasys opercularis, P.maculatus, P.maculumatum; Sphyraenidae, Sphyraena obtusata, S.japonicus; Lutjanidae, Lutjanus setae, L.fluviflama; Drepanidae, Drepane punctata; Carangidae, Rhabdosargus sarba and Terapon jarbua. In other important species juveniles do not appear to predominant in the same extent but are nevertheless extremely abundant; examples being Sardinella albella, Herklotichthys quadrimaculatus, H.puncta, Tryssa vitrirostris, Pellona ditchella, Leiognathus equulus, L.bindus, L.fasciatus, L.splendens, L.berbis, L.lineoletus. It is also important to record that in a number of species which are less common in the creeks, it is again the juvenile stage which occurs in great numbers. These include Carangidae, Carangoides chrysophrys.
An intresting feature of the length composition of a number of species is the rapid decline in catch as size increases. The most likely factors responsible for this are mortality within the estuarine environment and emigration from it.

Table 1. Fish species caught in the Estuaries in 1985. (% of total catch)

Leiognathidae	*Leiognathus eguulus*	27.1
	L.fasciatus	C
	L.berbis	11.4
	L.splendens	C
	L.lineoletus	5.8
	L.bindus	7.8
	Gazza minuta	8.7
	Secutor insidiator	7.7
Scianidae	*Joliniops dussumieri*	2.7
	J.sina	C
Gerridae	*Gerres oyena*	C
	G.filamentosus	7.4
Mullidae	*Upeneus vittatus*	2.1
	U.sulphurus	1.1
Pomadasydae	*Pomadasys opercularis*	C
	P.maculumatum	C
	P.maculatus	C
Sphyraenidae	*Sphyraena obtusata*	1
	S.japonicus	C
Clypeidae	*Sardinella albella*	3.7
	Herklotichtys quadrimaculatus	4.7
	H.punctata	C
	Thryssa vitrirostris	1.8
	Pellona ditchella	C
Lutjanidae	*Lutjanus setae*	C
	L.fluviflama	C
	L.russeli	C
Carangidae	*Carangoides chrysophrys*	C
	Alectis indicus	C
	Rhabdosargus sarba	C
	Pseudorhambus arsius	C

* C : common

Annex 8/7

SOME FISH QUALITY PARAMETERS OBSERVED IN MOMBASA MARKETS

P.M.Oduor.

SUMMARY:

Crude protein contents of most fish species analysed ranged between 14.0% ~~to~~ and 22.0% of protein on weight basis per gram of muscle.

Crude fat content seems to have a role in the rate of deterioration of dry salted fish.

Moulds, Insects, rodents play different roles in spoilage of sun-dried, dry salted and smoked fish.

INTRODUCTION:

The major nutrient in fish are proteins. Preservation of fish to prevent any losses nutritionally is the key to improving the nutritional status of a population. It is important to ensure that potentially available fish nutrients reach the consumer. Nutritional loss in this case can be defined as the nutrients from, and the value of fish which is available potentially for human consumption but fails to be consumed or sold as traditionally cured products. These losses are due to spoilage rendring the fish or fish product unfit to eat, to physical destruction and to lowering the nutritional value of the product. (FAO fishering technical paper No. 219).

METHODS

For protein content, the Kjeldahl method was used (Maynard and Johnson 1970). The fish were bought from the market fresh and 1 gram from each fish species was used.

For fat content, the soxhlet method was used (Windsor and Barlow (1981). Petroleum spirit Boiling point 80 - 100^{o}C was used instead of diethyl ether. The fish were bought from the market, sun-dried and 5 g of muscle from each used. The fish took five months before being discarded and observations were organoleptic. For storage and handling of fish, Majengo, Mwembe Tayari, Kilifi and Old town markets were visited.

RESULTS:§

PROTEIN CONTENT

NAME	CRUDE PROTEIN CONTENT/ gram wet weight
Lutjenus bohar	14.30%
Octopus	8.80%
Cuttle fish	9.60%
Getarin getarinus	15.40%
Pomadysis maculatus	15.80%
Tilapia (Bamburi fish farm)	17.90%
Leognathus equala	16.70%
Lethrinus harak	18.10%
Lethrinus miniatus	18.40%
Lethrinus nebulosus	18.80%
Cephalophoris argus	18.20%
Siganus canaliculatus	18.0%
Upeneus bensasi	18.30%
Shark	19.50
Epinephalus tauvina	22.80%

CRUDE FAT:

NAME	FAT CONTENT/5g DRY WEIGHT	ORGANOLEPTIC ASSESSMENT.
Trichinotus blochii	2.50%	After 5 months, no sign of spoilage
Heminipherous far	7.80%	Ants invaded this i the 4th month.
Drepane punctata	9.50%	No signs even durin 5th month.
Pseudopristoma plagiodesmus	11.50%	After 3 months, slight signs of deterioration notice some mouldy growth observed towards 4th month covering $\frac{I}{8}$ of body, extending to cover $\underline{I}$ $\frac{1}{3}$ of the boc during the 5th month Ants also prevalent.
Monodactylus argenteus	14.50%	1 month 3 days, moul growth covering about $\frac{1}{3}$ of the body seen to spread.
Pseudopeneus frateculus	14.80%	1 month 3 days, ants appeared eating the muscle, mouldy growt seen to be similar a in Monodactylus arge teus.

STORAGE:

NAME	MARKET	TYPE OF PRESERVATION
King fish	Old town	Brining
Shark	Mwembe Tayari Kilifi, Old Town	Dry salting
Clarius	Majengo	
Protopterus	Kilifi	Smoking
Nile Perch		
Eungalocypris	Majengo, Kilifi	Sun-drying

All observations made were organoleptic; the fish had been brought to the market ready for sale hence source where processing commenced was not reached.

DISCUSSION:

The lowest protein content was observed in the cuttle fish and octopus and Epinepherous tauvina the highest. The highest fat content was observed in Pseudopeneous frateculus and the lowest in Trichinotus blochii. The storage life of sun-dried fish showed some correlation with fat content in that the higher the fat content, the faster was the rate of deterioration. Ants were however seen to attack the fish indiscriminately.

Eungalocypris were attacked by worms which sources at the markets said appeared after 2 - 3 months and fed from within the fish. In the storage placed at night, rats mainly ate the fish. The nile perch (smoked) was not affected but this could be due to the short storage time they take in the markets - they takes less than 2 weeks before being sold. King fish did not show any signs of deterioration when still brined in the 'well' Infact the storage period according to the dealers could extend upto 6 years. The sharks were affected

(after a fairly short time almost two months within drying) by beetles and moulds (not identified). and destroyed the muscle. Clarius, protopterus only affected by cockroaches on a minor scale and by rats only when stored at night. They stay in the market for a short time before being cold and during the day, they are exposed outside to the sun in the markets.

The fat content relation to spoilage was seen to be appreciably significant considering the lowest fat content observed on Trichinotus blochii (2.50%) and Pseudopeneus fratoculus (14.80%). It is obvious therefore that the higher the fat the faster the rate of deterioration and vice versa. This could be due to the fact that a high fat content in the flesh will act as a barrier to diffusion of water from the centre of the fish to the surface hence spoilage due to high water activity in fish suitable for microbial growth. (FAO Tech. paper No. 219). The fact that the smoked Nile perch is not attacked in any way though it is fatty is partly explained by the short time they take in the market and also due to a possibility of the phenolic substances found in wood smoke having an anti-oxidant activity (preventing rancidity) and/~~mx~~ may provide some protection for the fat. (FAO fisheries tecn. paper). This could hold time for Clarias and protopterus which do not undergo visible spoilage though they also take a short time in the market. Cocktoaches. Rats are their major attackers.

The King fish which are brined in a bag well for a long time survived without any attack. Possible explanation here is that the salty conditions are too adverse for any of the pests to survive. Their consumption rate has to go up after removal from the well as they are fatty and the ones which had been removed from brine for some time were being attached by some beetles.

For the dry salted sub-dried shark, first they are so many in the markets, parked closely together especially at Mwembe Tayari market under damp conditions. The damp conditions encourage the mould spores to proliferate due to high water activity possible (FAO papre No. 219;). The fish are packed closely together and this aids spread of moulds. They are fed on by adult beetles indiscriminately all three year round and these could also spread the spores when the spores stick on their legs. The environment favours the breeding of beetle larvae being wet, filthy, with all kinds of wastes from this fish markets. Some of the sharks which were being dried near the markets were attacked by some fly larvae.

Where as the fish studied have very high content of proteins, for this to be available, improvement on traditional curing methods are necessary. It is almost convenient to smoke fatty fish to minimize spoilage or to brine them. Sun dried salted fish should be spaced to avoid rapid attack by moulds and other agents, pesticides or other such sprays could be used; to eradicate the beetles; removal of fish wastes from the storage premises as these may contribute breeding sites for pests. Use of traps to prevent rodents. However, different factors play different roles in fish spoilage and one or a combination of two can not be seen as a major source of spoilage.

REFERENCES

1. FAO Fisheries Techn. Paper No. 219 page (1)

2. Introduction to Fishery By - Products (By Malcolm Windsor & Stuart Barlow; Page 153 - 154.

3. Maynard & Johnson (1970) - Methods in Food analysis (Page 670 - 671).

4. FAO Fisheries Techn. Paper No. 219 (Page 6)

" (10)

(16)

A study of the biochemical levels in commercial oysters, *Crassostrea cucullata* Barr .

Laila U. Abubaker
Assistant Research Officer, KMFRI

Abstract.

The nutritive value of *Crassostrea cucullata* Barr was investigated in March and May 1986. The study indicatedthat this species is rich in protein and carbohydrate which are necessary for a balanced diet.

Introduction;

Oysters and other bivalves are a low-cost subsistance food of the coastal people. The molluscan resources of this coast are largely unexploited as only a minority of people eat them, consumption being restricted to tourists. The oyster meat is unknown to many Kenyans especially those inland. However, it is believed that oyster fishery will have a good commercial potential in the country once the meat becomes acceptable to the locals. Thus an understanding of the biochemical composition and stage of development when nutritional value is optimum are prerequisite for planning large scale culture.

The present study describes the biochemical composition during the growth period of *C.cucullata* grown on mangrove poles at Gazi oyster culture (= experimental culture project)

Material and methods.

Samples were pooled from at least 20 individuals of uniform size between March and May 1986, and analysed for their food value. In general, the methods elaborated by Giese (1967)for invertebrates were followed for both preparation and biochemical estimations. For the biochemical composition, the levels (in % dry weight) of protein and carbohydrate were estimated. The water level (in % wet weight) was determined by drying at 100°C to constant weight. The levels of protein and carbohydrate were estimated using previously dried sample. The total nitrogen value as determined by the semi-micro Kjeldhl method (Joslyn, 1970) was multiplied by the conversion factor 6.25 to obtain the total protein value. The total carbhydrate (in % glucose of dry weight) was estimated by the Anthron method (Seigter et al,1950).

Results.

The table below shows the result obtained compared with C.virginica (Galtsoff, 1964), C.gigas (A.C.Giese), local beef and eggs.

% composition	C.cucullata	C.virginica	C.gigas	beef	eggs
protein	56.08	49	9.8	18.7	45.4
carbohydr.	7.58	10.5	4.5	0.5	1.0
water	75.6	80.5	-	64.7	66.3

Water levels in % wet weight. Protein and carbohydrate levels in % dry weight.

In May 1986 the results are as follows for C.cucullata:
Protein: 49.9 %, carbohydrate: 0.38 %, water: 87 %

The table shows that oyster meat is as nutritive as local chicken eggs.
In May there is a fall in the protein and carbohydrate levels. This could be the time when the oysters have spawned as the reserve nutrients have been converted to gamete material. However, more analyses should be done on weekly bases in order to arrive at a definite conclusion.

References.

Giese, A.C. 1967. Some methods for study of the biochemical composition of marine invertebrates. Oceanogr. Mar.Biol.Ann.Rev. 5: 157-186.

Giese, A.C. 1969. A new approach to the biochemical composition of the mollusc body. Oceanogr.Mar.Biol.Ann. Rev. 7: 175-229.

Ajana, A.M. 1980. Fishery of the mangrove oyster, C.gasar Adanson (1757), in the Lagos area, Nigeria. Aquaculture 21: 129-137.

Stephen, D. 1980. The reproductive biology of the Indian Oyster C.madrasensis (Preston). II. Gametogenic cycle and biochemical levels. Aquaculture 21: 147-153.

Maynard A.Josyln 1970. Methods in food analysis.

Pearsons , 8th edition, Chemical analysis of foods.

Annex 8/9

MANGROVE ECOLOGY

R.K. Ruwa

Mangroves are important for nutrient release, offer habitats for several organisms, protect shores and in terms of human economic uses they are used for building purposes, fuel etc. Beside mangrove ecosystems mariculture projects are in practice. But even with this knowledge mangroves have not been exonorated from the myth that they are idle forests.

In Kenya, although they are protected under the Governmen Forest Acts, they have been cut down in some areas for the construction of salt and mariculture ponds. The mangrove ecosystems in Kenya are also faced with an eminent degradation of their environments due to the dumping of sewage and solid wastes from fast growin coastal towns, some of which a couple or three decades ago were villages.

Since ecological information on mangrove ecosystems in Kenya, which could be used for conservation purposes and direct or indirect planned exploitation of this resource,is lacking, this project was initiated. It is geared to gather information (a) regardin species diversity in mangrove forests (b) their role as suitable mariculture sites and in our case e.g. oyster culture, and (c) their role in protecting shorelines from erosion which is very common in Lamu District.

1.1. Mangrove Environment

Mangrove seedlings germinate in brackish water environment Brackish water conditions are therefore prerequisites for mangrove development and occurence. In Kenya the brackish water conditions are created by river discharges and seepage of underground water into the intertidal zone.

A survey on the intertidal environment of various parts of the Kenya coastline showed that there is considerable amount of underground fresh water seeping into the intertidal zone which therefore creates the brackish water environments. The fresh water mixes with marine salts in the sediments or mixes with the sea water as indicated by the salinity records in Table 1. This seepage phenomenon has now explained the existence of mangroves on areas without any river flowing into the sea e.g. Bamburi, Kanamai, Mida etc. (see also annex 11).

1.2. Species diversity

Since the Kenya coastline has brackish water biotopes with and without mangroves, the role of the latter in increasing species diversity in Kenya can be evaluated. Thus beginning with the Crustacea, a faunal species composition of the crabs was initiated.
The current areas of study are :

(a) Kanamai beach, where there is a muddy shore with considerable seepage but, has no mangroves
(b) Bamburi and Mkomani, where there are small mangrove patches growing on brackish environments created by seepage only.
(c) Gazi mangrove forest, where the brackish water environment is created by seasonal rivelets and seepage (see also annex 11).

To date,the species composition is as shown in Table 2. From the latter Table there is a clear indication that mangrove vegetation increases species diversity in brackish water biotopes. Further work is in progress to establish the relative abundances of various species in relation to forest size or area of seepage and the microhabitat description prefered by each species.

Table 1 : Salinity ($^{\circ}/_{\circ\circ}$) measurements at various points where water was seeping from underground into the intertidal zone. The measurements were done at low tide when it was not raining.

Point of seepage	Gazi	Nyali	Bamburi	Kanamai	Mkomani	Shelly	Tiwi
1	16	18	25	22	16	33	6
2	18	19	26	26	17	34	7
3	21	23	28	28	-	35	9
4	-	-	30	29	-	-	12
5	-	-	31	-	-	-	10
6	-	-	-	-	-	-	15
7	-	-	-	-	-	-	17
8	-	-	-	-	-	-	20
9	-	-	-	-	-	-	24
10	-	-	-	-	-	-	29
11	-	-	-	-	-	-	32
Date	2/6/85	4/6/85	5/6/85	8/7/85	11/7/85	21/8/85	22/8/85

Table 2 : Occurence of various types of brackish water crabs at Gazi, Kanamai, Bamburi and Mkomani. (x) indicates that the species was seen and (-) indicates: not seen to date, 18/6/86. Out of the four localities sampled it is only Kanamai beach swamp that has no mangroves.

SPECIES	Gazi	Kanamai	Bamburi	Mkomani
1. Uca annulipes	x	-	x	x
2. U. chlorophtalmus	x	-	x	x
3. U. marionis	x	x	x	-
4. U. vocans	-	x	x	-
5. U. tetragonon	x	x	x	x
6. U. inversa	x	-	-	-
7. U. urvillei	x	-	-	-
8. U. dussumieri	x	-	-	-
9. Macrophtalmus	x	x	-	-
10. M. milloti	x	x	-	-
11. M. consorbrinus	-	x	x	-
12. M. bosci	-	x	-	x
13. Thalanita crenata	x	x	x	x
14. Scylla serrata	x	x	-	-
15. Metopograpsus messor	x	-	x	x
16. Sersana elongatum	-	-	-	x
17. S. impressum	-	-	x	-
18. S. guttatum	x	-	-	-
19. S. plicatum	x	-	-	-
20. S. eulinene	x	-	-	-
21. S. meinerti	x	-	-	-
22. S. catenata	x	-	-	-
23. Pseudograpsus elongatus	x	-	-	-
24. Cardisoma carnifex	x	-	-	-
25. Eurycarcinus natalensis	x	-	-	-
26. Varuna litterata	x	-	-	-
27. Xanthid sp.	x	-	-	-
28. Ilyograpsus paludicola	x	-	-	-
Total No of species	23	9	9	7

Annex 8/10

GAZI OYSTER PROJECT I. GROWTH OF OYSTER *CRASSOSTREA CUCULLATA* BORN.

R.K.Ruwa.

Introduction.

The growth of oysters from the time of settlement is being monitored at Gazi Creek. This study is started to :

1. provide an idea on their patterns of growth at different levels on the shore
2. determine the suitable size and age for transplanting them without high risks of mechanically damaging them when cementing
3. study the effects of intraspecific and interspecific competition on their growth.

Methods.

Strung coconut shells whose surfaces have been entirely cemented with marine cement were suspended vertically on oyster racks in the interdidal zone . The surfaces of the coconut shells were used as sites for settlement of oyster spats. The shells were spaced at 10 cm intervals. The level of the first shell at the bottom was 1.1 m above datum, whereas the highest shell 2 m for the strings of 10 shells and 1.5 m for those of 5 shells. The strings were suspended on the racks on the 17th March 1986.

Observations and remarks.

Counts of the oyster spat that settled on the coconut shells were made. Their growth was followed by measuring their maximum shell lengths using a vernier calipers (Table 10. The measurements of their shell lengths showed that the oysters on the lower shells grow faster than those on the higher ones.
Barnacles were observed to be the only competitors for space on both the upper and the undersides of the coconut shells. The barnacles were mainly *Balanus amphitrite* and occasionally *Euraphia withersi*. Counts of the barnacles showed that the higher level coconut shells supported more specimens than the lower level ones (Table 2)>
The oyster spats settled more abundantly on the lower level shells and also more on the underside of the shells than on the uppersides (Table 3). Since the oyster settlement at the lower levels were higher and the growth was faster, and since there was less competition for space with barnacles, it was found more suitable to hang shorter strings of 5 coconut shells in the level 1.0-1.5 m above datum to collect the oyster spats.
Further studies were done to find out the significance of the relationship between their height on the shore and their growths. The sequence of the shells on one of the monitored strings was

reversed, having now the first shell uppermost and the last tenth one lowermost in decending order. This was done on the 26th May 1986 and the experiment is still in progress.
So far, the sizes of the growing oysters on the coconut shells are not yet suitable for removal without high risks of mechanical damages. The oysters are therefore still being nursed on the shells

Table 1.

Ranges of shell lengths (in mm) of the oysters on coconut shells suspended on the racks on 17th March 1986.
A, B and C denote the strings.
Note: some dark silting sometimes concealed some oysters in the lower levels. C was not measured on the 9th May 1986.

Nr. of coconut shell	Elevation (m) above datum	1st April 1986			16th April 1986		
		A	B	C	A	B	C
1	1.1	1.6	2.1-3.2	1.5	0.7-2.8	1.2-6.4	0.6-5.0
2	1.2	2.0	1.9	1.2	1.2-5.5	3.5-4.9	0.6-2.4
3	1.3	0	0	1.3-2.7	1.0	1.1	1.0
4	1.4	0	0	0	0.8	0.7-1.5	1.6-1.8
5	1.5	0	0	0	1.0-1.5	0	1.0-1.8
6	1.6	-	0	0	-	2.0-2.1	0.5
7	1.7	-	0	0	-	1.0	0
8	1.8	-	0	0	-	0	0
9	1.9	-	0	0	-	0	0
10	2.0	-	0	0	-	0	0

Nr.	29th April 1986			9th May 1986		21st May 1986		
	A	B	C	A	B	A	B	C
1	1.7-8.0	1.6-10.6	1.0-4.4	1.2-9.1	1.0-14.0	1.0-11.9	1.5-15.5	1.3-10.2
2	1.0-10.7	1.1-8.0	1.2-4.0	1.5-17.1	1.6-13.0	1.0-19.0	1.0-14.8	1.3-10.7
3	1.5-2.0	1.0-2.0	1.0-9.6	1.6-3.4	1.0-3.4	2.3-5.4	1.0-5.7	1.5-15.5
4	1.1-1.7	1.0-2.2	1.5	1.2-5.2	1.0-5.8	1.0-6.0	1.8-8.0	1.5-4.8
5	1.1-3.2	1.2-2.2	1.0	1.7-5.3	1.2-5.8	1.0-4.6	2.0-6.0	1.7-7.0
6	-	1.6	1.4-4.2	-	1.3-6.0	-	1.5-6.2	1.3-7.3
7	-	1.4-2.5	1.5	-	1.2-3.6	-	1.6-3.9	1.8-4.0
8	-	1.2	0	-	1.0-2.6	-	1.5-3.0	1.5-3.8
9	-	1.0	0	-	0	-	2.0-3.0	0
10	-	0	0	-	0	-	0	0

Table 2

Relationship between settlement of barnacles and the oyster Crassostrea cucullata Born on the 8 coconut strings (as in Table 1 and 3).
The counts were made on the 26th May 1986.
The numbers in parantheses represent the numbers of barnacles.

Nr.coconut shell	Underside of coconut shell		Upperside of coconut shell	
1	101	(13)	9	(0)
2	66	(31)	10	(4)
3	31	(71)	6	(2)
4	84	(110)	18	(0)
5	117	(270)	17	(7)
6	87	(89)	18	(33)
7	81	(155)	28	(80)
8	59	(1075)	4	(167)
9	12	(870)	0	(288)
10	0	(665)	0	(51)

Table 3.

Patterns of settlement of the oyster *Crassostrea cucullata* Born on cemented coconut shells.
A, B and C denote the strings.
Note: some dark silting sometimes concealed some oysters in the lower levels.
Numbers represent the numbers of oysters settled on the inner surfaces of the shells.
Numbers in parenthesis represent the numbers of oysters settled on the upper surfaces of the shells.

Nr.coconut shell	Elevation (m) above datum	1st April 1986 A	B	C	16th April 1986 A	B	C
1	1.1	1 (2)	4 (2)	1 (1)	15 (21)	26 (9)	4 (8)
2	1.2	1 (0)	4 (1)	3 (0)	4 (8)	5 (5)	8 (0)
3	1.3	0 (0)	0 (0)	2 (0)	6 (0)	1 (0)	2 (4)
4	1.4	0 (0)	0 (0)	0 (0)	8 (2)	16 (3)	2 (0)
5	1.5	0 (0)	0 (0)	0 (0)	8 (0)	0 (0)	2 (0)
6	1.6	-	0 (0)	0 (0)	-	3 (0)	7 (0)
7	1.7	-	0 (0)	0 (0)	-	2 (0)	0 (0)
8	1.8	-	0 (0)	0 (0)	-	0 (0)	0 (0)
9	1.9	-	0 (0)	0 (0)	-	0 (0)	0 (0)
10	2.0	-	0 (0)	0 (0)	-	0 (0)	0 (0)

Table 3

Nr.shell	28th April 1986			6th May 1986			15th May 1986		
	A	B	C	A	B	C	A	B	C
1	155 (22)	81 (11)	29 (3)	141 (24)	91 (0)	32 (0)	149 (31)	72 (7)	56 (5)
2	25 (11)	51 (13)	42 (0)	29 (8)	72 (0)	33 (2)	33 (11)	46 (6)	34 (0)
3	21 (8)	14 (0)	10 (0)	25 (5)	16 (2)	15 (9)	29 (6)	14 (2)	15 (17)
4	31 (2)	18 (0)	5 (0)	37 (2)	26 (6)	12 (0)	33 (1)	47 (3)	21 (0)
5	26 (1)	7 (0)	7 (0)	37 (0)	68 (6)	15 (3)	28 (0)	93 (4)	26 (2)
6	-	22 (1)	35 (1)	-	64 (0)	61 (2)	-	68 (10)	37 (0)
7	-	7 (0)	10 (2)	-	41 (0)	31 (23)	-	51 (9)	24 (2)
8	-	6 (0)	1 (0)	-	17 (0)	6 (3)	-	4 (0)	8 (0)
9	-	2 (0)	3 (0)	-	0 (0)	7 (0)	-	6 (0)	3 (0)
10	-	0 (0)	0 (0)	-	0 (0)	2 (0)	-	1 (0)	0 (0)

Annex 8/11

THE DISTRIBUTION AND ABUNDANCE OF CORALS ALONG THE KENYA COAST.

N. Muthiga.

Introduction.

In vieuw of the importance of coral reefs to the littoral ecology of adjoining coasts, a coral reef project was started with the following objectives.

(1) To survey the Scleractinia and other anthozoans in various biotopes along the Kenya coast.

(2) To select suitable corals for growth studies, the main criteria being dominance within the various biotopes and a morphological structure allowing for quick and easy measurement of growth.

Method.

(1) Spot check method: consists of swimming along a reef slope reef crest or reef flat and recording any new species of coral encountered and the biotope and depth.

(2) For more detailed study of the community structure, a transect line is laid along or across a zone and any coral underlying this line is measured and recorded.

The following sites were studied:

Location	≠ of sites
Kiunga Marine National Reserve	5
Malindi Marine National Park	4
Mida creek	2
Kanamai	2
Bamburi	1
Nyali	1
Tiwi	2
Diani	2
Shimoni (Kisite Island)	3

A wide range of reef types including mainland and island fringing reefs, interdidal and submerged reefs were studied.

Results of the survey.

A tentative checklist was compiled (Appendix I) which includes corals identified in the field, and corals that are part of the K.M.F.R.I. collection and the University of Nairobi, Zoology Dept collection. The corals identified includes 50 genera and more than 144 species.
The Kenyan coast is therefore relatively rich in coral species comparable to reefs in the South East Asian region which have the greatest abundance and diversity of hermatypic corals. Most of the reefs visited were fairly shallow (20 m) and therefore with deeper areas being explored, more species could be discovered. Other corals not included in the Order Scleractinia also occur along the Kenyan coast including the families Tubiporidae, Helioporidae, Milleporidae and Stylasteridae. Appendix II shows the distribution of the most abundant genera along the Kenyan coast. Acropora, Pocillopora, Montipora, Porites, Favites, Platygyra, Pavona and Echinopora are the most common genera, while Auropora and Favia had the most number of species. From the spot checks, the Malindi Marine National Park, Mida creek and Shimoni had the highest abundance of genera.
For more detailed work, transects were laid along the reef crest, slope and flat at North reef at the Malindi Marine National Park (as described above). The data that was collected will be included in a paper for publication similar work is carried out on other reefs including Mida creek and Shimoni. The data collected thus will give us an idea of the community structure of these reefs including species diversity and abundance. This data can be used as a base for future monitoring of these reefs.

Results of Growth Studies.

Six coral colonies of the genera Acropora were tagged with insulated electrical wire (5 branches each) and subsequent measurements were made. The average growth rate was 5 cm in seven months. As growth measurements were not taken frequently, we cannot deduce whether the growth rate changes due to charges in the environment (i.e. cooler water, less sunlight, lower salinity etc.). As Malindi is far away from the Marine station, having a steddy schedule is difficult to maintain. However with transport readily available, more corals need to be tagged on different parts of the reef.

APPENDIX I: A TENTATIVE CHECKLIST OF HERMATYPIC CORAL SPECIES FOUND ALONG THE KENYA COAST.

Systematics:

Order SCLERACTINIA	Bourne, 1900
Suborder Astrocoeniina	Vaughan & Wells 1943
Family Thamnasteriidae	Wells, 1956
Genus Psammocora	Dana
P. haimgana	Milne - Edwards & Haime, 1851
P. nierstrazi	Horst, 1921
P. explanulata	Horst, 1921
P. contigua	Esper
Family Astrocoeniidae	Koby
Genus Stylocoeniella	Yabe & Sugiyama, 1935
S. armata	(Ehvenberg, 1834)
Family Pocilloporidae	Gray, 1842
Genus Pocillopora	Lamarck, 1816
P. damicornis	(Linnaeus, 1758)
P. verrucosa	(Ellis & Solander, 1786)
P. eyedouxi	Edwards & Haime, 1860
Genus Seriatopora	Lamarck, 1816
S. hytrix	Dana, 1846
S. caliendrum	Ehrenberg, 1834
Genus Stylophora	Schweigger, 1819
S. pistillata	Esper, 1797
Family Acroporidae	Verrill, 1902
Genus Acropora	Oken, 1815
Acropora formosa	Dana, 1846
Acropora pharaonis	Milne - Edwards & Haime
Acropora humilis	Dana, 1846
Acropora rotumana	Gardinee
Acropora secale	Studer, 1878
Acropora florida	Dana, 1846
Acropora palifera	Lamarck

A. granulosa	Milne - Edwards & Haime, 1860
A. clathrata	Brook, 1891
A. cuneata	Dana
A. millepora	Ehrenberg, 1834
A. ocellata	Klunzinger
A. hyacinthus	Dana, 1846
A. cytherea	Dana, 1846
A. hemprichi	Ehrenberg
A. aculeus	Dana, 1846
A. variabilis	Klunzinger
Genus Astreopora	Blainville, 1830
A. myriophthalma	Lamarck, 1816
A. incrustans	Bernard, 1896
Suborder Fungiina	Verrill, 1865
Family Fungiidae	Dana, 1846
Genus Cycloseris	Edwards & Haime, 1849
C. cyclolithes	Lamarck, 1801
C. patelliformis	Boschma
Genus Diaseris	Edwards & Haime, 1849
D. distorta	Michelin, 1843
Genus Fungia	Lamarck, 1801
Subgenus Fungia	Lamarck, 1801
F. (F.) fungites	Linnaeus, 1758
Subgenus Vevrillofungia	Wells, 1966
F. (V) repanda	Dana, 1846
F. (V) granulosa	Klunzinger, 1879
F. (V) plana	Studer
Subgenus Pleuractis	Verrill, 1844
F. (P) scutaria	Lamarck, 1801
Genus Herpolitha	Eschscholtz, 1824
H. limax	
Genus Halomitra	Dana, 1846
H. philippinensis	Studer
Genus Po	Edwards & Haime, 1849
P. crustacea	Pallas, 1766

Family Poritidae	Gray, 1842
Genus Porites	Link, 1807
P. lobota	Dana, 1846
P. compressa	Dana, 1846
P. lutea	Edwards & Haime, 1860
P. nigrescens	Dana, 1846
Porites (Synaraea) convexa	Verill
P. sp 1 & P.sp 2	
Genus Goniopora de	Blainville, 1830
G. stokesi	Edwards & Haime, 1851
G. lobota	Edwards & Haime, 1860
G. columna	Dana, 1846
Genus Alveopora	Blainville
A. mortenseni	Crossland
Family Siderastreidae	Vaughan & Wells, 1943
Genus siderastrea	
* Siderastres sp.	
Family Agariciidae	Gray, 1847
Genus Pavona	Lamarck, 1801
P. frondifera	Lamarck
P. varians	Vervill, 1864
P. maldivensis	Gardiner, 1905
P. esplanulata	Lamarck, 1816
Genus Pachyseris	Edwards & Haime, 1849
P. rugosa	Lamarck 1801
P. speciosa	Dana, 1846
Genus Gardinoseris	Scheer & Pillai, 1974
G. planulata	Dana
* Genus Coscinaraea	Edwards & Haime, 1848
C. monile	Forskal, 1775
Genus Agariciella	
A. minikoiensis	Gardiner
Genus Coeloseris	Vaughan, 1918
C. mayeri	Vaughan, 1918
Suborder Faviina	Vaughan & Wells, 1943
Family Faviidae	Gregory, 1900
Genus Favia	Oken, 1815
F. stelligera	Dana, 1846

F. laxa	Klunzinger, 1879
F. pallida	Dana, 1846
F. favus	Forskal, 1775
F. speciosa	Dana, 1846
F. maxima	Veron, Pichon & Wijsman-Best,1977
Genus Favites	Link, 1807
F. abdita	Ellis & Solander, 1786
F. pentagona	Esper, 1794
Genus Goniastrea	Edwards & Haime, 1848
G. retiformis	Lamarck , 1816
G. australiensis	Edwards & Haime
Genus Platygyra	Ehrenberg, 1834
P. daedalea	Ellis & Solander, 1786
P. lamellina	Ehrenberg
Genus Leptoria	Edwards & Haime, 1848
L. phrygia	Ellis & Solander, 1786
Genus Oulophyllia	Edwards & Haime, 1848
O. crispa	Lamarck, 1816
Genus Leptastrea	Edwards & Haime, 1848
L. purpurea	Dana, 1846
Genus Cyphastrea	Edwards & Haime, 1848
C. serailia	Forskal, 1775
C. chalcidium	Forskal, 1775
C. microphthalma	Lamarck, 1816
Genus Echinopora	Lamarck, 1816
E. lamellosa	Esper, 1775
E. gemmacea	Lamarck
Family Trachyphyllidae	Verrill,1901
Genus Trachyphyllia	Edwards & Haime, 1848
T. geoffroyi	Audouin, 1826
Family Rhizangiidae	d'Orbigny
Genus Culicia	
C. cuticulata	Klunzinger
Family Oullinidae	Gray, 1847
Genus Galaxea	Oken, 1815
G. clavus	Dana
G. fascicularis	Linnaeus, 1767
Family Merulinidae	Verrill, 1866
Genus Hydnophora	Fischer de Waldheim, 1807
H. rigida	Dana, 1846

H. exesa	Pallas, 1766
H. microconos	Lamarck, 1816
Genus Merulina	Ehrenberg, 1834
M. ampliata	Ellis and Solander, 1786
Family Mussidae	Ortman, 1890
Genus Acanthastrea	Edwards & Haime, 1848
A. echinata	Dana, 1846
Genus Lobophyllia	Blainville, 1830
L. hemprichii	Ehrenberg, 1834
L. costata	Dana
L. hataii	Yabe, Sugiyama & Eguchi, 1936
Genus Symphyllia	Edwards & Haime, 1848
Symphyllia sp.	
Family Pectiniidae	Vaughan & Wells, 1943
Genus Echinophyllia	Klunzinger, 1879
E. aspera	(Ellis & Solander, 1788)
Genus Oxypora	Saville - Kent, 1871
O. iacera	Verrill, 1864
Genus Mycedium	Oken, 1815
M. elephantotus	Pallas, 1766
Genus Pectinia	Oken, 1815
P. lactuca	Pallas, 1766
Suborder Caryophylliina	Vaughan & Wells, 1943
Family Caryophyllidae	Gray, 1847
Genus Physogyra	Quelch, 1886
P. lichtensteini	(Milne - Edwards and Haime, 1848)
Genus Plerogyro	Milne - Edwards and Haime, 1848
P. sinuosa	
Genus Gyrosmilia	Milne - Edwards and Haime, 1851
G. interrupta	Ehrenberg, 1834
Suborder Dendrophylliina	Vaughan and Wells, 1943
Family Dendrophyliidae	Gray, 1847
Genus Tubastraea	Lesson, 1834
T. coccinea	Ehrenberg, 1834
T. diaphana	Dana
T. micrantha	Ehrenberg
Genus Heteropsammia	Edwards & Haime, 1848
H. cochlea	Spengler, 1781
H. michelini	Milne - Edwards and Haime, 1848
Genus Turbinaria	Oken, 1818
T. peltata	Esper, 1794

T. frondens	Dana, 1846
T. crater	Pallas
T. stellulata	Lamarck, 1816.

APPENDIX II: THE DISTRIBUTION OF CORAL GENERA ALONG THE KENYAN COAST.

Genera	Kiunga	Malindi	Maida Creek	Kanamai	Bamburi	Nyali	Tiwi	Diani	Shimoni
Psammocora	*	*	*	*			*		
Stylophora	*	*	*	*					*
Seriatophora	*	*	*	*			*		*
Pocillopora	*	*	*	*	*	*	*	*	*
Acropora	*	*	*	*	*	*	*	*	*
Astreopora	*	*			*		*		*
Montipora	*	*	*	*	*	*	*	*	*
Pavona	*	*	*	*		*	*	*	*
Coeloseris				*					*
Pachyseris	*	*	*		*	*	*	*	*
Fungia	*	*	*			*		*	*
Herpolitha		*				*			*
Goniopora	*	*	*	*	*		*		*
Porites	*	*	*	*	*	*	*	*	*
Alveopora		*	*	*			*		*
Favia	*	*	*	*	*	*	*	*	*
Favites	*	*	*	*		*	*	*	*
Platygyra	*	*	*	*	*	*		*	*
Leptoria	*	*							*
Hydnophora	*	*	*			*		*	*
Leptasterea	*	*	*	*					*
Cyphastrea	*	*	*	*			*		*
Echinopora	*	*	*	*	*	*	*		*
Lobophyllia		*	*						*
Mycedium		*	*						*

Tubastrea	*	*	*					*
Turbinaria		*	*				*	*
Millepora	*	*	*	*	*	*		*

Appendix 2.

Oysters: Kenya's underexploited food resource

By OSEI KOFI

IN a secluded creek beside the Indian Ocean, a marine biologist from Belgium toils in the brackish water and dreams of a new high-protein food for Africa's undernourished masses — oysters.

"The snob appeal attached to oysters would be destroyed," Professor Philip Polk, Dean of Biology at the Free University of Brussels, said as he worked with two Kenyan assistants in the green water of Gazi Creek, South of Mombasa. "The protein content of Oysters is far superior to that of any red meat or even fish, and here are oysters in inexhaustible quantities."

Agencies

Polk, stripped to the waist and burned brown by the fierce equatorial sun, said he wanted the world's private and international development agencies such as the United Nations Children Fund to think about oysters seriously "Third World families should be encouraged to feed their babies with oysters. Oysters as a food are versatile and easily transportable. They can be dried, packed canned or mixed with other foods", he said.

Polk came to Kenya 18 months ago to supervise 20 Belgium-funded marine and aquaculture projects ranging from coral reef protection to plankton and algae classifications. He found osysters flourishing wild, growing in mangrove outcrops in the estuaries and fresh water inlets that dot the Kenyan coast.

The lush tropical vegetation marking the shoreline where fresh and sea water meet has helped create a natural reservoir of brackish water which is clogged with plankton and other nutrients, forming a perfect habitat for oysters, other molluscs and crustaceans, says Polk. "What you see here is the beginning of viable, lucrative industry for this country," Polk says with the sweep of his arms over 90,000 young oysters that he and Kenyan assistants, Renison Ruwa and Michael Ngoa are cultivating.

From this collection of wooden frames in the mud beside the sleepy waterfront of Gazi, Polk hopes to see Kenya break the dominance of Japanese, French and Spanish producers in the world's annual 800, tonne oyster market.

The wild Kenyan oyster is about half the size of the European variety because of the Mombasa coast's crowded oyster colonies and is unsuitable for export. Polk is seeking to change this. "We transplant them onto culture beds where each oyster has room to expand. They should grow as big as, if not bigger, than the European or Japanese variety," he said.

Tourists

He aims to sell his initial harvests to the dozens of luxury tourist hotels along the coast where some 300,000 affluent West Germans, Italians, Britons and Scandinavians holiday each year. "The hotels have expressed keen interest. But we have a year to go before our first harvest," said 32-year-old Ruwa, who is preparing for his doctrate in marine ecology under Polk.

The cash earned with the first harvests would then be used to teach villagers living on the creeks and estuaries to create oyster beds which could later be expanded into shrimp and lobster farming, according to Polk.

Villages

Polk who says he loves "the sea, Bach and French cuisine — in that order," is an ardent conservationist. He would like to see the young men in the villages, who make their living from collecting and selling sea shells to tourists, switch to oyster farming. "But you cannot urge the government to ban the sale of these rare shells unless you have a more licrative alternative for the mostly unemployed school leavers," he said.

Asked if he was not being too ambitious Polk said: "In 1978 South Korea did not produce a single commercial oyster. Today it is the world's fourth biggest producer, harvesting over 70,000 tonnes a year both for exports and the home market."

Polk believes Kenya and other African states venturing into commercial oyster production would have a big advantage because European oyster beds are being contaminated by industrial waster and pollution. "Very soon, European consumers will ditch European and Japanese produce for Africa's," he told Reuters.

Senegal is the only African country which produces oysters commercially, harvesting about 200 tonnes annually, mostly culled from the wild.

— Reuter.

OYSTERS - THE ANSWER TO WORLD'S FOOD WOES

SUNDAY MAIL
18th May 1986

food woes

GAZI, (Kenya) : In a secluded creek beside the Indian Ocean, a marine biologist from Belgium toils in the brackish water and dreams of a new high-protein food for Africa's undernourished masses — oysters.

"The snob appeal attached to oysters should be destroyed," said Professor Philip Polk, Dean of Biology at the Free University of Brussels, as he worked with two Kenyan assistants in the green water of Gazi Creek, south of Mombasa.

"The protein content of oysters is far superior to that of any red meat or even fish, and here are oysters in inexhaustible quantities."

Professor Polk, stripped to the waist and burned brown by the fierce Equatorial sun, said he wanted the world's private and international development agencies such as the United Nations Children's Fund (Unicef) to consider oysters as a basic food.

"Third World families should be encouraged to feed their babies with oysters. Oysters as a food are versatile and easily transportable. They can be dried, packed, canned or mixed with other food," he said.

Professor Polk came to Kenya 18 months ago to supervise 20 Belgian-funded marine and aquaculture projects ranging from coral reef protection to plankton and algae classifications.

He found oysters flourishing wild, growing in mangrove outcrops in the estuaries and freshwater inlets that dot the Kenyan coast.

The lush tropical vegetation on the shoreline where fresh and sea water meet has helped create a natural reservoir of brackish water swarming with plankton and other nutrients, a perfect habitat for oysters, other molluscus and crustaceans, says Professor Polk.

"What you see here is the beginning of a viable, lucrative industry for this country," he says with a sweep of his arms over 90,000 young oysters that he and Kenyan assistants Renison Ruwa and Michael Ngoa are cultivating.

From this collection of wooden frames in the mud beside the sleepy waterfront of Gazi, Professor Polk hopes to see Kenya break the dominance of Japanese, French and Spanish producers in the world's annual 800,000 tonne oyster market.

The wild Kenyan oyster is about half the size of the European variety because of the Mombasa coast's crowded oyster colonies and is unsuitable for export.

Professor Polk is seeking to- by exploiting the oyster both for export and domestic consumption.

"We transplant them onto culture beds where each oyster has room to expand. They should grow as big as, if not bigger, than the European or Japanese variety," he said.

He aims to sell his initial harvests to the dozens of luxury tourist hotels along the coast where some 300,000 affluent West Germans, Italians, Britons and Scandinavians holiday each year.

"The hotels have expressed keen interest. But we have a year to go before our first harvest," said 32-year-old Ruwa, who is preparing for his doctorate in marine ecology under Professor Polk.

The cash earned with the first harvests would then be used to teach villagers living on the creeks and estuaries to create oyster beds which could later be expanded into shrimp and lobster farming.

Professor Polk who says he loves "the sea, beach and French cuisine — in that order," is an ardent conservationist. He would like to see the young men in the villages, who make their living from collecting and selling sea shells to tourists, switch to oyster farming.

**

"But you cannot urge the Government to ban the sale of these rare shells unless you have a more lucrative alternative for the mostly unemployed school leavers," he said.

Asked if he was not being too ambitious, Professor Polk said: "In 1978, South Korea did not produce a single commercial oyster. Today it is the world's fourth biggest producer, harvesting over 70,000 tonnes a year, both for export and the home market."

He believes Kenya and other African states venturing into commercial oyster production would have a big advantage because European oyster beds are being contaminated by industrial waste and pollution.

Senegal is the only African country which produces oysters commercially, harvesting about 200 tonnes annually, mostly culled from the wild.

At present, Kenyans themselves do not eat oysters. Professor Polk is all in favour of encouraging them to develop a taste.

He firmly believes a change of menu would be of enormous benefit to coastal dwellers, and is trying to persuade the government to sponsor a programme to help promote oyster cultivation for local consumption. — Reuter

Annex 10

THE AUTECOLOGY OF THE EDIBLE OYSTER CRASSOSTREA CUCULLATA BORN, 1778: SIZE RELATED VERTICAL DISTRIBUTION AT MKOMANI, MOMBASA.

E. Okemwa[1] R.K. Ruwa[1] and P. Polk[2]

1. Kenya Marine and Fisheries Research Institute
   P.O. Box 81651
   Mombasa, Kenya

2. Laboratory of Ecology and Systematics
   Free University of Brussels
   Pleinlaan, 2
   1050 Brussels, Belgium

SUMMARY

The littoral *Crassostrea cucullata* occurs between 1.05 - 3.35 m, with the highest density occuring between 1.85 - 2.75 m above datum. Its distribution is size related as demonstrated by computation of correlation coefficients (r) and regression equations. The shell lenghts (i.e. maximum linear dimension) decreases in an upshore direction. The analyses show high r-values which are significant at $p < 0.001$. The equations and the r-values are as follows: (i) for the lower level oysters between 1 - 1.85 m: $y=43.64 - 6.49\ x$, $r = -0.659$ (ii) for the mid-level oysters between 1.86 - 2.75 m : $y = 62.67 - 17.14\ x$, $r = -0.941$ and (iii) for the high level oysters between 2.76 - 3.35m: $y = 91.44 - 24.85\ x$, $r = -0.899$ where y stands for the mean shell length (mm) and x is the mean height (m) above datum. The elevation and density related effects on the shell lenghts of the oysters are discussed.

../2

INTRODUCTION

Crassostrea cucullata is a littoral oyster found on the trunks, stilt roots and pneumatophores of mangrove plants and rocky substrata in brackish-marine environments. Zoogeographically it is an Indo-West Pacific species (Day 1974). The ecological studies of this species done in the Western Indian Ocean in Seychelles (Taylor 1968); Aldabra (Taylor 1970); Tanzania (Hartnoll 1976); Somalia (Chelazzi and Vannini 1980) and Kenya (Ruwa 1984) indicate that it is abundantly found in the upper eulittoral zone following the shore terminology of Lewis (1964) and Hartnoll (1976). In some cases its upper limit is known to be slightly (0.3 - 0.5 m) above the mean high water spring tide level, probably changing with wave action (Hartnoll 1976, Chelazzi and Vannini 1980).

Various studies on vertical distribution of molluscs on the sea shores have demonstrated that they may be size-related both interspecifically and intraspecifically (Vermeij 1972, 1973; Ruwa and Brakel 1981). Similar quantitative studies on Crassostrea cucullata are non-existant to the best of our knowledge. Since this is an economically important species which can be cultured (van Someren and Whitehead 1961) the following study was also geared to define the levels which support large sizes of oysters and where they are found in highest densities on the cliffs.

The tides on which the oysters depend for their filter feeding (Morton 1977) exhibit a large range in this portion of the Western Indian Ocean and are semi-diurnal. According to Brakel (1982) the average tidal ranges at at spring tide days and neap tide days are 3.2 m and 1.0 m respecitvely. The extreme high water spring (EHWS) is 4.0 m; mean high water spring (MHWS), 3.5 m; mean high water neap (MHWN), 2.4 m; mean low water neap (MLWN) 1.4 m; mean low water spring (MLWS), 0.3 m; and the extreme low water spring (ELWS), - 0.1 m.

MATERIALS AND METHODS

The study was carried out at Mkomani rocky cliffs, Mombasa (figure 1) on a randomly chosen population of Crassostrea cucullata covering an area measuring about 4 x 2.5 m on a vertically rising cliff in March/ April 1985. The shell lenghts (i.e. maximum linear dimension) of all live oysters in this population were measured using vernier callipers to the nearest 0.1 mm in consecutive 10 cm vertical bands going perpendicularly upwards to the base of the cliff to as far as the oysters were encountered. From several measurements of the time at which the water level reached the base of the cliff during the calm water around neap tide days, the height of the base above datum was determined according to the Kenya Ports Authority (1985) tide tables. This enabled the heights of the oyster bands to be expressed above datum.

RESULTS

A total of 1470 oysters were measured. From these measurements a frequency table for each oyster band was made at the following size intervals: 1.0 - 10.9 mm; 11.0 - 20.9 mm; 21.0 - 30.9; 31.0 - 40.9 mm; 41.0 - 50.9 mm and 51.0 - 60.9 mm, to study the changes of the modal class from one level of the oyster band to the other. From these data percentages were worked out and used for constructing the histograms (figure 2).

The histograms showed that the modal class shifts left-wards, towards the y-axis when traced from the lowest to the highest oyster levels. The modal class shifted from size range 31.0 - 40.9 mm at the levels between 1.0 - 1.10 m and 1.80 - 1.90 m to size range 21.0 - 30.9 mm at the levels between 1.90 - 2.00 m and 2.20 - 2.30 m. It then subsequently shifted to 11.0 - 20.9 mm at the levels between 2.30 - 2.40 m and 3.00 - 3.10 m and finally to size range 1.1 - 10.9 mm at the levels between 3.10 - 3.20 m and 3.30 - 3.40 m.

The mean heights (elevation) of the oyster bands and the mean shell sizes of the oysters were computed. The mean shell sizes were then plotted against elevation (figure 3). The plot showed that three linear regressions could convtniently be fitted to describe the relationship. The regression equations were calculated and fitted. The correlation coefficients (r) were all significant ($p < 0.001$) and negative.

A further comparison was made to find out if there were density related effects on the mean shell lenghts of the oysters with height on the cliffs. To facilitate the comparisons plots of the number of oysters per band at each mean height or elevation were plotted along with their values of mean shell lenghts in figure 3. The densities at the peaks and troughs indicated with the alphabetical letters A to J were used for comparisons.

The area between 1.85 and 2.75 m above datum had the highest density of oysters. The comparisons showed that even for almost similar numbers of oysters e.g. B and E, C and J, D and F; the samples B, C and D at lower levels had bigger mean shell lenghts than their counterparts. Similarly, even for situations where e.g. D and G, F and I, H and J where D, F and H are lower level samples with larger numbers of individuals than their counterparts they still showed bigger mean shell lengths. These results indicate that the changes in mean shell size between the lower and higher level oysters are independent of their densities.

DISCUSSION

The high negative correlation coefficients (r) significantly ($p < 0.001$) demonstrate that Crassostrea cucullata exhibits size related patterns in its vertical distribution with an upshore reduction in shell length. The results clearly show that the upshore reduction in shell length is caused by the abundance of small sized oysters in the upper levels whereas conversely, the lower levels support a larger number of relatively bigger sized oysters. A similar type of size gradient was described in the filter feeding mussel Mytilus edulis L. populations by Newcombe (1935) and Seed (1968). They showed that the growth rate in this mussel at lower levels was greater than at higher levels. Thus the lower level mussels grow

../6

to larger sizes than the higher level ones. From our study we do not have data on growth rates and of ages of the oysters for comparison. However from the knowledge that oysters are filter feeders which depend on the high tides for their feeding action to take place (Morton 1977) and that the duration of continuous submersion and frequency of the latter decrease in an upshore direction, the causes and consequences are the same as those of the equally filter feeding mussels. The longer duration and higher frequency of submersion allows the lower level oysters to acquire more food because they can feed for longer periods and consequently grow faster than their higher level counterparts.

There are demonstrations that in some littoral bivalves density may affect their growth rates and size (Trevallion et al 1970). In our study it can be notably seen that at non-successive levels the mean shell size is still larger for oysters in comparatively lower levels even for situations where the lower level samples have larger numbers of individuals than the higher level samples. The difference in size between the lower and higher level oysters may therefore principally be due to the differences in the duration and frequency of feeding periods rather than their differences in densities.

ACKNOWLEDGEMENT

We thank Dr. V. Jaccarini, Department of Zoology, University of Nairobi for his comments on the manuscript; Messers J. Anunda and J. Kitonga for helping in gathering the data, and the Director of Kenya Marine and Fisheries Research Institute Mr. S.O. Allela for his cooperation.

This work is part of the Kenya/Belgian Project in Marine Ecology and management of the coastal Zone.

../8

REFERENCES

(1) Brakel, W.H. (1982). Tidal patterns on the East African Coast and their implications for littoral biota. UNESCO/ALESCO Symposium on the Coastal and Marine Environment of the Red Sea, Gulf of Aden and Tropical Western Indian Ocean. The Red Sea & Gulf of Aden Environmental Programme. Jeddah: Vol. 2, pp. 403-418.

(2) Chelazzi, G., and M. Vannini (1980). Zonation of intertidal molluscs on rocky shores of Southern Somali. Estuarine Coastal Mar. Sci. 10: 569-583.

(3) Day J.H. (1974). A guide to marine life of South African shores. 2nd edition. Cape Town: Balkema, 300pp.

(4) Hartnoll, R.G. (1976). The ecology of some rocky shores in tropical East Africa. Estuarine Coa stal Mar. Sci. 4: 1 - 21.

(5) Kenya Ports Authority (1985). Tide tables for East African Ports. Mombasa: Rodwell Press Ltd.; 48 pp.

(6) Lewis J.R. (1964). The ecology of rocky shores. London: Hodder & Stoughton Ltd.., 323 pp.

(7) Morton B.S. (1977). The tidal rhythm of feeding and digestion in the Pacific oyster, Crassostrea gigas (Thunberg). J. exp. mar. Biol. Ecol. 26: 135 - 151.

../9

(8) Newcombe, C.H. (1935). A study of the community relationships of the sea mussel, Mytilus edulis L. Ecology 16: 234 - 243.

(9) Ruwa, R.K. (1984). Invertebrate faunal zonation on rocky shores around Mombasa, Kenya. Kenya Journal of Science and Technology series B 5 (1 and 2): 49 - 65.

(10) Ruwa, R.K. and Brakel, W.H. (1981). Tidal periodicity and size related variation in the zonation of the gastropod Nerita plicata on an East African rocky shore. Kenya Journal of Science and Technology Series B 2 (2): 61 -67.

(11) Seed, R. (1968). Factors influencing shell shape in the mussel Mytilus edulis. J. Mar. Biol. Assoc. U.K. 48: 561 - 584.

(12) Taylor, J.D. (1968). Coral reef associated invertebrate communities (mainly molluscan) around Mahe, Seychelles. Philos. Trans. R. Soc. London Ser. B. 254: 129 - 206.

(13) ______________ (1970). Intertidal zonation at Aldabra atoll. Philos. Trans. R. Soc. London Ser. B. 260: 173 - 213.

(14) Trevallion, A., Edwards, R.R.C., and Steel, J.H. (1970). Dynamics of a benthic bivalve, pp. 285 - 295. In: J. H. Steel (ed) Marine food chains. Los Angeles: University of California Press.

(15) van Someren, V.D. and Whitehead P.J. (1961). An investigation of the biology and culture of an East African oyster, Crassostrea cucullata. Fishery Publication No. 14; 36 pp.

(16) Vermeij, G.J. (1972). Intraspecific shore-level size gradients in intertidal molluscs. Ecology 53(4): 693 - 700.

(17) ______________ (1973). Morphological patterns in high intertidal gastropods: Adaptive strategies and their limitations. Marine Biology 20: 319 - 346.

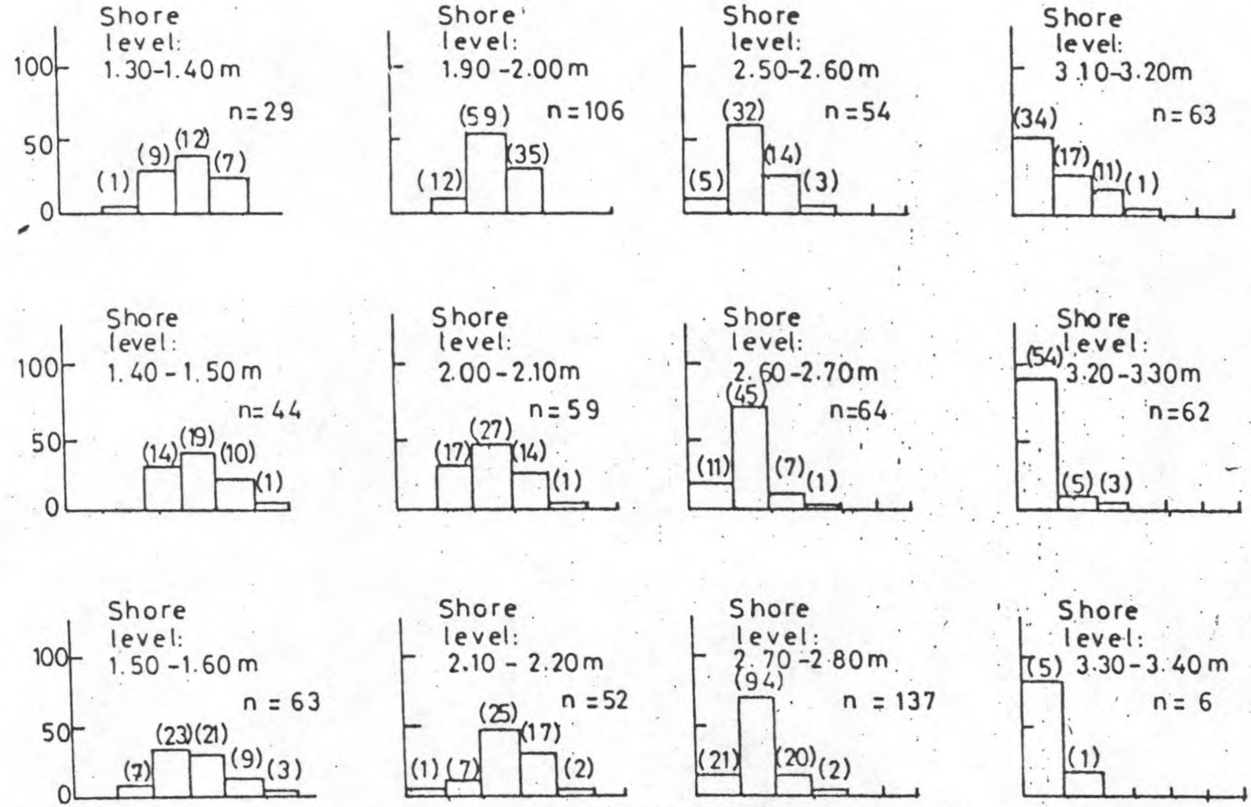
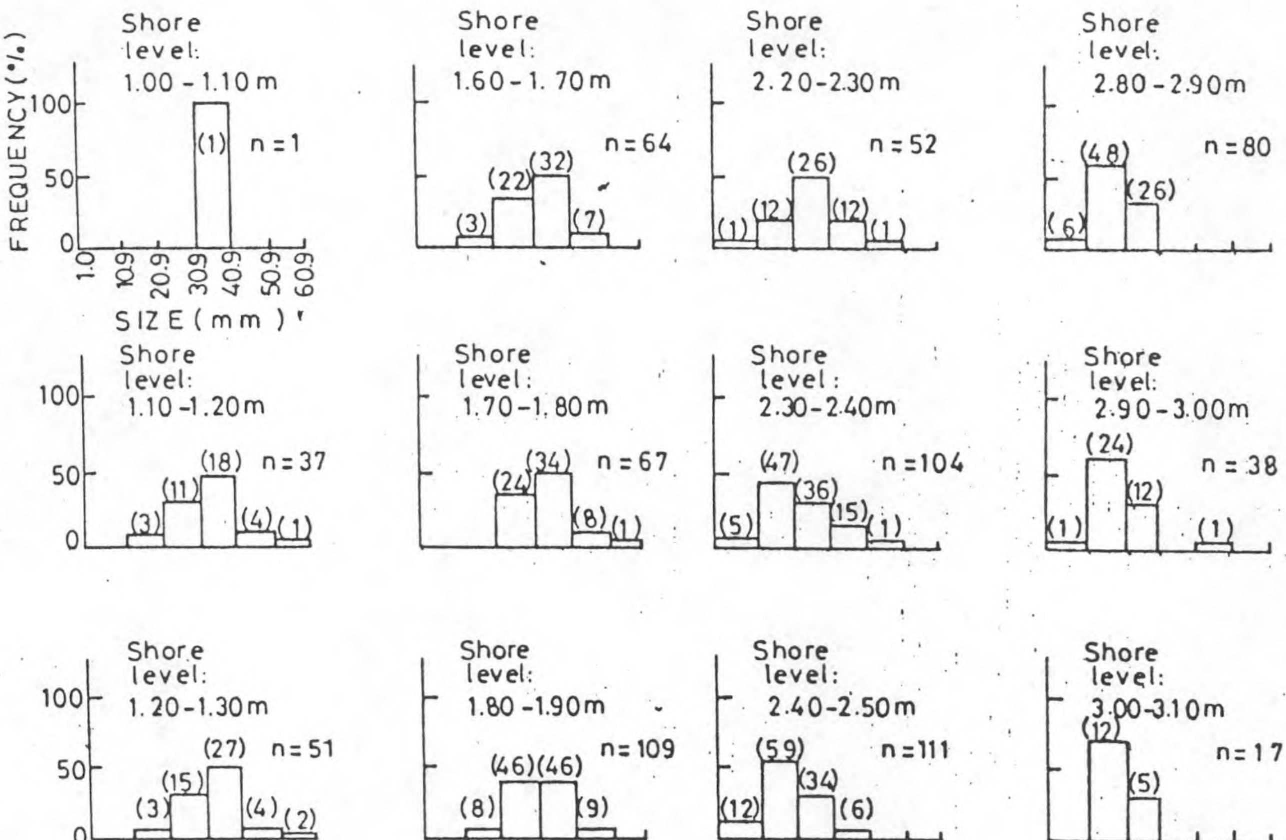


Fig. 2. Histograms to show distribution of Crassostrea cucullata Born by size classes in various levels of the cliff. The number of oysters in each size class are shown in parentheses and n stands for total number of oysters.

/12


FREQUENCY (%)
SIZE (mm)
1.0
10.9
20.9
30.9
40.9
50.9
60.9
0
50
100
Shore level: 1.00 - 1.10 m
n = 1
(1)
Shore level: 1.60 - 1.70 m
n = 64
(3) (22) (32) (7)
Shore level: 2.20-2.30 m
n = 52
(1) (12) (26) (12) (1)
Shore level: 2.80 - 2.90 m
n = 80
(6) (48) (26)
Shore level: 1.10 -1.20 m
n = 37
(3) (11) (18) (4) (1)
Shore level: 1.70 - 1.80 m
n = 67
(24) (34) (8) (1)
Shore level: 2.30 - 2.40 m
n = 104
(5) (47) (36) (15) (1)
Shore level: 2.90 - 3.00 m
n = 38
(1) (24) (12) (1)
Shore level: 1.20 - 1.30 m
n = 51
(3) (15) (27) (4) (2)
Shore level: 1.80 - 1.90 m
n = 109
(8) (46) (46) (9)
Shore level: 2.40 - 2.50 m
n = 111
(12) (59) (34) (6)
Shore level: 3.00 - 3.10 m
n = 17
(12) (5)

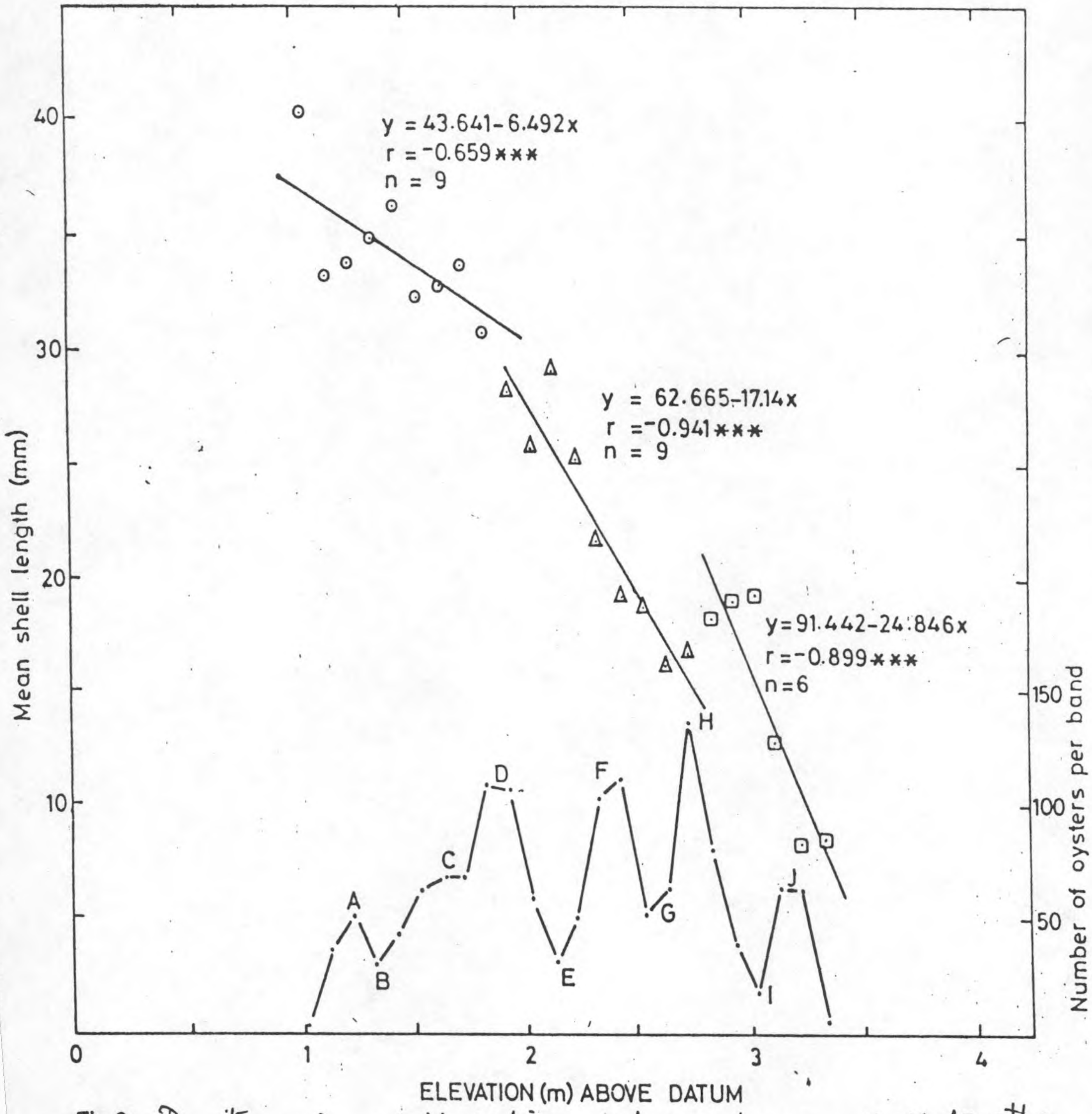


Fig.3 Density and relationship between mean shell lengths of Crassostrea cucullata Born and shore levels (elevation) above datum.

Annex 11

SOME OBSERVATIONS AND REMARKS ON MANGROVE DISTRIBUTION IN KENYA

R.K. Ruwa[1] and P. Polk[2]

1. Kenya Marine and Fisheries Research Institute
   P.O. Box 81651
   MOMBASA, Kenya

2. Laboratory of Ecology
   Free University of Brussels
   Pleinlaan, 2
   B- 1050 BRUSSELS, Belgium

INTRODUCTION

The distribution of mangroves in the tropics is linked with the presence of estuaries and creeks (Macnae 1968, Barth 1982). There is a consensus that river discharges into the oceans cause the brackish water micro-environment which is the key factor for development of mangroves and that in sheltered conditions they form luxuriant forests (Macnae 1968, Barth 1982, Joshi and Boshale 1982, Snedaker 1982).

In Kenya a similar pattern (figure 1) exists but with some specific differences. We observe that there are no mangrove trees in the estuary of River Sabaki despite the fact that it is a permanent river. Secondly the bulk of the mangrove forest cover occurs in creeks and estuaries of seasonal rivers (Doute *et al* 1981). We additionally see mangroves growing at places without any river inputs such as:

a) in front of rocky cliffs where there is heavy wave action e.g. Kanamai;
b) in the sheltered inlets of the sea whose ambient water salinities are oceanic i.e. 35‰, eg. Mida.
c) in a sheltered site behind the high rocky cliffs at Bamburi where some mangroves are thriving successfully.

.../2

These niches occupied by some of the mangroves in Kenya appear to be exceptional at first sight. As these exceptions are most interesting we set forth to study the micro-environments of:

a) the lone mangrove of Kanamai;

b) the estuarine system of Gazi mangrove swamp;

c) the Mida creek mangrove ecosystem with an aim of explaining the observed local distribution patterns of the mangroves in Kenya.

METHOD AND RESULTS

The site where the lone mangrove Sonneratia alba J. Sm. at Kanamai is thriving remains wet throughout the low tide period. Carefull observations on the micro-environment under the mangrove reveals small trickles of water coming out from the underground. The salinities at these discharge points including those of neighbourhing pools in the vicinity of the mangrove tree were measured using a refractometer. They were measured during ebb tide and at high tide on a sunny day. The salinities at high tide were constantly 35‰ i.e. fully oceanic salinity. The results of the measurements during ebb tide are as shown in figure 2. Other salinity measurements were carried out at the Maftaha Gazi Bay, Gazi mangrove biotope (figure 3). Almost all the water in the bay is replaced in each daily tidal cycle. There are two seasonal rivers discharging into this bay namely, Mkurumuji and Kidogoweni. During the dry season (January to April) they are almost non-existent but they discharge heavily during the rainy season in May and June. The salinities were taken on a sunny day during the daytime low tide at areas 1, 2, 3, 4, 5 and 6 (see Table 1 and figure 3). At site 2 (figure 3) three seepage points were detected during low tide. These had the following salinities: 16, 18 and 20‰. At high tide the salinities in the bay were 33 - 35‰. Further salinity measurements were carried out at the Mida mangrove biotope. The salinities were measured during low tide, in the daytime on a sunny day. The salinities at various seepage points were 29, 30, 31 and 32‰. Almost all the water in this creek is also replaced in each daily tidal cycle.

DISCUSSIONS AND CONCLUSIONS

Seepage of underground water into the sea is very common in the lower eulittoral zone:

a) at the bases of high rising rocky cliffs e.g. Kanamai, Mtwapa, Bamburi, Mombasa Island, Tiwi, Msambweni etc.

b) on beaches e.g. Kanamai, Tiwi etc.

c) in creeks e.g. Gazi, Mida etc.

Although Isaac and Isaac (1968) and Knutzen and Jasuund (1979) mentioned about the seepage in Kenya they neither measured the salinities of the seepages nor did they study their consequences to the marine life.

From our data on salinities it is clear that seepages of underground water to the seashore change the micro-environmental conditions from oceanic to brackish water, creating suitable micro-habitats for colonization by mangrove seedlings and therefore offer suitable habitats for mangrove development. Ituli's (1984) flow model for underground water flow in the Athi and Tana River basin indicates that the Mida area is one of the places exhibiting highest flow rates into the sea. The latter may explain the existence of a big mangrove forest at Mida without any river discharging into it. This seepage phenomenon was overlooked by Isaac and Isaac (1968) when describing the distribution of mangroves in Kenya.

The role of seepage in the mangrove colonization and development was reported by Macnae and Kalk (1962a, b) after observing that on the riverless Inhaca Island (Mozambique) mangrove forests were growing in areas without river discharge and were 30 km away from the

.../5

nearest river input on the mainland. At the sites of these mangroves there was flow of underground water into the intertidal zone. This underground water was fresh water because wells dug near the mangrove forest areas were yielding portable freshwater. This seepage was therefore evidently responsible for creating a brackish environment which allowed colonization by mangroves. Similarly at the Kenya coast boreholes near mangrove forests give portable fresh water. In a semiarid zone like the Kenya coastal zone the presence of underground portable water near mangrove forests seems to explain why major villages and boreholes are concentrated around these biotopes. Indeed, in view of the information available we can even say that the mangroves are indicating where underground water is released into the sea and that seepage is playing an important role in the distribution of mangroves in this semi-arid Kenya coast.

REFERENCES

1. Barth, H. (1982). The biogeography of mangroves. In: Tasks for vegetation science. Vol. 2, p. 35 - 59. (Ed. by D. N. Sen and K. S. Rasjpurohit). The Hague: Dr. W. Junk Publishers.

2. Doute, R. N., Ochanda, N. and Epp, H. (1981). A forest inventory of Kenya using remote sensing techniques, KREMU Technical Report Series No. 30, Nairobi.

3. Isaac, W. E. and Isaac, F. M. (1968). Marine botany of Kenya Coast. 3: General account of environment, flora and vegetation. J. East Afr. Nat. Hist. Soc. 27 (1): 7 - 28.

4. Ituli, J. T. (1984). A regional groundwater flow model for the Athi - Tana River basin. M.Sc. thesis, Free University of Brussels.

5. Joshi, G. V. and Boshale, L. J. (1982). Estuarine Ecosystem of India. In: Tasks for vegetation science. Vol. 2, p. 21 - 33. (Ed. by D. N. Sen and K. S. Rasjpurohit). The Hague: Dr. W. Junk Publishers.

6. Knutzen, J. and Jasuund, E. (1979). Note on littoral algae from Mombasa, Kenya. J. East Afr. Nat. Hist. Soc. 168: 1 - 4.

7. Macnae, W. (1968). A general account of the fauna and flora of mangrove swamps and forests in the Indo-West Pacific region. Adv. Mar. Biol. 6: 73 - 270.

8. Macnae, W. and Kalk, M. (1962a). The ecology of the mangrove swamps of Inhaca Island, Mozambique. J. Ecol. 50: 19 - 35.

9. ________ (1962b) The fauna and flora of the sand Flats and Inhaca Island, Mozambique. J. anim. Ecol. 31: 93 - 128.

10. Snedaker, S. C. (1982). Mangrove species zonation: Why? In: Tasks for vegetation science. Vol. 2, p. 111 - 125. (Ed. D. N. Sen and K. S. Rasjpurohit). Dr. W. Junk Publishers.

TABLE 1 : Salinity of isolated pools at Gazi mangrove biotope on a sunny day during low tide on 15/7/85. n = number of measurements at different points.

SITE	SALINITY ‰					
1. River discharge area	27	28	29	-	-	-
	n=2	n=3	n=2			
2. Pool	27	28	29	-	-	-
	n=1	n=4	n=2			
3. Pool	27	28	29	-	-	-
	n=3	n=4	n=2			
4. Pool	28	29	30	31	32	33
	n=1	n=3	n=3	n=2	n=1	n=1
5. Pool	30	31	32	33	-	-
	n=1	n=2	n=12	n=1		
6. Pool	30	31	32	33	-	-
	n=2	n=6	n=1	n=1		

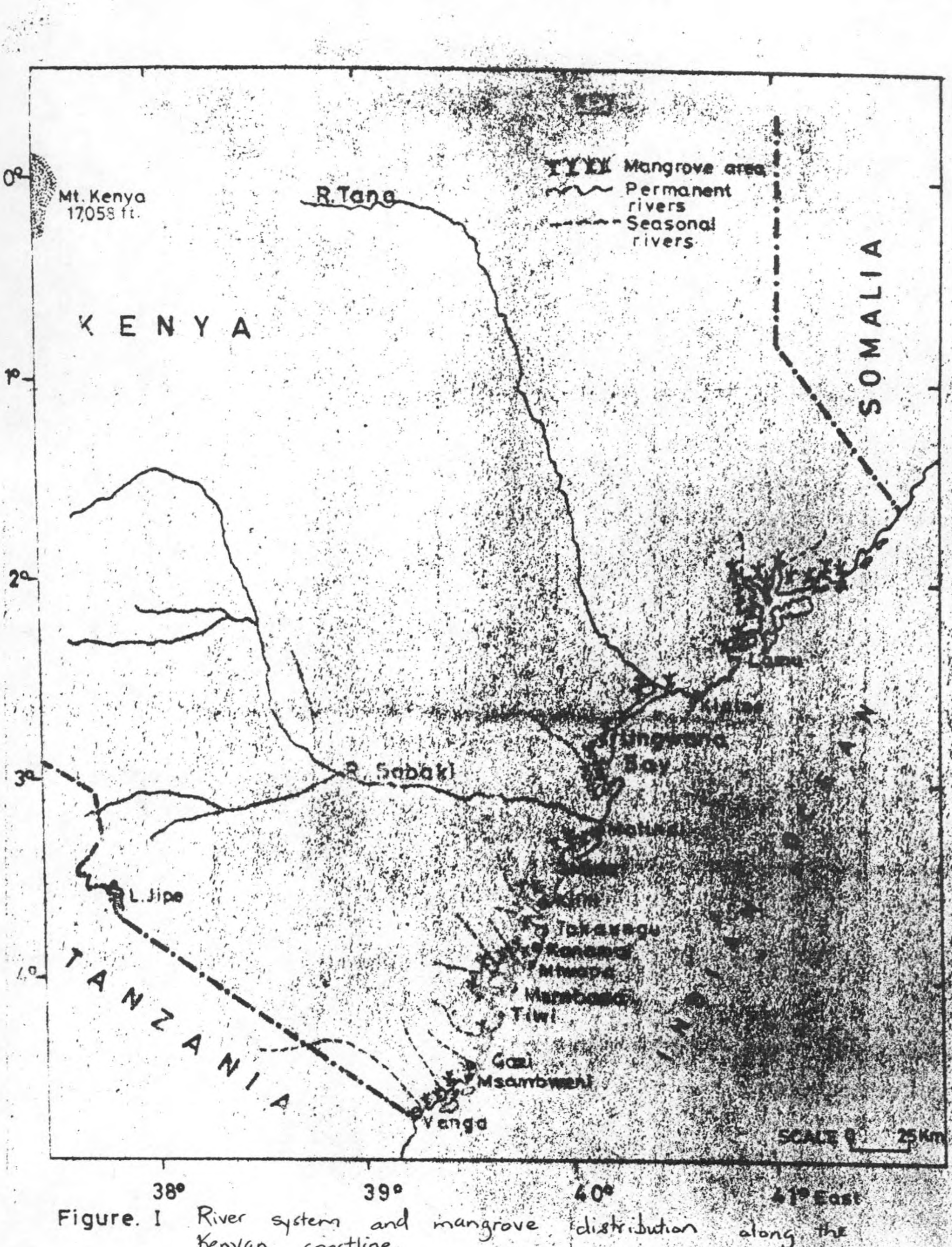


Figure. I River system and mangrove distribution along the Kenyan coastline.

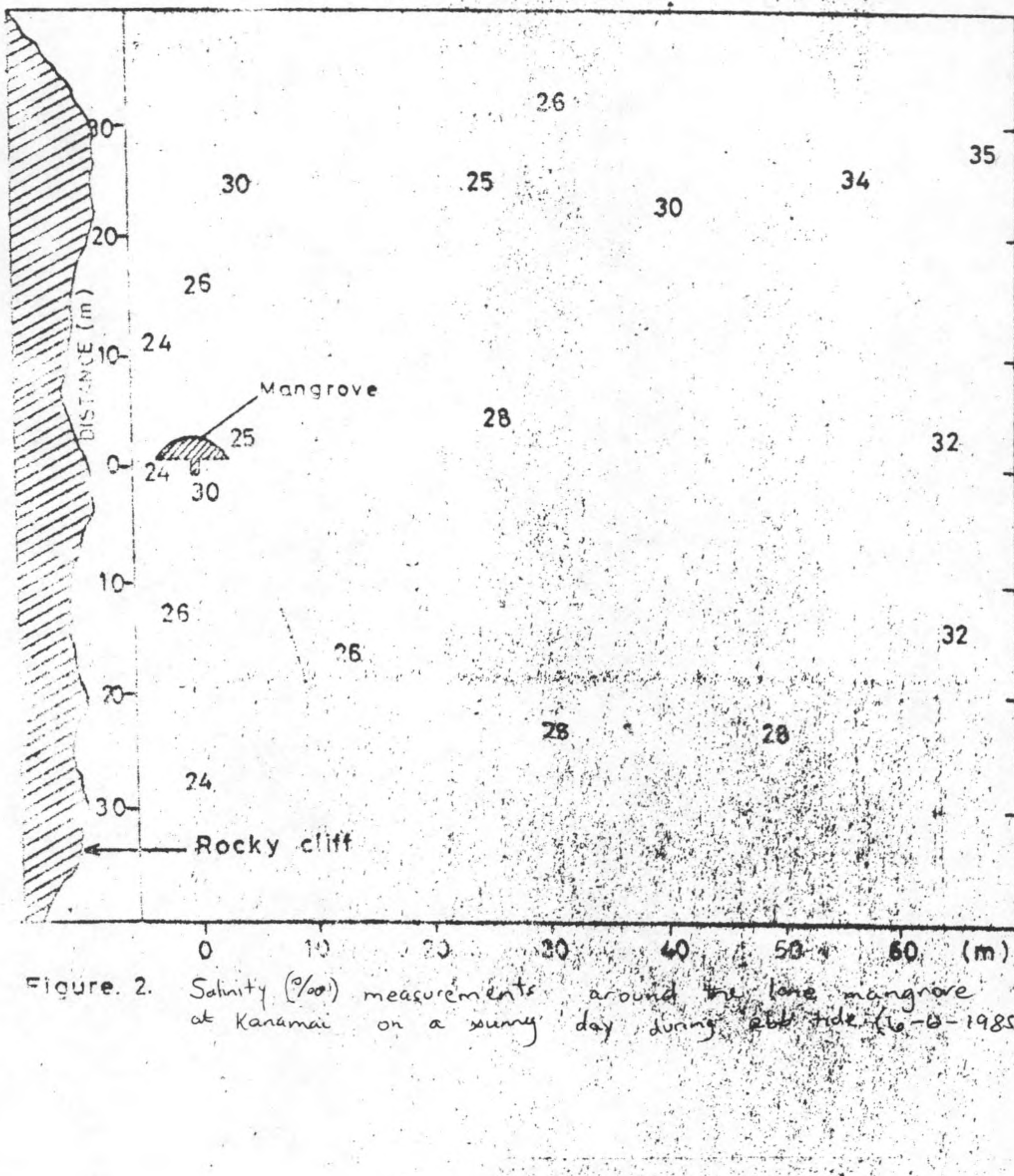


Figure. 2. Salinity (‰) measurements around the lone mangrove at Kanamai on a sunny day during ebb tide (16-8-1985)

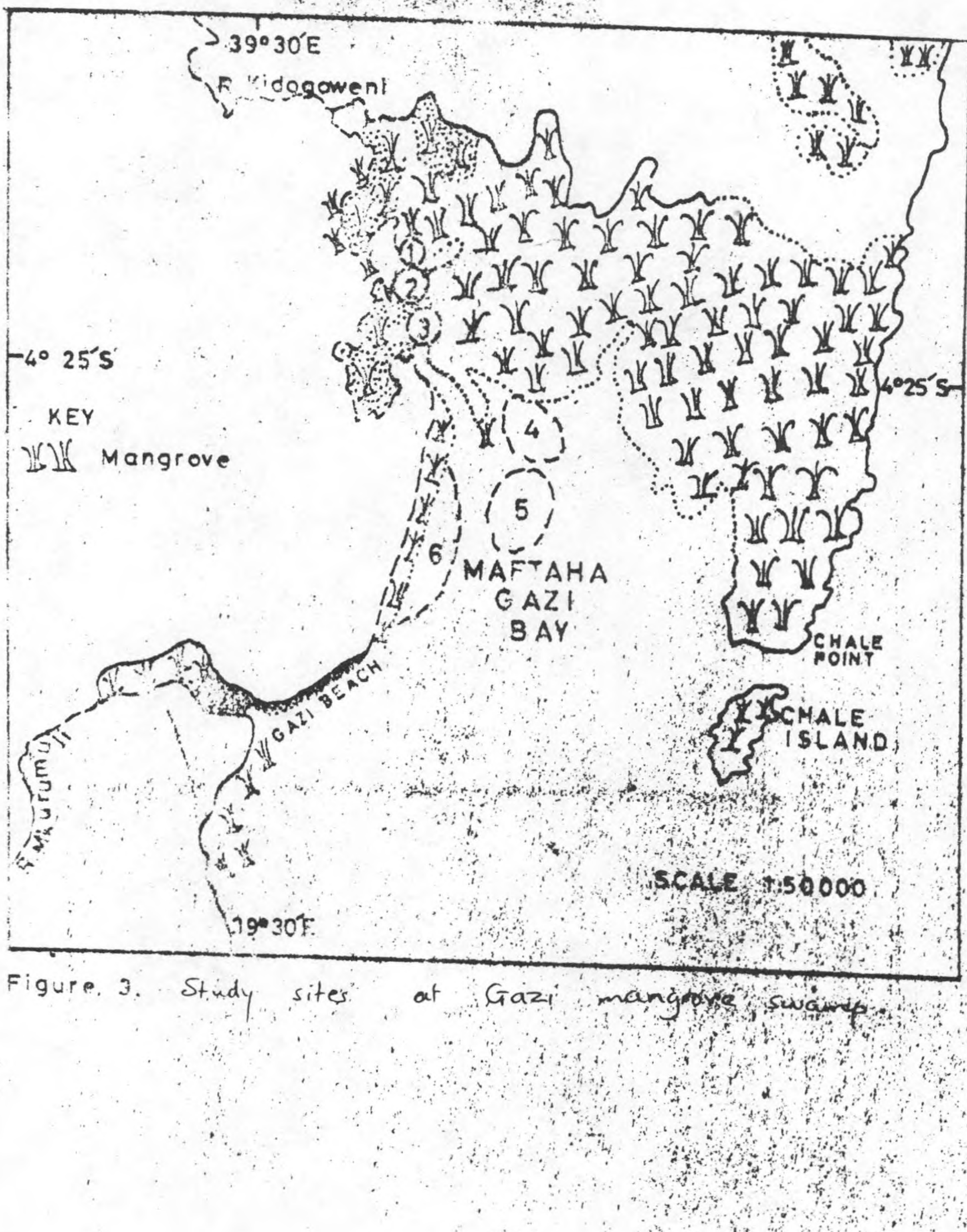


Figure. 3. Study sites at Gazi mangrove swamp.

Annex 12

THE BIOLOGY OF MARINE COPEPODS IN KENYAN WATERS.

1. Planktonic copepods from coastal and inshore waters of Tudor Creek, Mombasa.

E. N. Okemwa, Kenya Marine and Fisheries Research Institute, Mombasa, Kenya.

N. Revis, Free University of Brussels, Faculty of Science, Laboratory of Ecology, Brussels, Belgium.

SUMMARY

Fifty two free swimming planktonic copepod species were identified from the samples collected from three stations in Tudor Creek. This appears to be the first systematic account of copepods reported from the Coastal and inshore waters of Kenya.

INTRODUCTION

Zooplankton is a source of food for many fish species which themselves serve as a basis for the artisanal fishery well-known in East Africa. To understand the secondary and tertiary productivity, it is desirable that the systematics of the Zooplankton is known. As copepods are quantitatively the most important group, research on this taxon is particularly significant. Although much work has been done in South Africa and in the Red sea, the copepod fauna of East Africa is not well known, except for the work of sewell (1929,1932,1947, & 1948), and Smith and Lane (1981), who worked in the Western Indian Ocean, but did not include creek waters. Wickstead (1965 & 1968) published work on tropical plankton, and Okera (1974) examined the zooplankton of the inshore waters of Tanzania.

Reay and Kimaro (1984) wrote the first paper on zooplankton from Tudor Creek. This study demonstrated the possibility of seasonal, lunar and tidal influences on the abundance and composition of zooplankton at the mouth of Tudor Creek. Apart from that no attempt has been made to study the Marine copepod fauna in Kenya. The taxonomy of the free -swimming copepods of Kenya will also contribute to the knowledge of the zoogeography of this group.

..../2

STUDY AREA

The Coastline of East Africa alternates between fringing reef and tidal mangrove creeks. Tudor Creek is a tidal Mangrove estuary located at short distance East of Mombasa Port (Fig.1). The three stations were chosen to represent creek mouth, creek channel and inner creek waters.

Tidal exchange in Tudor Creek is considerable and a tidal range of 4.0 m was recorded during a spring tide at Mombasa Port (Brakel, 1982). The residence time for water in the estuary is not yet known.

The temperature range during the period of study was greatest in the upper estuary and varied between 30.0 °C in December 1984 and 29.5 °C in March 1985 at station 3 (Figure 2). In the middle region the water temperature varied between 29.5 °C in December 1984 and 29.0 °C in March 1985. In the mouth of the estuary temperatures varied between 29.0 °C and 28.0 °C. Depth at station 1 was 40m and decreased gradually to 5m in station 3. Turbidity (measured as secchi depth) decreased from station 1 to station 3.

Salinities recorded at station 1 were consistently high and did not drop below 35 parts per thousand (Figure 2). In the upper estuary and middle channel salinities were also high and varied between 34.5 and 30.0 parts per thousand. All this period rainfall was below average.

METHODS AND MATERIALS

The samples were obtained using a Bongo net fitted with a flow meter towed at 4.0m S^{-1} for 15 minutes from a research vessel with a 210 hp diesel powered engine The Bongo towing frame was fitted with two cylindrical - conical nets (Mesh diameter 335 m and 500 m), each 0.6m in diameter, connected by a central yoke to which the towing wire is attached. All the tows were horizontal to the surface and samples were taken at a mean depth of 1.4m.

The sample was immediately stored in a 5% formaline solution. Samples from 335 m net were analysed. Samples were taken only during day time, twice a month, betwee neap and spring tides. The work reported here began in December 1984 and goes till March 1985; the project is still in progress.

LABORATORY METHODS

Preparation for analysis involved passing the sample through a 42 m mesh sieve and placing the residue in the petri dishes. The sub-samples were then sorted out under a binocular microscope and copepods were put separately in the petri dishes.

To identify the copepods to species level, it is necessary to dissect the animal and draw the antennae, antennules, mouth parts, thoracopods and furca. The keys and reference books by Giesbrecht (1892), sars (1901), sewell (1929,1932,1947 & 1948), Rose (1933), Bradford (1972), Owre and Foyo (1967), Frost and Fleminger (1968), and Fleminger (1973) were used.

RESULTS AND DISCUSSION

A total of 96 net tows was taken during the study period, of this number 8 hauls were made each month at each station. The Zooplankton is rich and abundant in the Creek. Copepods were dominant and present in all stations sampled (Table 1). From all stations, 52 species were identified. Forty one species were found at station 1, and 30 of those were specific for this station. In station 2, 20 specie were found of which 7 were specific. In station 3 there were only 6 species found, of which 2 were specific for this station and this supports the gradient hypothesis Apparently, there exists a gradient in diversity and each station has a more or less characteristic Copepod - fauna. Species diversity is directly related to the number of species unique to the station. A number of species was represented by only one individual so it is possible that such species were present, but undetected at another station.

Information on the abiotic environment from the series of stations in Tudor Creek is given in figure 2. These demonstrated increasing temperature and turbidity, and decreasing water depth from the mouth to the uppermost stations of the creek, with salinity remaining more or less constant.

Throughout the study period (December, 1984 - March, 1985) temperature fluctuation of almost 3 ^{o}C can be associated with a gradient of decreasing depth and the relative movement of 'Creek' and 'Coastal' waters in relation to the tides.

..../4

The implication is that the abiotic characteristics at any of the three stations in the system is faced with a complex state of flux in relation to tidal movement. Therefore, depending on the extent to which copepods are affected by the variations in abiotic factors observed, then this state of flux is also likely to apply to their diversity and abundance. An ecological gradien observed in Tudor Creek can be related to the observed gradients of increasing temperature decreasing depth and turbidity from the mouth inwards. It is i interesting to observe that the diversity was high in station 1 and low in station33.

In inshore waters of Dar-es-salaam in Tanzania, South East Africa, Okera (1974) observed Rhincalanus cornutus, Acartia danae, Centropages gracilis and Temora discaudata. Apparently there is higher diversity in Mombasa water than in Tanzania waters. This may be attributed to the productivity of the area. Rythe et all (1966) mapped the Western Indian Ocean and showed Mombasa to have a productivity of more than 1.00 g C/m^2/day in contrast to Dar-es-salaam at 0.26-0.50 g C/m^2/day. Since we don't have enough data on abiotic parameters, it is difficult to conclude precisely. Plankton distribution can vary greatly over very small distances: it has a very "patchy" distribution. Their distribution varies considerably with depth and time.

Smith and Lane (1981) reported the occurrence and distribution of Paracalanus aculeatus, Acartia danae, clausocalanus farrani, Centropages furcatus, Scolecithr danae, Canthocalanus, Pleuromamma piseki, Pleuromamma indica, Rhincalanus cornutu and Macro-setella gracilis in offshore waters of Somalia in the Indian Ocean. Th Copepod fauna at station 1 can be regarded as Oceanic as defined by Smith & Lane (1981), and Sewell (1947)& 1948).

The species found by Smith and Lane (1981) and Okera (1974) were found in our samples.

Table 1. Classified list of copepod species and their occurrence in three statio[ns] of Tudor Creek, Mombasa.

	Station 1	Station 2	Station 3
CALANOIDA			
Fam. Calanidae Dana 1853			
Canthocalanue pauper (Giesbrecht 1888)	x	x	x
Undinula vulgorie (Dana 1849)	x	x	
Fam. Eucalanidae Giesbrecht 1892			
Eucalanus spp.	x	x	
Rhincalanus cornutus (Dana 1849)	x	x	
Fam. Paracalanidae Giesbrecht 1892			
Acrocalanus Longicornis Giesbrecht 1888	x	x	
Paracalanus aculeatus Giesbrecht 1892	x	x	
Fam. Pseudocalinidae Sars 1902			
Clausocalanus farrani Sewell 1929		x	
Fam. Euchaetidae Sars 1902			
Euchaeta marina (Prestandra 1933)	x		
Euchaeta pubera Sars 1907	x		
Euchaeta tenuis Esterly 1906	x		
Fam. Soolecithricidae Sars 1902			
Scolecithrix danae (Lubbock 1856)		x	
Fam. Temoridae Sars 1902			
Temora discaudata Giesbrecht 1888	x		
Temora stylifera Dana 1849	x		
Temora turbinata Dana 1849	x		
Fam. Metriidae Sars 1902			
Pleuromamma indica Wolfenden 1905	x		
Pleuromamma piseki Farran 1929	x		
Fam. Centropagidae Giesbrecht 1892			
Centropages brachiatus Dana 1849	x		
Centropages furcatus Dana 1849	x	x	
Centropages gracilis Dana 1849	x		
Centropages orsinii Giesbrecht 1892	x		
Fam. Lucicutiidae Sars 1902			
Lucicutia flavicornis (Claus 1863)	x		
Fam. Candaciidae Giesbrecht 1892			
Candacia bispinosa Claus 1863		x	
Candacia catula Giesbrecht 1892		x	

.../6

	Station 1	Station 2	Station
Candacia longimana Claus 1863	x		
Candacia magna Sewell 1912	x		
Candacia pachydactyla Dana 1848	x		
Candacia simplex Giesbrecht 1892	x		
Fam. Pontellidae Sars 1902			
Calanopia elliptica Dana 1849	x	x	
Labidocera acuta Giesbrecht 1892			x
Labidocera kroyeri Brady 1883		x	x
Labidocera detruncatum Dana 1914		x	x
Labidocera minuta Giesbrecht 1892			
Pontellina plumata Dana 1849	x		
Pontellopsis herdmani Thompson & Scott 1903		x	
Fam. Acartia Sars 1903			
Acartia danae Giesbrecht 1889	x		
Acartia bispinosa Carl 1907	x	x	x
Fam. Tortanidae Sars 1902			
Tortanus barbatus (Brady 1883			x
POECILOSTOMATOIDA			
Fam. Corycaeidae Claus 1863			
Corycaeus spp.	x	x	
Fam. Oncaeidae Giesbrecht 1892			
Oncaea mediterranea Claus 1863	x		
Oncaea venusta Philippi 1843	x		
Fam. Sapphirinidae Thorell 1859			
Copilia mirabilis Dana 1849	x	x	
Copilia quadrata Dana 1849	x	x	
Sapphirina auritens Claus 1863- sinuicauda Brady 1883	x		
Sapphirina nigromaculata Claus 1863	x		
Sapphirina ovatolanceolata Dana 1849-gemma Dana 1849	x		
Fam. Clausidiidae Embleton 1901			
Saphirella tropica Wolfenden 1905	x		

CYCLOPOIDA

Fam. Oithonidae Sars 1913		
Oithona plumifera Baird 1843	x	
Oithona setigera Dana 1849	x	

HARPACTICOIDA

Fam. Ectinosomatidae Moore 1878		
Microsetella rosea Dana 1849		x
Fam. Miracidae Dana 1846		
Macrosetella gracilis Dana 1849		x
Fam. Tachidiidae Sars 1909		
Euterpina acutifrons (Dana 1849)	x	
Fam. Harpacticidae Dana 1846		
Harpacticella spp.	x	

MONSTRILLOIDA

Fam. Monstrillidae Sars 1911	x	

ACKNOWLEDGEMENTS

We thank Prof. Dr. P. Polk for coaching the work and commenting the manuscript, the staff of the Kenya Marine and Fisheries Research Institute; to only mention a few: Messers P. Mathendu, J. Anunda, N. Maroko, J. Kitonga and S. Muiru who assisted on numerous occasions in the field. We thank also the Director of Kenya Marine and Fisheries Research Institute Mr. S. O. Allella for his cooperation.

We thank most sincerely the Kenya/Belgian Marine Sciences Project for the collaboration with equipments, research and discussion.

REFERENCES

(1) Bradford, J. M., 1972. Systematics and ecology of New Zealand Central East Coast Plankton sampled at Kaikoura. Bull. N. Z. Dept. scient. ind. Res., 207 : 1-89.

(2) Brakel, W. H., 1982. Tidal patterns on the East African Coast and their implications for the littoral biota. Proceedings of the symposium on the Coastel and Marine environment of the Red Sea, Gulf of Aden & Tr Western Indian Ocean 2 : 403-418.

(3) Brodsky, K.A., 1950 (1967). Calanoida of the far eastern and polar seas of the USSR. Zool. Inst. Acad. Sci. of the USSR, Fauna n° 35 : 37-87.

(4) Decker De A., 1964. Observations on the Ecology and distribution of Copep in the Marine Plankton of South Africa. Invest. Rep. Div. Sea Fish. South., 51 : 1-67

(5) Fleminger, A., 1973. Pattern, number, variability, and taxonomic signific of integumental organs (sensilla and glandular pores) in the genus Eucalanus (Copepoda, Calanoida). Fish. Bull., 71 : 965-1010.

(6) Frost, B. & Fleminger, A., A revision of the genus Clausocalanus (Copepoda calanoida) with remarks on the distribution patterns in diagnostic characters. Bull. Scripps Inst. Oceanogr. Univ. Calif., 12 : 1-235.

(7) Giesbrecht, W., 1892. Systematik und Faunistik der pelagischen Copepoden des Golfes von Neapel und der angrenzenden meeres-abschnitte. Fauna und Flora des Golfes von Neapel 19 : 1-830.

(8) Greenwood, J. G., 1979. Calanoid Copepods of Moreton Bay (Queensland). IV. Family pontellidae. Proc. R. Soc. Qd., 89 : 1-21.

(9) Grice, G.D., 1964. Two new species of Calanoid Copepods from the Galapagos Islands, with remarks on the identify of three other species. Crustacea 6 : 255-264.

(10) Husemann, K. 1965. A revision of the genus Lucicutia (Copepoda, Calanoida) with a key to its species. Bull. Mar. Sci., 16 : 702-747.

(11) Okera, W. 1974. The zooplankton of the inshore waters of Dar-es-Salaam (Tanzania, S. E. Africa) with observations on reactions to artificial light. Mar. Biol., 26 : 13-25.

(12) Owre, H. B. & Foyo, M., 1967. Copepods of the Florida Current. Fauna Caribbea 1 : 1-137.

(13) Reay, P.J. & Kimaro, M.M., 1984. Surface Zooplankton studies in Port Mombasa during the North East Monsoon. Kenya Journal of Science ar Technology series B 5 : 27-48.

(14) Rose, M., 1933. Copepodes Pelagiques. Faune de France 26 : 1-374 Lechev Paris.

(15) Ryther, J.H., Hall, J.P., Pease, A.K., Bakun, A., & Jones, M. M. 1966. Primary organic production in relation to chemistry and hydrography of the Western Indian Ocean. Limnol. Oceanogr. 11 : 371-380.

(16) Sars, G. O., 1901. Copepoda Calanoida. An Account of the Crustacea of Nc 4 : 1-28.

(17) Scott, A., 1909. The Copepoda of the Siboga-Expedition. I Free-swimming littoral and semi-parasitic Copepoda. Siboga-Exped., Mon.29a. Brill E.J., Leiden, 323 p.

(18) Sewell, R.B.S., 1929. The Copepoda of Indian Seas. Calanoida. Mem. Indi Mus., 10 : 1-221.

(19) Sewell, R.B.S., 1932. The Copepoda of Indian Seas. Calanoida. Mem. Indi Mus., 10 : 223-407.

(20) Sewell, R.B.S., 1947. The Free-Swimming planktonic Copepoda. Systematic account. Sci. Rep. Murray Exped., 8 : 1-303.

(21) Sewell, R.B.S., 1948. The Free-swimming planktonic Copepoda. Geograph Distribution. Sci. Rep. Murray Exped., 3 : 317-592.

(22) Smith, S. L. & Lane, P.V.Z., 1981. Biological Oceanography of the Somali Current Data Report. Informal Data Report N° 29098 Brookhaven Natio Laboratory, Upton N.Y., 126 p.

(23) Wells, J.B., 1976. Keys to the aid in the identification of marine harpa coid copepods. Aberdeen University Press.

(24) Wickstead, J.H. 1965. An introduction to the study of tropical plankton. Hutchinson and Co., London, 160 p.

(25) Wickstead, J.H. 1968. Temperate and tropical plankton; a quantitative comparison. J. Zool. Lond 155 : 253-269.

E. Okemwa,
Kenya Marine and Fisheries Research Institute,
P. O. Box 81651,
MOMBASA.
Kenya.

N. Revis,
Free University of Brussels,
Faculty of Science,
Laboratory of Ecology,
Pleinlaan 2, 1050
BRUSSELS,
Belgium.

Annex 13

Changes in Kenyan coral reef community structure and function due to exploitation

Timothy R. McClanahan & Nyawira A. Muthiga

Friends World College, East African Centre, P.O. Box 526, Machakos, Kenya

Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya.

Keywords: Coral Reefs, Diadema, Echinometra mathaei, Overfishing, Overshelling, Predation, Sea Urchins.

Abstract. A study of the burrowing sea urchin Echinometra mathaei, on a coral reef lagoon adjacent to a heavily populated tourist beach, showed a five fold increase in the urchins' biomass over 15 years. A comparison with a lesser exploited reef lagoon, showed that the more exploited reef had 10 times fewer fish, less coral cover and a lower biomass of two species of sea urchin from the genus Diadema. A niche study of these three species of sea urchin indicates that they may be ecologically separated by their predator avoidance strategies. As an explanation of the changes occuring on the exploited fringing reef lagoon, we suggest the hypothesis that in the absence of predators, Echinometra mathaei populations increase and outcompete other sea urchin grazers because of their abiltiy to feed closer to the reef substrate (due to their burrowing ability). Unrestricted by predators, their feeding behavior allows them to eat living coral and breakdown reef substratum. This eventually leads to a loss of live coral cover, topographic complexity, species diversity, biomass and ultimately the productivity of the reefs.

There is a concern in tropical areas of the world that overfishing and shelling may be causing a subsequent increase in sea urchin populations (Hay, 1984). This in turn may cause an increase in biodegradation of coral reef substrate and a loss of habitat and coastal protection (Glynn et al., 1979). From these premises we studied the community structure of Kenyan fringing reefs in order to determine changes that occur due to exploitation.

Studies of the burrowing sea urchin Echinometra mathaei (de Blanville) were repeated after fifteen years on a fringing reef at Diani, Kenya. Diani is the most heavily populated tourist beach in East Africa. A large influx of tourists have used this beach for over twenty years and fishing and shelling rates have undoubtedly been high in order to supply the tourist industry. As a comparison, a similiar study was undertaken on a less exploited reef of similiar structure at Kanamai, Kenya. Measurements at both sites, on the outer reef edge and inner reef lagoon, included sea urchin sizes, densities (numbers per meter squared), biomass, percent live coral cover and fish population measurements. Studies of sediment in the gut and sediment defecation rates of E. mathaei were also undertaken. Additionally, a study of the major sea urchin species inhabiting hard substrate at Kanamai

(*Diadema setosum* (Leske), *Diadema savignyi* (Michelin), *E. mathaei*) was undertaken to determine if predation affected their niche separation.

A comparison of the *E. mathaei* population at Diani showed large increases in the density, size and biomass on the inner reef lagoon but not on the outer reef edge where mean sizes and biomass were actually lower than fifteen years previously (Table 1, 2). Comparing these observations with the *E. mathaei* population at Kanamai we found densities and sizes were also lower in the Kanamai inner reef lagoon additionally a large part of the urchin biomass was contributed by the two other *Diadema* species. On the outer reef edge, *E. mathaei* densities and biomass were lower than at Diani but there were also significant differences between transects on the outer reef at both sites unlike the inner reef lagoons. Therefore, the differences on the outer reef (between 1970 and 1985) may be due to sampling differences rather than actual changes. The fish catch per unit effort was similiar on the two outer reef sites (Kanamai and Diani) which suggests that overfishing has not occured on the outer reefs. In the inner reef lagoon the fish density is an order of magnitude higher at Kanamai than at Diani. The general conclusion of this study is that the outer reef has not been subjected to overfishing and shelling as much as the inner reef lagoon, and *E. mathaei* population levels reflect this exploitation.

The sea urchin niche study lends further insight into the mechanisms of these observed changes. The three main species of sea urchin, which inhabit the hard substrate, are all omnivores eating a variety of algae, coral, invertebrates and other organisms associated with hard substrate (Herring, 1972; Lawrence, 1975). Therefore, we suggest that these species are ecologically separated by their predator avoidance strategies (Table 3). D. setosum has long poisonous spines and lives in groups. Both are strategies which allow it to live in the open and avoid predation. On the other extreme E. mathaei is solitary, has short spines and lives in burrows, which in the inner lagoon may be created in order to escape predation. D. savignyi has an intermediate strategy. It lives in smaller groups, has intermediate length poisonous spines and lives in naturally occuring crevices. This niche separation normally occurs in coral reefs where predation is an active influence on the reef community.

Our suggested hypothesis, to explain the changes that have occured in Diani, is that once predators are removed from the inner reef lagoon, by overfishing and shelling, the sea urchins can directly compete with each other for food. Most importantly E. mathaei can live outside of burrows and directly compete with the other two species of Diadema. We expect that the winner of this competition is the species which can feed closest to the substrate. E. mathaei has a strategy of feeding close to the substrate and ingesting large quantities of sediment. This allows it to create and live in burrows. We observe in the Diani inner reef lagoon that *E. mathaei* no longer inhabits burrows and feeds freely in the open. As well, the densities of *Diadema* were below the sampling intensity suggesting that they may have been outcompeted.

The major environmental problem arising from this change in community structure is that once *E. mathaei* is no longer restricted by predators it feeds freely on living coral and breaks down the reef substratum. Reducing the amount of living coral reduces calcium carbonate deposition, and reducing reef substratum reduces topographic complexity, which in turn reduces the total number of available niches, and therefore species diversity, biomass and reef productivity (Levin & Choat, 1980; Talbot, 1965). From gut analysis and defecation rate studies we find that the rate of sediment defecation and sediment in the gut content is proportional to the weight of the urchin (gut sediment in grams = 0.16 + 0.015wet weight of urchin in grams, r=0.73, n= 28; sediment defecation in grams = 0.27 + 0.12wet weight of urchin, r=0.50, n=32). Therefore, we suggest that the rate of substrate degradation is proportional to the biomass of *E. mathaei*. Measurements indicate that on Diani's inner reef the substrate degradation rate may be as high as 3.6 $kg/m^2/yr$. Since coral cover is low, it is impossible for this substrate and structure loss to be replaced. Even if management strategies were implemented, it would take many years before the ecosystem could return to one of high topographic complexity, species diversity and productivity. Presently, the Diani reef lagoon has been reduced to a simple ecosystem in which the major form of primary productivity is algae, growing on the hard substrate, and secondary productivity is in the form of *E. mathaei*, presently a species of no commercial value to man. The present standing crop of 5340 kg/ha (wet weight, shell included) is an order of magnitude higher than the most productive rangelands in East Africa (Pratt & Gwynne, 1977). Through proper management a larger percentage of this biomass could be in a form utilizable by man.

Good news from the human environmental perspective is that *E. mathaei* populations have not increased on the outer fringing reef edge. The reason may be that the outer reef edge has not been overfished and shelled to the same extent as the inner reef lagoon, or that the rough physical conditions in this area limit *E. mathaei* as well as man's ability to fish and shell. Ecological release of *E. mathaei* in this area could be highly detrimental since the outer reef is the physical barrier which protects the shore from erosion caused by waves, tides and currents. It is critical for future coastal management to determine the factors controlling *E. mathaei* in this area. As well, it will be necessary to determine whether gastropod or fish predators are more important in controlling E. mathaei populations. As E. mathaei is a common sea urchin species throughout the Indo-Pacific, we suggest that the scenario presented in this paper may be common in many Indo-Pacific areas where overfishing and shelling occur.

Acknowledgements

Support for this research came from the World Wildlife Fund. We are also grateful for the assistance of the School for Field Studies, Kenya Marine and Fisheries Research Institute, the Kenya-Belgium Program and the University of Nairobi Moana Marine Laboratory.

References

Glynn, P.W., Wellington, G.M. & C. Birkeland 1979. Coral reef growth in the Galapagos: limitations by sea urchins. Science, 203(4375): 47-49.

Hay, M.E. 1984. Patterns of fish and urchin grazing in caribbean reefs: are previous results typical? Ecology 65: 446-454.

Herring, P.J.J. 1972. Observations on the distribution and feeding habits of some littoral echinoids from Zanzibar. J. nat. Hist. Lond. 6: 169-175.

Lawrence, J.M. 1975. On the relationship between marine plants and sea urchins. Oceanogr. Mar. Biol. Ann. Rev. 13: 213-286.

Levin, L.L. & J.H. Choat 1980. Density and distribution patterns of the temperate marine fish Cheilodactylus spectabilis (Cheilodactylidae) in a reef environment. Mar. Biol. 57: 327-337.

Pratt, D.J. & M.D. Gwynne 1977. Rangeland Management and Ecology in East Africa. Hodder and Stoughton, London.,310pp.

Talbot, F.H. 1965. A description of the coral structure of Tuita reefs (Tanganyika territory, East Africa) and its fish fauna. Proc. zool. Soc. Lond. 145: 431-470.

Table 1. Data on *Echinometra mathaei* population structure and community structure on the inner fringing reef lagoons at Diani, Kenya 1971 and 1985, and Kanamai 1985.

	Kanamai 1985	Diani 1970[1]	Diani 1985
Echimometra mathaei			
Density, #/m^2	1.2 ± 2.0	5.3	14.2 ± 15.8**
Diameter, mm	37.1 ± 8.0	32.7	40.8 ± 7.4[2]
Biomass, g/m^2	33	110	534
Burrowed, %	74.7 ± 32.8	-	7.3 ± 7.2***
Diadema sp., g/m^2	54.4	-	undetected
Coral cover, %	5.5 ± 13.6	-	<1 [3]
Fish density, #/100m^2	69.8 ± 27.0	-	7.5 ± 4.7***

1 Data from Khamala (1971)

2 Diani 1970 is significantly smaller (p<0.01) than in 1985 and smaller than Kanamai, but Diani 1985 is not significantly different from Kanamai 1985.

3 Live coral cover was so low at Diani in 1985 that it was difficult to measure accurately but was usually one percent or less in the quadrats.

Table 2. Community structure data and *Echinometra mathaei* population data from the outer fringing reef at Diani 1970, 1985, and Kanamai 1985.

Echinometra mathaei	Kanamai 1985	Diani 1970[1]	Diani 1985
Density, #/m^2	0.5 ± 1.3	2.6	1.7 ± 1.0*
Diameter, mm	42.5 ± 7.1	43.7	31.2 ± 6.72 [2]
Biomass, g/m^2	20.1	116	31.1
Burrowed, %	100	-	100
Coral cover	3.6 + 8.4	-	<1[3]
Fish Catch/effort, kg/hr	1.46 ± 0.55	-	1.73 ± 0.7 NS

1 Data from Khamala (1971)

2 Diani 1985 is significantly smaller ($p<0.01$) than both Kanamai 1985 and Diani 1970.

3 Coral cover was so low at Diani that it was difficult to accurately measure but was usually one percent or lower.

Table 3. Niche separation study data for the three major species of sea urchin inhabiting hard substrate at Kanamai.

	D. setosum	*D. savignyi*	*E. mathaei*
Spine length, cm	15.6 ± 2.9	11.3 ± 2.2	2.0 ± 0.2**
Crevice or burrow width, cm [1]	28.4 ± 4.6	19.8 ± 11.4	8.8 ± 9.6**
In Crevices or burrows, %	12.7	51	80
Group size	3.0 ± 2.1	1.4 ± 0.8	1.0 ± 0.0**
In groups, %	78	22	0

1 Those individuals in areas with no crevices or crevices greater than 30 cm wide were considered in the open but 30 cm was used in calculating the averages.

ANNEX 14

POPULATION CHANGES OF A SEA URCHIN (*Echinometra mathaei*) ON AN EXPLOITED FRINGING REEF.

N.A. Muthiga and T.R. McClanahan

Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya

Friends World College, East African Centre, P.O. Box 526, Machakos, Kenya

Summary

A comparison of *Echinometra mathaei* densities and sizes was undertaken on an inner reef lagoon and an outer reef edge on a densely populated tourist beach at Diani, Kenya. *E. mathaei* densities and average lengths were significantly higher (t-test, $p < 0.001$) in the inner reef lagoon (density = 14.2 ± 1.7 #/m^2, n = 90; lengths = 40.8 ± 0.6 mm, n = 144) than on the outer reef edge (density = 1.7 ± 0.13 #/m^2, n = 60; lengths = 31.2 ± 0.8 mm, n = 68). A comparison with density and length data collected 15 years previously (Khamala, 1971) showed increases in the numbers and average lengths (t-test; $p < 0.05$) in the inner reef and a decrease in the average lengths (t-test; $p < 0.05$) on the outer reef edge. Using a correlation of the length and average weight of individual urchins (weight = 0.0021length$^{2.64}$, r = 0.96, n = 144) and the average length and density mesurements (#/m^2), an increase of 424 g/m^2 on the inner reef and a decrease of 81 g/m^2 on the

outer reef edge was found over the past 15 years. Quantities of sediment found in the gut contents of the sea urchins (69.5% by weight) were positively correlated with the weight of the sea urchins ($F = 67.5$, $p < 0.001$, $r = 0.73$) which suggests that reef substrate degradation rates are proportional to the urchin biomass. Therefore, we suggest that there has been an increase in reef substrate degradation rates on the inner reef lagoon but not on the outer reef edge.

The distribution of E. mathaei on the inner reef was positively correlated ($F = 82.2$, $p < 0.001$, $r = 0.69$) with the percent hard substrate (dead coral and coral rubble) but not on the outer reef, where the availability of shelter appears to be of greater importance. We suggest that the population increase in the inner reef is due to ecological release of E. mathaei from competitors and predators due to increased fishing and shelling activities. On the outer reef the stressful physical environment may limit both the sea urchin populations and man's ability to fish and shell.

Introduction

Sea urchins have a variable role in the coral reef community. As grazers of benthic algae they reduce algal cover and break down reef substratum which creates topographic complexity and can enhance coral recruitment (Birkeland & Randall, 1981; Sammarco, Levinton & Ogden, 1974; Dart, 1972). However, some species of sea urchin feed on living coral and therefore reduce coral survival and calcium carbonate deposition (Glynn, Wellington & Birkeland, 1979; Bak & van Eys, 1975; Lawrence, 1975). Hay (1984) has shown that in Carribbean coral reefs the prevalence of sea urchins is proportional to the degree of fishing. From this premise we studied the population changes of Echinometra mathaei (De Blainville) over the last fifteen years in Diani Beach, Kenya which is the most heavily populated tourist beach in East Africa. E. mathaei was previously studied at Diani by Khamala (1971) and in Zanzibar by Herring (1972). From these studies it has been determined that E. mathaei is an omnivorous burrowing sea urchin which feeds mostly on fleshy benthic algae but also on other invertebrates, including corals, inhabiting the coral reef benthos.

Methods

The size distribution, population density and factors affecting the distribution of E. mathaei were studied along three transects (300 meters each) within the inner reef lagoon and four transects (150 meters each) on the outer reef edge at the same study site as Khamala (1971). One meter quadrats were established at 10 meter intervals within the inner reef lagoon and at 5 meter intervals on the outer reef edge. The number of E. mathaei were counted and the percent cover of coral, hard substrate (dead coral and coral rubble), and seagrass was estimated. Random collections of <u>E. mathaei</u> were made within the two locations, the shortest and longest test axes and wet weights of these urchins were measured. A length weight relationship was established for individual urchins. This combined with the urchin density ($\#/m^2$) and the average length of the urchins, at each time and site, was used to estimate and compare biomass changes. All measurements of variance are standard errors of the mean.

The quantity of sediment in the gut of <u>E. mathaei</u> was determined by dissecting the gut contents, drying, weighing, treating with a 10% hypochlorite solution (to dissolve off the organic matter) and then drying and weighing again.

Results

The average density ($\#/m^2$) of <u>E. mathaei</u> within the three inner reef transects was 14.1 $\pm$ 1.7 individuals/m^2 (n = 90) and did not differ significantly between transects (12.1 $\pm$ 1.3, 18.1 $\pm$ 2.1, 12.3 $\pm$ 1.5; ANOVA, $F_{2,87}$ = 1.4). Densities of <u>E. mathaei</u> on the outer reef (1.7 $\pm$ 0.13 individuals/m^2, n = 60) were significantly lower (t-test; $p < 0.001$) than on the inner reef. However, there was also a significant difference in the densities between transects within the outer reef (2.9 $\pm$ 0.35, 1.3 $\pm$ 0.23, 1.5 $\pm$ 0.22, 0.8 $\pm$ 0.23; ANOVA, $F_{3,56}$ = 2.99, $p < 0.05$). The densities within the inner reef lagoon were nearly three times higher than those found in the 1970 study (5.3 individuals/m^2) but were comparable on the outer reef edge (2.6 individuals/m^2).

A comparison of the distribution of E. mathaei along the inner reef transects shows that the difference in densities is due to a large increase of E. mathaei in the inner reef lagoon (middle and seaward positions, Fig. 1). This difference is attributed to the distribution of hard substrate (Fig. 2) which correlated significantly ($r = 0.69$, $F = 82.2$, $p < 0.001$, $n = 90$) with the densities of E. mathaei on the inner reef but not on the outer reef (Fig. 3).

The density of live coral cover was low on both the inner and outer reefs (< 1%).

The average size of the sea urchin tests (short + long axis/2) were significantly smaller (t-test, $p < 0.001$) on the outer reef (31.2 ± 0.81 mm, $n = 68$) than on the inner reef (40.9 ± 0.62 mm, $n = 144$). This is the reverse of the 1971 study in which the outer reef urchins were significantly larger (43.7mm) than the inner reef urchins (32.7mm). A comparison between the 1971 study and the present study shows that the the inner reef urchins are larger and the outer reef urchins smaller than in 1971 (t-test, $p < 0.05$, Fig. 4).

Changes in biomass determined from a regression of the average length versus weight of the individual urchins (weight $= 0.0021\ \text{length}^{2.64}$, $r = 0.96$, $n=144$, Fig. 5) and the average urchin density, determined that there has been an increase in biomass in the inner reef of 424 g/m^2 from 110 g/m^2 in 1970 to 534 g/m^2 (5340 kg/ha) in 1985. On the outer reef there has been a loss of 81 g/m^2 from 116 g/m^2 to 31.1 g/m^2 during the 15 year period.

Analysis of the gut content of the sea urchins showed no significant differences between the percent fractions of sediment and organic matter between the inner and outer reefs (t-test). It was determined that the greater fraction of the urchin's gut content is sediment (inner reef = 72.9 ± ; n = ;outer reef = 66.0 ± ; n =). The total gut content and the sediment fraction were positively correlated (gut content, $F = 89.5$, $r = 0.78$, $p < 0.001$; sediment, $F = 67.5$, $r = 0.73$, $p < 0.001$) with the wet weight of the urchins (Fig. 6).

Discussion

The results indicate that the major change in the *E. mathaei* population has occured within the inner reef, and more specifically within the inner reef lagoon. All parameters of size, density and biomass show large increases in the last fifteen years. Since this section of the reef has comparably low physical and environmental stresses; such as tidal exposure, waves and currents, we would suspect that biotic factors such as competition and predation to be major determinants of the community structure. Because of the low physical stress and the areas proximity to the shore, fishing and shelling may be the major causes of the observed changes. We suggest that the removal of the sea urchin predators and competitors, combined with the low physical stress factor has led to the observed population increase.

This conclusion is largely conjectural as direct measurements of predator and competitor population changes have not been made. Yet, because of the close proximity of tourists, which create a demand for finfish and shellfish, this hypothesis remains a likely explanation. An alternative explanation is that the differences are due to the time and success of the sea urchin's last larval recruitment. This is suspected to be a major force in the outbreaks of _Acanthaster planci_ in the eastern Indo-pacific (Birkeland, 1982). The differences in _E. mathaei_ sizes on the outer reef between 1970 and 1985 may be a result of this factor.

The distribution and density of _E. mathaei_ on the inner reef appears to be greatly dependent on the availability of hard substrate, unlike the outer reef population. A large part of _E. mathaei's_ diet consists of fleshy algae (Khamala, 1971) which grows on hard substrate. _E. mathaei_ on the inner reef is therefore competing for fleshy algae which grows on the hard substrate. However, the sea urchins on the outer reef are restricted to sheltered areas (crevices and burrows). The rough physical conditions on the outer reef and the distance from the shore may make it less inhabitable by _E. mathaei_ and less susceptible to overfishing and shelling .

From the gut content studies, we find that sediment is a large fraction of _E. mathaei's_ diet. Since the urchins are distributed on hard substrate we would suspect that a large proportion of this sediment is scraped from dead coral and coral rubble, and the urchins are greatly contributing to the breakdown of the reef substratum. The quantity of sediment in the gut content is also proportional to the urchin's weight which would suggest that feeding and substrate degradation rates are proportional to the urchin's biomass. Therefore, there has probably been an increase in reef substrate degradation on the inner reef but not on the outer reef in the last fifteen years. Since the outer reef is the critical structure for the protection of the shoreline, from waves and other physical factors, it is good news from the human environmental perspective that degradation rates have probably not increased in this area. As coral cover on the inner reef is low, calcium carbonate deposition is probably also low, and the sea urchin's conversion of hard substrate into soft substrate may eventually limit their population by reducing the quantity of hard substrate.

It is unknown whether or not these urchins are the cause of the low coral cover, but _E. mathaei_ is an omnivore eating numerous organisms including coral which inhabit hard substrate (Herring, 1972). Its density within the inner reef is also a function of the percent hard substrate or in other words dead coral. From personal observations on similiar reefs, we suggest that this is a low value for coral cover and that some effect of exploitation and the ecological release of this sea urchin may be responsible.

The major environmental concern arising from this study is not the problem of reef substrate degradation but rather the change in the inner reef's community structure. The inner reef lagoon, which is usually a diverse community, has (from our observations on other invertebrate and fish species in this reef and other reefs within this area) been transformed into a simple ecosystem where primary productivity is being utilized almost exclusively by one sea urchin herbivore which is presently not utilized by man in East Africa. The _E. mathaei_ standing crop of 5340 kg/ha is an order of magnitude greater than the values found on the most productive rangelands in East Africa (Pratt and Gwynne, 1977). Although, direct comparisons may not be possible, it is unfortunate that in Africa, where the availability of protein in most peoples diet is limited, such a large quantity of secondary productivity is in an unutilized form. Proper management of this ecosystem could render a larger fraction of this productivity for human consumption.

Acknowledgements

We are grateful for funding from the World Wildlife Fund. The

Kenya Marine and Fisheries Research Institute, the Kenya-Belgium program and the Moana Marine Laboratory for their assistance and use of their facilities. R.B. McClanahan for assistance with the field work, P. Polk and K.H. Mann for review of the manuscript.

References

Bak, R.P.M. & van Eys, G. (1975) Predation of the sea urchin *Diadema antillarum* Philippi on living coral. *Oecologia*, 20, 11-15.

Birkeland, C. (1982) Terrestrial Runoff as a cause of outbreaks of Acanthaster planci (Echinodermata: Asteroidea). *Mar. Biol.* 69, 175-185.

Birkeland, C. & Randall, R.H. (1981) Facilitation of coral recruitment by echinoid excavations. *Proc. 4th Int. Coral Reef Symp.* 1, 695-698.

Dart, J.K.G. (1972) Echinoids, algal lawn and coral recolonization. *Nature*, 239, 50-51.

Ebert, T.A. (1982) Longevity, life history, and relative body wall size in sea urchins. *Ecol. Monogr*. 52(4), 353- 394.

Glynn, P.W., Wellington, G.M. & Birkeland, C. (1979) Coral reef growth in the Galapagos: limitation by sea urchins. *Science*, 203(4375), 47-49.

Hay, H.E. (1984) Patterns of fish and urchin grazing on carribbean coral reefs: are previous results typical? Ecology, 65, 446-454.

Herring, P.J. (1972) Observations on the distribution and feeding habits of some littoral echinoids from Zanzibar. J. nat. Hist., 6, 169-175.

Khamala, C.P.M. (1971) Ecology of Echinometra mathaei (Echinoidea: Echinodermata) at Diani Beach, Kenya. Mar. Biol. 2(2), 167-172.

Lawrence, J.M. (1975) On the relationship between marine plants and sea urchins. Oceanogr. Mar. Biol. Ann. Rev. 13, 213-286.

Pratt, D.J. & Gwynne, M.D. (1977) Rangeland Management and Ecology in East Africa. Hodder and Stoughton, London.

Sammarco, P.W. Levinton, J.S. & Ogden, J.C. (1974) Grazing and control of coral reef community structure by Diadema antillarum Phillipi (Echinodermata: Echinoidea): a preliminary study. J. Mar. Res. 32(1), 47-53.

Figure 1. The density of Echinometra mathaei along transects calculated for landward, middle and seaward positions along the inner and outer reefs in 1970 ( ) and in 1985 ( ). The bars represent the 95% confidence intervals for the 1985 data. Each point was calculated by averaging quadrats within each location from the different transects.

Figure 2. The distribution of hard substrate and seagrass along the inner reef transects.

Figure 3. The density of E. mathaei as a function of the estimated hard substrate on the inner (;solid line) and outer reef (;broken line). Open symbols represent a single data point, solid symbols represent multiple data points.

Figure 4. Frequency histograms of the mean test diameters for E. mathaei on the inner and outer reef in 1970 (open blocks) and 1985 (striped blocks).

Figure 5. Correlation between the average length and wet weight of E. mathaei individuals.

Figure 6. Dry weight of the total gut content (;solid line) and the sediment content (;broken line) of E. mathaei as a function of its wet weight.

Muthiga, McClanahan Figure 1

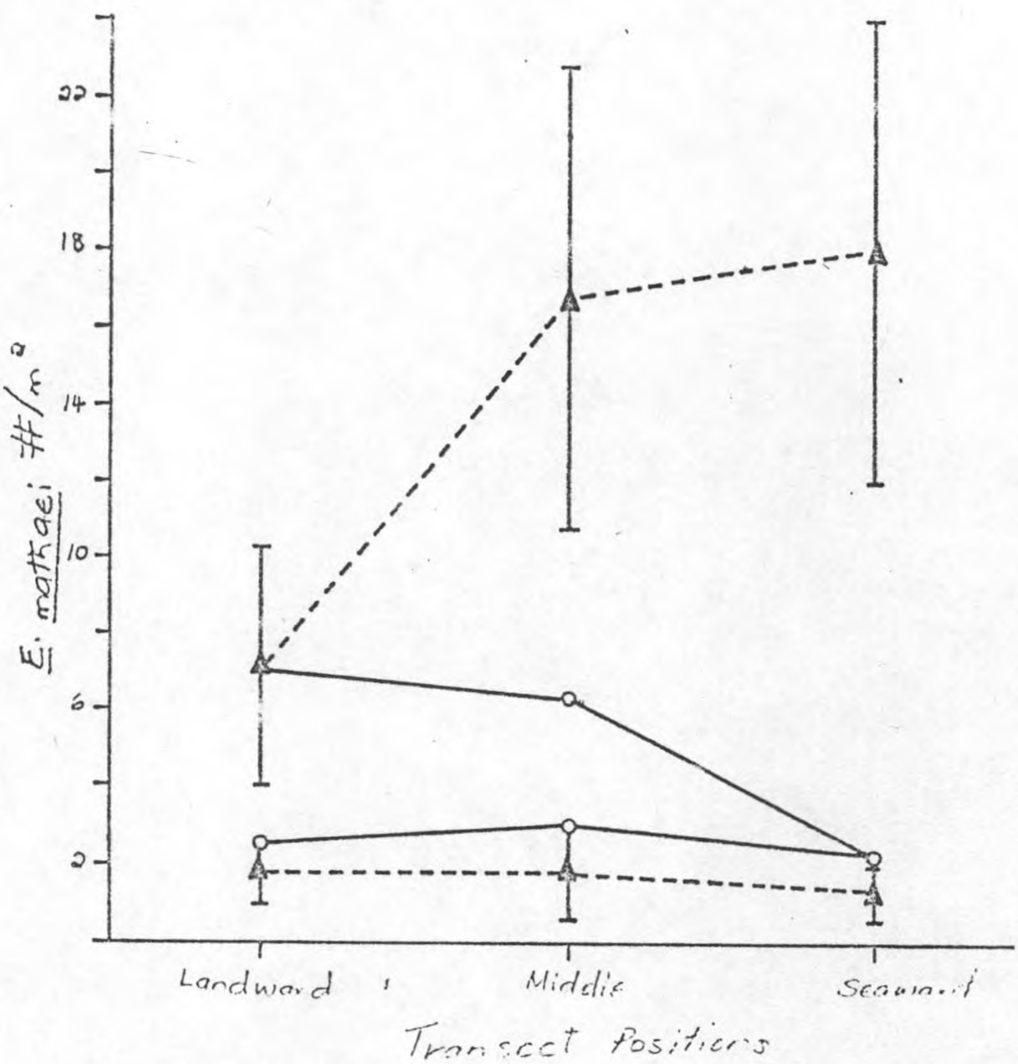
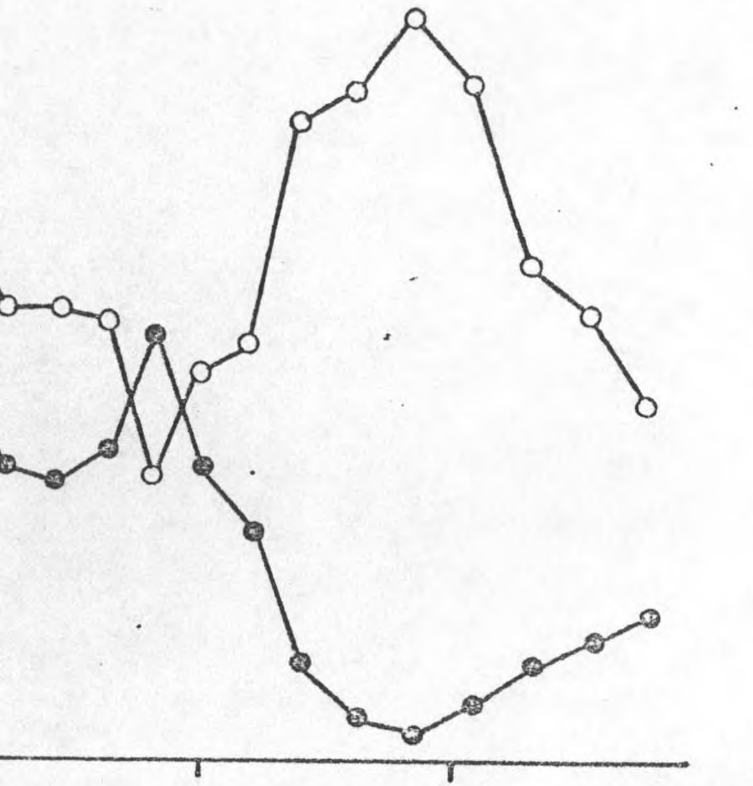
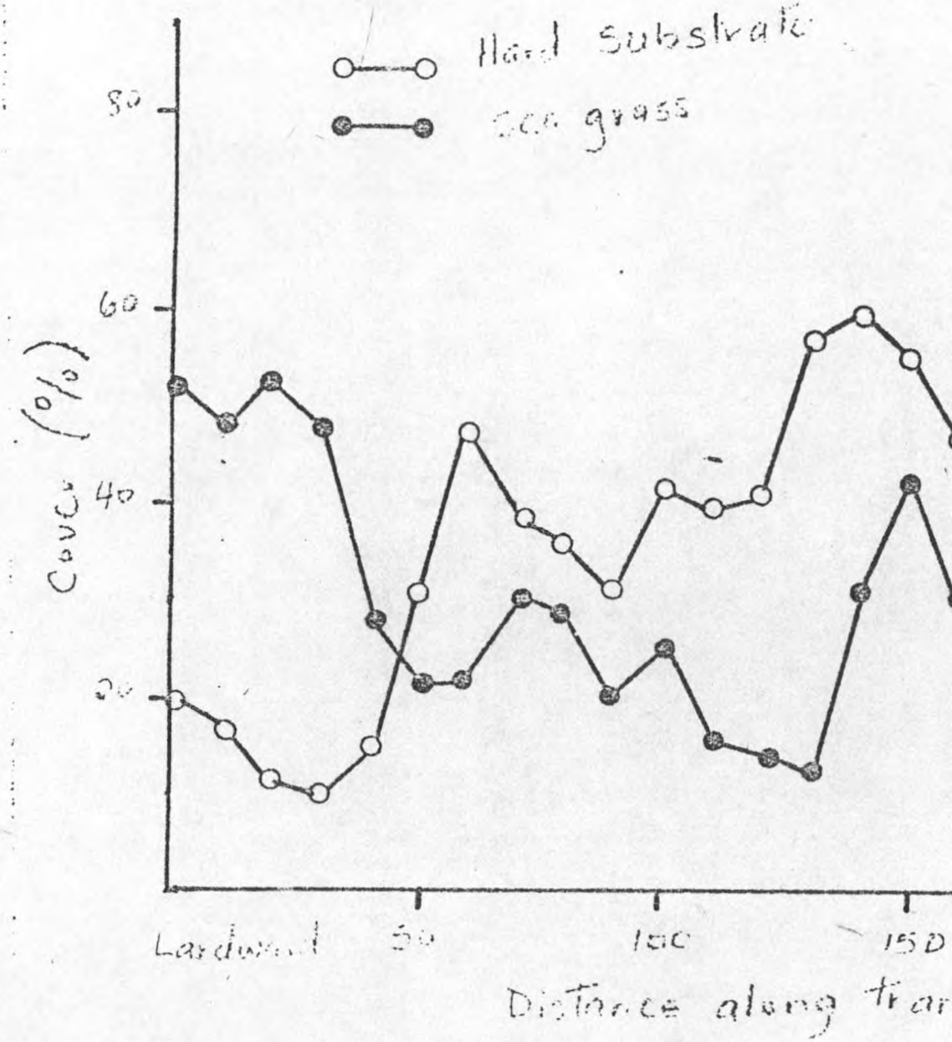


Figure. 2

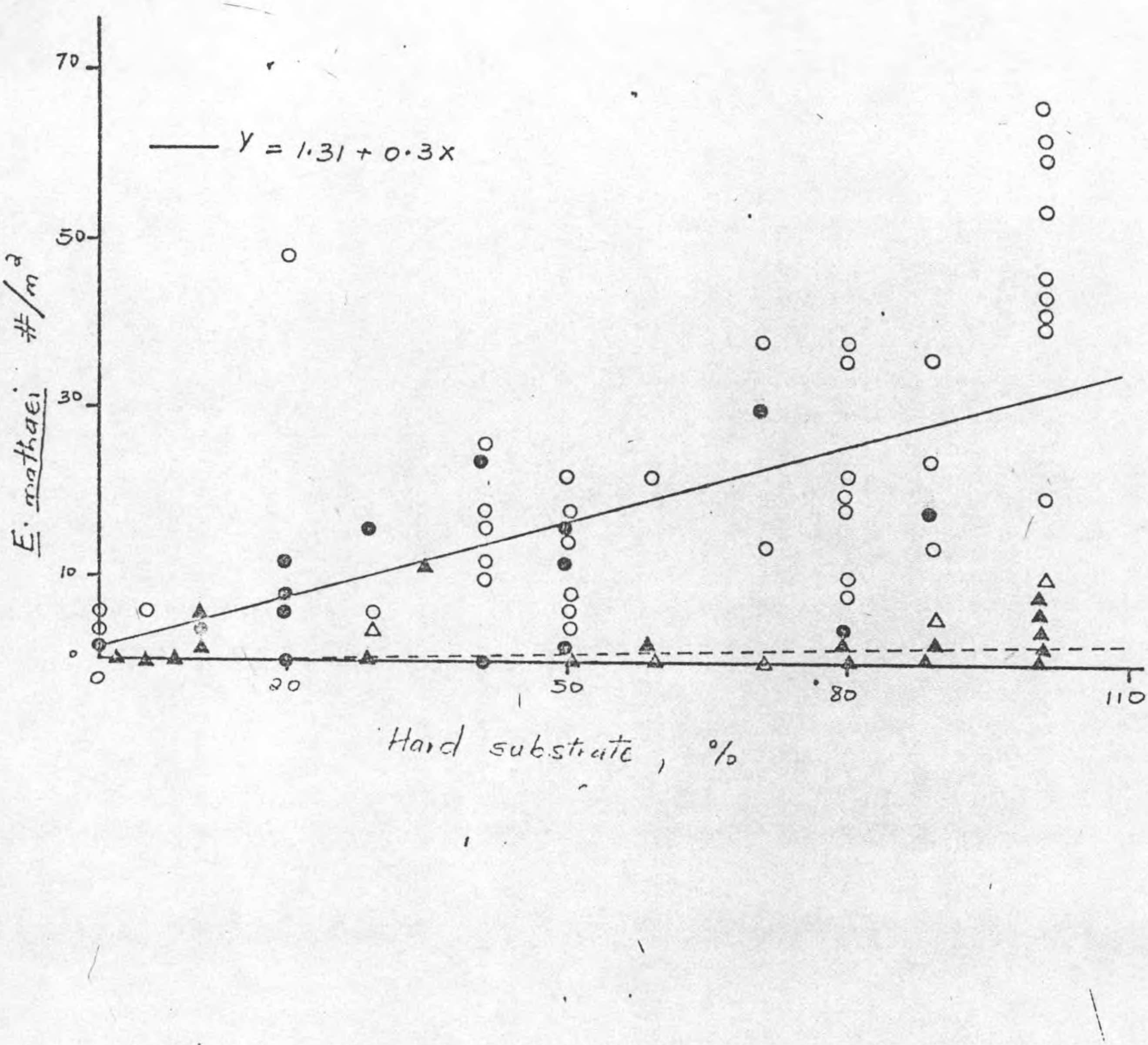


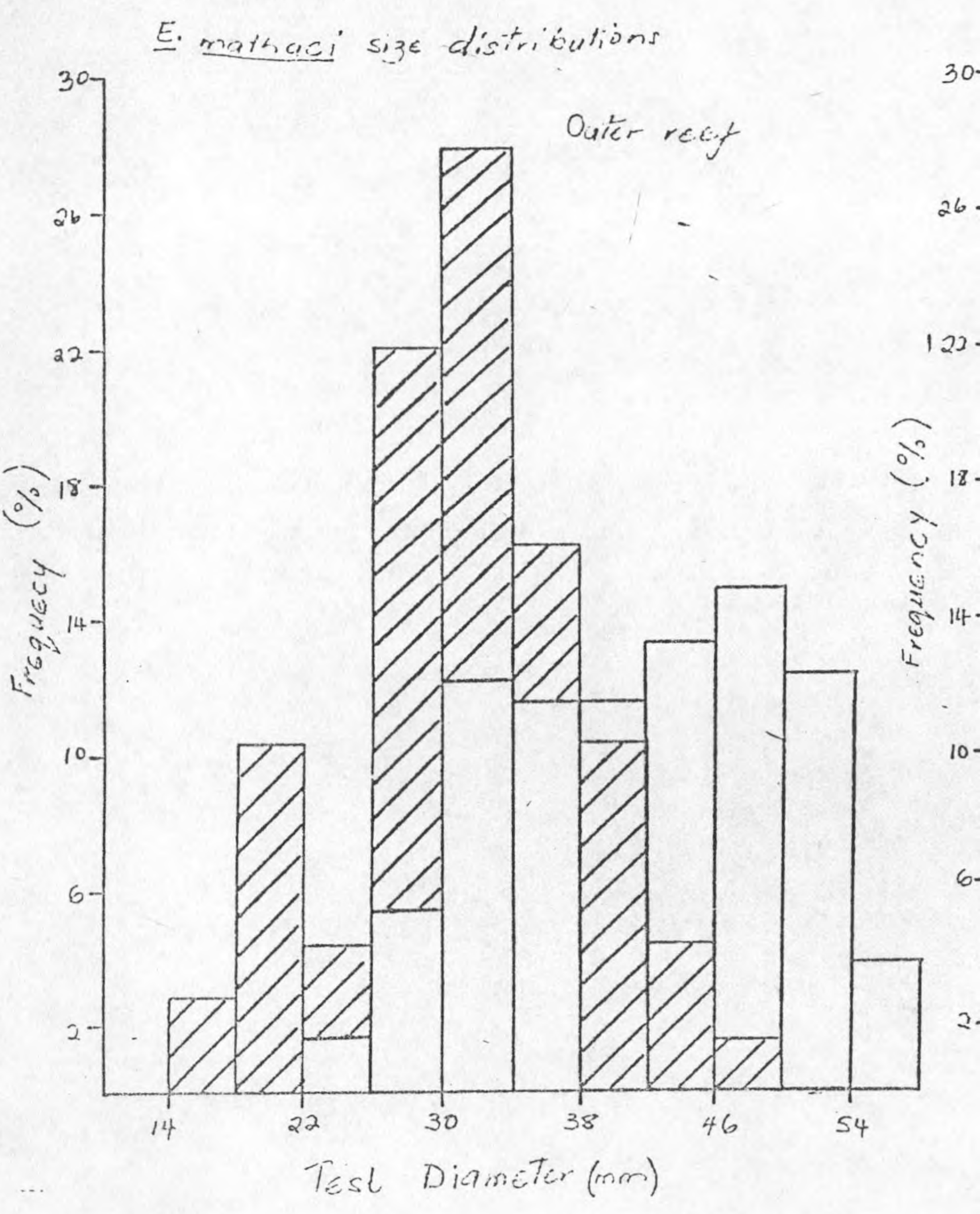
Muthiga, Ha



Hard substrate
Sea grass
80
60
40
20
Cover (%)
Landward
50
100
150
Distance along tran

Muñoz, McClanahan Figure 3

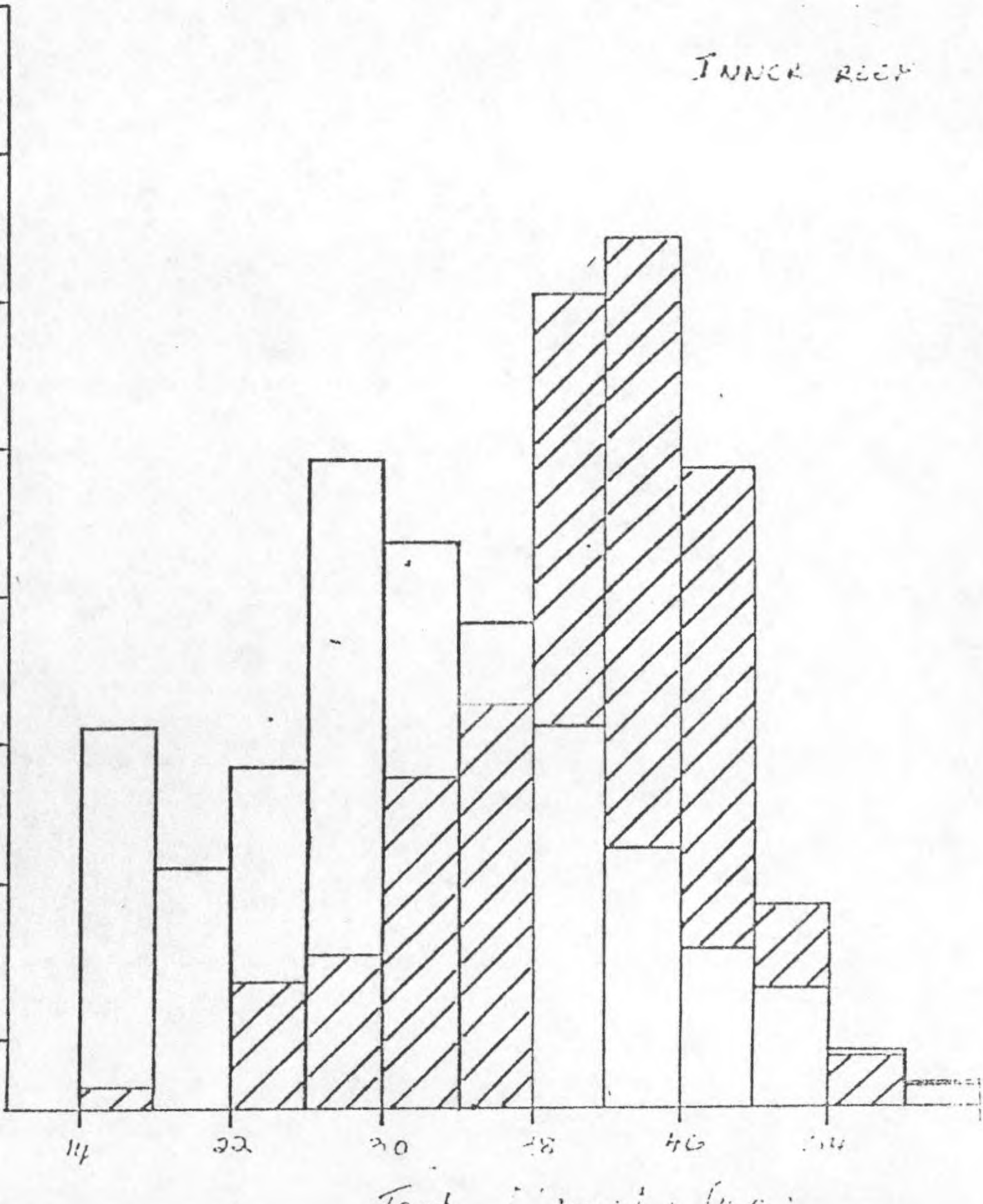




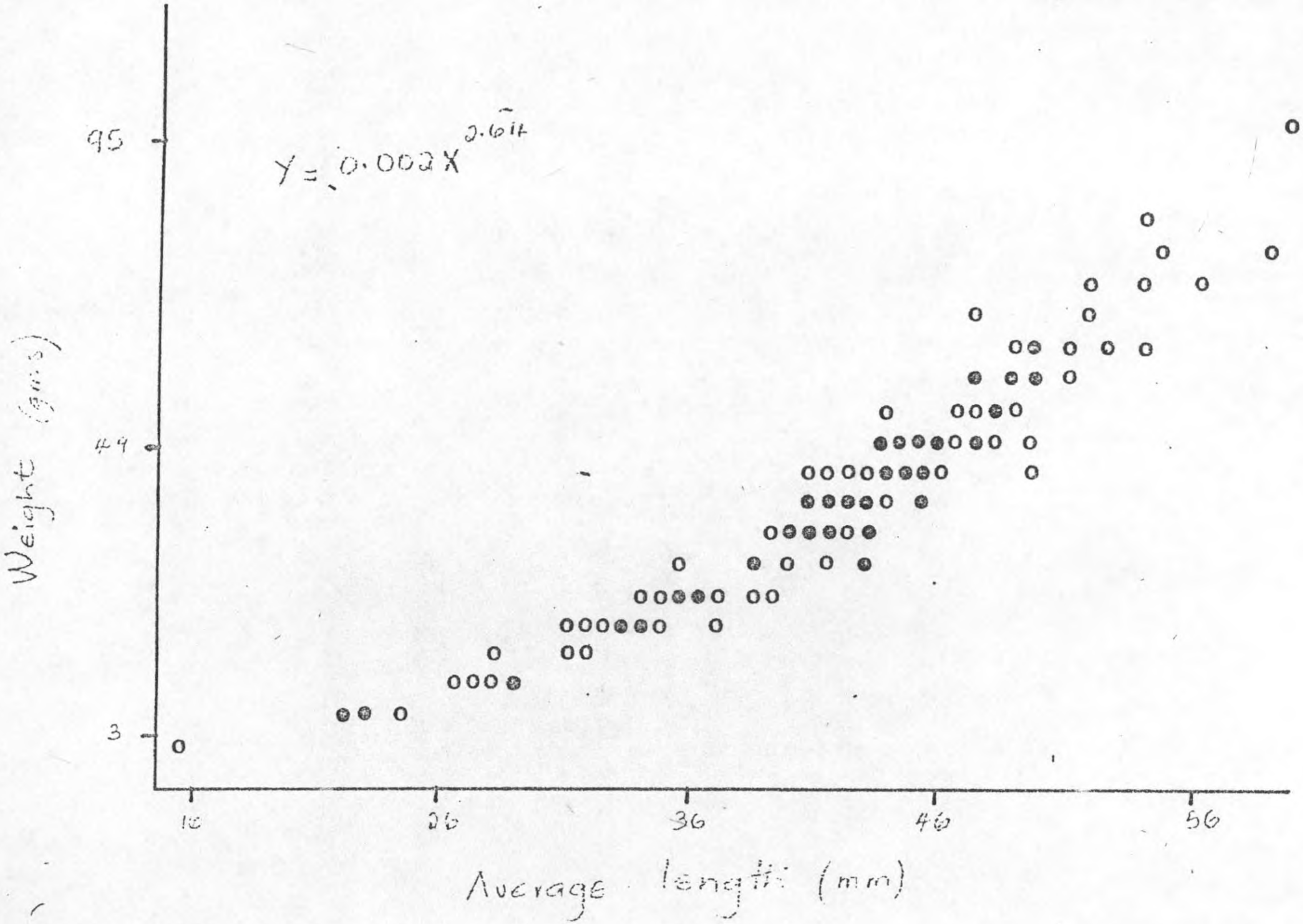
E. mathaei size distributions
Outer reef
Freguecy (%)
30
26
22
18
14
10
6
2
14
22
30
38
46
54
Test Diameter (mm)
Frequency (%)

MUTHIGA, McClanahan Figure 4

E. mathaei size distributions



Muthiga, McClanahan Figure 5



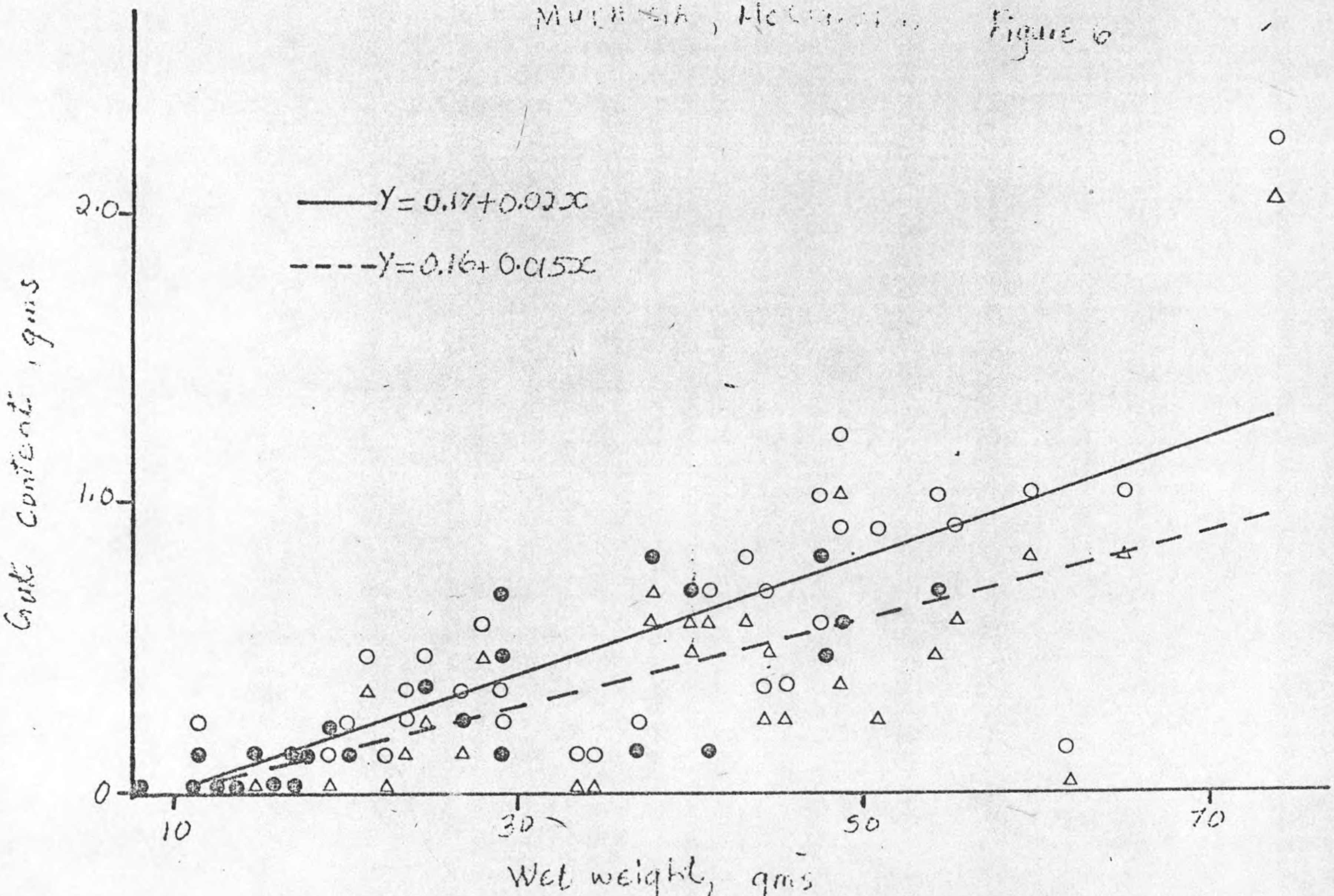


Figure 6
Y = 0.17+0.02x
Y = 0.16+ 0.015x
2.0
1.0
0
10
30
50
70
Gut content, gms
Wet weight, gms

Annex 15

NON-ENCRUSTING MACROALGAL ZONATION ON ROCKY CLIFFS AROUND MOMBASA, KENYA*

H.A. OYIEKE AND R.K. RUWA

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

P.O. BOX 81651

MOMBASA

KENYA

*(Kenya/Belgium Project in Marine ecology and Management of the coastal zone. Publication No. 4).

A B S T R A C T

The zonation of 35 species of rocky cliff non-encrusting macroalgae is described. Out of this total number of species 10 are new records for Kenya; these are *Caulacanthus ustulatus*, *Ceramium camouii*, *Gelidiella myriocladia*, *Platysiphonia miniata*, *Pterocladia nana* (Rhodophyta); *Cladophora mauritiana*, *C. saviniana*, *Ulva pertusa*, *Valonia fastigiata* (Chlorophyta) and *Dictyota adnata* (Phaeophyta). Using the shore terminology of Lewis (1964) and Hartnoll (1976) the patterns of distribution of the species which are seen frequently or abundantly are as follows; (a) Littoral fringe: *Bostrichia binderi*, *B. tenella* (Rhodophyta) and *Chaetomorpha* spp (Chlorophyta); (b) Upper eulittoral zone; *Catenella opuntia*, *Caulacanthus ustulatus*, *Ceramium camouii*, *Lophosiphonia reptabunda*, *Murayella periclados* (Rhodophyta), *Caulerpa fastigiata*, *Cladophora patentioramease*, *C. sundanensis*, *Enteromorpha kylinii*, *E. ramulosa* (Chlorophyta); (c) Lower eulittoral zone; *Acrocystis nana* (Rhodophyta) and *Ulva pertusa* (Chlorophyta).

The cliffs which are predominantly limestone are heavily pitted and eroded frequently giving rise to overhangs. The pits are responsible for enabling the occurrences of small percentages of algal cover on surfaces which are fully exposed to sunlight whereas the overhangs are responsible for the high percentages of algal cover in the undercut surfaces of the cliffs. The ecological significance of these topographical variations combined with the differences in exposure to sunlight on the distributions of the various algal species encountered in this study is discussed.

INTRODUCTION

Studies on the marine rocky cliff macroalgae of the Kenya coast deal mostly with their taxonomy and species lists rather than their ecology (Lawson 1969, Moorjani 1980). Due to their important role in the food chains of rocky cliff invertebrates, creations of microhabitats and competition for space with rocky cliff invertebrates, the following study on their patterns of zonation was carried out. The marine environment of this area has been reviewed by Ruwa (1984).

MATERIALS AND METHODS

The studies were carried out at localities around Mombasa (Figure 1 a and b) from April to August 1985. The line transect - quadrat method was used to study the zonation patterns on cliffs which are cavernous and hence well sheltered from direct insolation and those which have no overhangs and are therefore exposed to direct insolation.

The type of sheltering varied. The Baobab cliff is completely sheltered by a thick terrestrial canopy whereas some of the Kenya Marine and Fisheries Research Institute (KMFRI) profiles are completely sheltered under the KMFRI building and the rest are sheltered by overhangs. The maximum heights of the undercuts of the cliffs were measured.

The sampling for the vertical profiles began from bases of the cliffs going perpendicularly upwards to as far as the non-encrusting macroalgae were encountered each time laying the quadrats consecutively. The sampling for the horizontal profiles also began at the bases of the cliffs but proceeded towards the sea till the point where the rock entered into a lagoon or pool.

The heights, above datum, of the bases of the cliffs were determined from several observations made during calm waters around neap tide days, using the Kenya Ports Authority (1985) tide tables. This enabled the heights of the algal zones to be converted and expressed as heights above datum. The universal shore terminology (Fig. 2) according to Lewis (1964) and Hartnoll (1976) was used to indicate the positions of the various species.

Along each 25cm wide transect the percentages of the algal cover at each ¼m level were estimated using 25 x 25 quadrat which had 100 equal squares. The number of squares that had Rhodophytes and Chlorophytes were counted and recorded separately. After making the estimates, a sample of the algae was removed using a chisel and a hammer. These were placed in labelled specimen tubes and sent to the laboratory for identification using dissecting and compound light microscopes. The identification guides, used were those of Coppejans (1983), Jaasund (1976) and Taylor (1960).

.../3

RESULTS

A total number of 28 transects were studied out of which 16 were sheltered and the rest exposed to insolation. For the exposed vertical profiles, their species composition and the percentage cover of the Rhodophytes and Chlorophytes are as shown in tables 1 and 2 respectively and figure 3(a-l). The species composition for the sheltered vertical profiles are as shown in tables 3 and 4 while the percentage covers for the Rhodophytes and Chlorophytes are shown in figure 4(a-q).

The horizontal platforms were all exposed except those of Baobab cliff (V1) and ~~the~~ Kanamai cliff profile (Xa). The species composition of these profiles are shown in tables 5 and 6 whereas the percentages of the algal cover are as shown in Figure 5(a-d) for exposed and Figure 6(a-f) for sheltered cliffs.

The pattern distribution of the algae on the vertical faces of both sheltered and exposed cliffs was such that Rhodophytes exhibited higher percentages of algal cover than Chlorophytes. However, on the other hand, the sloping horizontal platforms had higher percentages of Chlorophytes except those platforms which were fully sheltered e.g. Baobab profile (V1) and Kanamai (Xa) or those which were partially sheltered e.g. Tiwi (1) Florida (III) and Kanamai (Xb).

Rhodophytes exhibited largest algal cover under well sheltered conditions but on exposed cliffs they were almost exclusively confined in pit crevices and depressions. Some species e.g. Bostrichia binderi, Catenella opuntia, Lophosiphonia reptabunda and Murrayella periclados were most frequently encountered in cavernous conditions, whereas Bostrichia tenella, Caulacanthus ustulatus and Ceramium camouii were equally common in both crevices and cavernous niches.

For the species of Chlorophyta some were encountered most frequently under cavernous conditions whereas others were almost equally common in both cavernous and, in crevices in exposed conditions. The species which most frequently occurred in cavernous conditions are: Caulerpa fastigiata, Cladophora mauritiana, C. patentiramea and C. savigniana, whereas Cladophoropsis sundanensis, Enteromorpha kylinii, E. ramulosa, Chaetomorpha spp and Ulva pertusa were almost equally common on both cavernous and in crevices of exposed-cliffs. However, Chaetomorpha spp grows very luxuriantly under full sheltered conditions. Rhizoclonium grande was mainly found on the platforms.

Some species encountered in the transects were very rare and scanty and these are: Anadyomene wrightii, Boergesenia forbesii, Valonia aegagropila, Pterocladia nana and Gracilaria salicornia. Boergesenia forbesii and Valonia aegagropila were found in damp or wet habitats whereas Valonia fastigiata, Pterocladia nana and Gracilaria salicornia were encountered in small depressions which collected sea-water and fine sand. Bryopsis pennata was found on wet overhangs.

There were no attempts to describe the zonation of the Cyanophytes. However, it was noted that there was luxuriant growth of *Lyngbya* spp both on the vertical cliffs and exposed horizontal platforms of the cliffs in the upper eulittoral zone. *Scytonema* spp was common among the Bostrichia. As for the Phaeophytes, they were very scanty. *Padina* spp was found growing on an exposed horizontal platform with fine damp sand in the upper eulittoral zone at KMFRI. *Dictyota adnata* was found on a sheltered horizontal platform in the lower eulittoral zone at Baobab cliff.

DISCUSSION

Comparing the present list of species with the records of Isaac (1967, 1968 1971), Isaac and Isaac (1968), Knutzen and Jaasund (1979) and Moorjani (1980) the following 10 species are new records for Kenya: *Caulacanthus ustulatus*, *Ceramium camouii*, *Gelidiella myriocladia*, *Platysiphonia miniata*, *Pterocladia nana* (Rhodophyta), *Cladophora mauritiana*, *C. saviniana*, *Ulva pertusa*, *Valonia fastigiata* (Chlorophyta), and *Dictyota adnata* (Phaeophyta).

The Rhodophyta dominates the upper eulittoral zone and Littoral fringe habitats which are shaded. The shading effect is provided by the numerous pits, crevices, vertical nature of the cliffs and their overhangs. The exposed steep surfaces of the cliffs do not receive as much insolation around midday as the equally exposed horizontal platforms receive. The latter tend to get warmer than the steep surfaces. Under fully sheltered conditions they grow luxuriantly (Taylor 1960). Exposed cliffs are almost bare

.../6

except in pits and crevices. The Chlorophyta dominate the Upper eulittoral zone and Lower eulittoral zone under exposed conditions especially where the cliff flattens to form a horizontal platform. The only green algal species encountered which does not flourish in exposed conditions but does in sheltered conditions is a Chaetomorpha spp. It may extend into the Littoral fringe under such suitable conditions.

Insolation creates high temperatures and consequently enhances dessication during low tide. Higher temperatures and dessication is greater in exposed than in shaded sites. Since high temperatures and dessication inhibit growth of algae (Lewis 1964) it is therefore not unexpected that larger algal cover occur in cavernous habitats and that in exposed surfaces growth is confined to crevices and depressions which offer shade against direct insolation.

Some of the factors that affect algal abundance and distribution have been discussed. But it should be further pointed out that other factors like grazing, effects of wave-borne sand etc. may change the patterns of abundance and distribution (Taylor 1960, Lewis 1964). These factors are relevant for the distribution and abundance of algae in Kenya because there are several types of grazers on the rocky cliffs (e.g. littorinids, neritids, chitons, patellids) (Ruwa 1984) and sand deposits are very common along the Kenya shoreline. To understand how the zonation of the species found on the Kenya rocky cliffs may change due to their response to various biotic and abiotic factors, in different time scales, further ecological studies need to be done.

.../7

A C K N O W L E D G E M E N T S

We thank: Dr. E. Coppejans for assisting us in the identification of algae during his stay in Kenya; Prof. P. Polk, Director of the Kenya/Belgium Project and Prof. K. Mshigeni, University of Dar-es-Salaam, for their comments and suggestions on the manuscript and finally, the Director of Kenya Marine and Fisheries Research Institute, Mr. S.O. Allela for his co-operation.

REFERENCES

Coppejans, E. (1983). Iconographic d' Algues Mediterraneennes Vaduz: J. Cramer, A.R. Grantner verlag KG., XXVIII, 317 plates.

Hartnoll, R.G. (1976). The ecology of some rocky shores in tropical East Africa.
Estuarine and Coastal Marine Sciences 4 : 1 - 21

Isaac, W.E. (1967). Marine Botany of the Kenya Coast. 1. A first list of Kenya Marine Algae.
J. East Afr. Nat. Hist. Soc. 26(144) : 75 - 81

Isaac, W.E. (1968). Marine Botany of the Kenya Coast 2. A second list of Kenya Marine Algae.
J. East Afr. Nat. Hist. Soc. 27(116) : 1 - 6

Isaac, W.E. (1971). Marine Botany of the Kenya Coast 5. A third list of Kenya Marine Algae.
J. East Afr. Nat. Hist. Soc.
28(122) : 1 - 233

Isaac, W.E. and Isaac, F.M. (1968)
Marine Botany of Kenya Coast 3. General account of environment flora and vegetation.
J. East Afr. Nat. Hist. Soc. 27(116) : 7 - 28

Jansune, E. (1976). Intertidal Seaweeds in Tanzania 1st Ed. Tromso: University of Tromso. 1?? pp.
Kenya Ports Authority (1985) Tide tables for East African Ports Mombasa: Rodwell press, ?5pp.

Knutzen, J. and Jaasund, E. (1979). Note on littoral algae from Mombasa Kenya. J. East Afr. Nat. Hist. Soc. 10.: 1-4

Lawson, G.W. (1969). Some observations on the littoral ecology of rocky shores in East Africa (Kenya and Tanzania). Trans. R. Soc. S. Africa 38: 329 - 340

Lewis, J.R. (1964). The ecology of rocky shores. English University Press, London, 323pp.

Moorjani, S.A. (1980). Rocky shore zonation in Kenya. Horizontal and vertical distribution patterns in Marine flora. Paper presented at the UNESCO-ALECSO symposium on the coastal and marine environment of the Red Sea, Gulf of Aden and tropical Western Indian ocean, Khartoum, Sudan.

Ruwa, R.K. (1984). Invertebrate faunal zonation on rocky shores around Mombasa, Kenya. Kenya Journal of Science and Technology series B 5(1 and 2) : 49 - 65.

Taylor, W.R. (1960). Marine algae of the eastern tropical and subtropical coasts of the Americas. Michigan : The University of Michigan Press, 870pp.

LEGENDS FOR FIGURES

Figure 1 (a) A map of Kenya coastline showing region of study

1 (b) A map of Mombasa area showing localities studied.

Figure 2 Division of shore according to Lewis (1964) and Hartnoll (1976)

Figure 3(a - l) Percentage distribution of Rhodophyta and Chlorophyta on exposed vertical cliffs. The acronyms LF, UEZ and LEZ stand for Littoral fringe, Upper eulittoral zone and Lower eulittoral zone respectively. The position of the base of the cliff is indicated by the acronym at the point of origin.

Figure 4(a - q) Percentage distribution of Rhodophyta and Chlorophyta on sheltered vertical cliffs. Arrows indicates heights of the undercuts above datum.

Figure 5(a - d) Percentage distribution of Rhodophyta and Chlorophyta on the platforms continuing from exposed cliffs.

Figure 6(a - f) Percentage distribution of Rhodophyta and Chlorophyta on the platforms continuing from sheltered cliffs.

Table I. The distribution of Rhodophyta on exposed vertical cliffs: (1) Tiwi (II) Shelly (III) Florida (IV) Mombasa Hospital (V) Fort Jesus (VI) Baobab (VII) Kenya Marine and Fisheries Research Institute (KMFRI) (VIII) Mckenzie Point (IX) Nyali and (X) Kanamai. The alphabetical letters stand for profiles where more than two profiles were taken at one locality.

Species	Study sites												
	I	II	III	IVa	IVb	IVc	Va	VIa	VIIa	VIIb	VIII	IX	INFERENCE
Acrocystis nana Zanardini	-	LEZ	-	-	-	-	-	-	UEZ	UEZ	-	-	LEZ
Bostrichia binderi Harvey	-	LF	LF	-	-	-	-	-	LF	-	UEZ	-	LF
Bostrichia tenella (Vahl) J. Ag	LF	LF	LF	LF	LF	UEZ	UEZ	UEZ	LF	LF	UEZ	LF	LF
Caloglossa leprieurii (Mont.) J. Agardh	-	-	-	-	-	-	-	UEZ	-	-	-	-	UEZ
Catenella opuntia (Goodenough & Woodw), Grev.	-	-	-	-	-	-	-	-	LF	-	-	-	LF
Caulacanthus ustulatus (Mart.) Kutzing	-	UEZ	UEZ	-	-	LEZ	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ
Centroceras clavulatum (C. Ag) Montagne	-	-	LEZ	-	-	-	-	-	-	LEZ	-	UEZ	UEZ
Ceramium camouii Dawson	-	LEZ	-	UEZ	UEZ	-	UEZ	-	-	-	UEZ	UEZ	UEZ
Gelidiella myriocladia (Borgs) Feldmann et Hamel	-	-	-	-	-	LEZ	-	-	-	-	-	-	UEZ
Gelidium pusilum (Stackh.) Le Jol	-	-	-	-	UEZ	-	-	-	-	-	-	-	UEZ
Gracilaria salicornia (J. Ag) Dawson	-	-	-	-	-	-	-	-	UEZ	LEZ	-	-	LEZ
Lophosiphonia reptabunda (Suhr) Jaasund	-	-	-	-	-	-	UEZ	-	-	-	UEZ	UEZ	UEZ
Murrayella periclados (C. Ag) Schmitz	-	-	-	-	-	-	UEZ	-	UEZ	-	UEZ	-	UEZ
Platysiphonia miniata (Ag) Borgesen	-	-	-	-	-	-	-	-	-	-	-	-	-
Polysiphonia variegata (Ag) Zanardini	-	-	-	-	-	-	-	UEZ	-	-	-	-	UEZ
Pterocladia nana Okamura	-	-	-	-	-	-	-	-	UEZ	-	-	-	UEZ
Position of base of cliff	LEZ	LEZ	LEZ	LEZ	LEZ	LEZ	UEZ	LEZ	UEZ	LEZ	UEZ	LEZ	

Table 2 The distribution of Chlorophyta on exposed vertical cliffs. The description of the localities (study sites) are as stated in Table 1

Species	Study sites												
	I	II	III	IVa	IVb	IVc	Va	VI	VIIa	VIIb	VIII	IX	INFERENCE
Anadyomene wrightii Gray	–	–	–	–	–	–	–	–	–	–	–	–	–
Boergesenia forbesii (Harvey) Feldmann	–	–	–	–	–	–	–	–	–	–	–	–	–
Bryopsis pennata Lamouroux	–	–	–	–	–	–	–	–	–	–	–	–	–
Caulerpa fastigiata Montagne	–	–	–	UEZ	–	–	–	–	–	–	–	–	UEZ
Chaetomorpha spp	LF	LF	LF	LF	LF	UEZ	LF	LF	LF	LF	UEZ	LF	LF
Cladophora mauritiana Kutzing	–	–	–	–	–	–	–	–	–	–	–	–	–
Cladophora patentiramea (Mont.) Kutz	–	UEZ	–	UEZ	UEZ	–	UEZ	–	–	UEZ	–	–	UEZ
Cladophora saviniana Borgesen	–	–	–	–	–	–	–	–	–	–	–	–	–
Cladophoropsis sundanensis Reinbold	LEZ	UEZ	UEZ	UEZ	–	–	UEZ	–	UEZ	–	UEZ	UEZ	UEZ
Enteromorpha kylinii Bliding sensu Dawson	–	LEZ	LEZ	–	–	–	–	UEZ	UEZ	UEZ	UEZ	–	UEZ
Enteromorpha ramulosa (J.E. Smith) Hooker	–	–	–	–	UEZ	–	UEZ	UEZ	UEZ	UEZ.	UEZ	–	UEZ
Rhizoclonium grande	–	–	–	–	–	–	–	–	–	–	–	–	–
Ulva pertusa Kjellman	UEZ	–	UEZ	LEZ	–	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ
Ulva rigida C. Ag.	–	–	–	–	–	–	LEZ	–	–	–	–	–	LEZ
Valonia aegagropila C. Ag.	–	–	–	–	–	–	–	–	–	–	–	–	–
Valonia fastigiata Harvey	–	–	–	–	–	–	–	–	–	–	–	–	–
Position of base of cliff	LEZ	LEZ	LEZ	LEZ	LEZ	LEZ	UEZ	LEZ	UEZ	UEZ	UEZ	LEZ	

Table [illegible] The distribution of Rhodophyta on sheltered vertical cliffs. The description of the localities (study sites) are as stated in Table 1

Species	Study sites																
	I	II	III	IVd	IVe	Vb	Vc	VI	VIIc	VIId	VIIe	VIIf	VIII	IX	Xa	Xb	INFERENCE
Acrocystis nana Zanardini	LEZ	LEZ	LEZ	-	-	-	-	-	LEZ	-	-	UEZ	-	-	-	-	LEZ
Bostrichia binderi Harvey	LEZ	LF	LF	-	-	LF	-	-	LF	UEZ	UEZ	LF	LF	LF	LF	UEZ	LF
Bostrichia tenella (Vahl) J. Ag	LEZ	LF	LF	UEZ	UEZ	LF	LF	LF	LF	LF	LEZ	LF	UEZ	LF	LF	UEZ	LF
Caloglossa leprourii (Mont.) J. Agardh	-	-	-	-	-	-	-	UEZ	UEZ	-	-	-	-	-	-	-	UEZ
Catenella opuntia (Goodenough & Woodw.) Grev	UEZ	-	UEZ	UEZ	-	-	LF	UEZ	UEZ	UEZ	UEZ	-	-	-	UEZ	UEZ	UEZ
Caulacanthus ustulatus (Mert.) Kutzing	LEZ	UEZ	UEZ	-	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ	-	UEZ	-	UEZ	-	UEZ	UEZ
Centroceras clavulatum (C.Ag) Montane	-	-	-	-	-	-	-	-	-	-	-	-	-	UEZ	-	-	UEZ
Ceramium camouii Dawson	UEZ	UEZ	UEZ	-	UEZ	UEZ	-	UEZ	-	-	-	-	-	UEZ	-	UEZ	UEZ
Gelidiella myriocladia (Borgs) Feldmann et Hamel	-	-	LEZ	-	LEZ	-	-	-	-	-	UEZ	-	-	-	-	UEZ	LEZ
Gelidium pusillum (Stackh.) Le Jol	LEZ	-	LEZ	-	UEZ	-	UEZ	-	-	-	-	-	-	-	-	-	LEZ
Gracilaria salicornia (J.Ag) Dawson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lophosiphonia reptabunda (Suhr) Jaasund	UEZ	-	UEZ	-	-	UEZ	UEZ	-	LEZ	-	UEZ	-	UEZ	UEZ	-	UEZ	UEZ
Murayella periclados (C. Ag.) Schmitz	UEZ	-	UEZ	-	-	UEZ	UEZ	UEZ	UEZ	UEZ	UEZ	-	UEZ	-	-	UEZ	UEZ
Platysiphonia miniata Borgesen	-	-	-	-	-	-	-	LEZ	-	-	-	-	-	-	-	-	LEZ
Polysiphonia variegata (Ag.) Zanardini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pterocladia nana Okamura	-	-	-	-	-	-	-	UEZ	-	-	-	-	-	-	-	-	UEZ
Position of base of cliff	LEZ	LEZ	LEZ	LEZ	LEZ	UEZ	UEZ	LEZ	LEZ	UEZ	UEZ	LEZ	UEZ	UEZ	UEZ	UEZ	

Table 4 The distribution of Chlorophyta on sheltered vertical cliffs. The description of the localities (study sites) are as described in Table 1

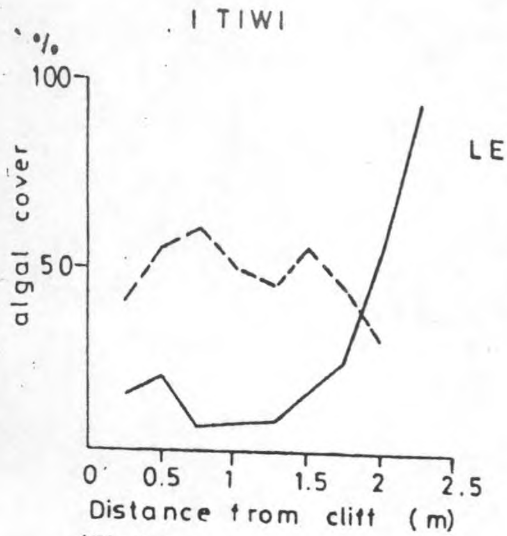
Species	Study sites																
	I	II	III	IVd	IVe	Vb	Vc	VI	VIIc	VIId	VIIe	VIIf	VIII	IX	Xa	Xb	INFERENC
Anadyomene wrightii Gray	-	-	-	-	-	-	-	-	-	-	-	LEZ	-	-	-	-	LEZ
Boergesenia forbesii (Harvey) Feldmann	LEZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LEZ
Bryopsis pennata Lamouroux	-	-	-	-	LEZ	-	-	-	-	-	-	-	-	-	-	-	LEZ
Caulerpa fastigiata Montagne	LEZ	LF	LEZ	-	-	UEZ	-	LEZ	UEZ	-	-	-	-	-	-	-	UEZ
Chaetomorpha spp	-	UEZ	LF	LF	-	LF	LEZ	LF	LF	LF	LF	LF	UEZ	LF	LF	LF	LF
Cladophora mauritiana Kutzing	-	LEZ	-	-	LEZ	-	-	LEZ	-	-	-	-	-	UEZ	-	UEZ	UEZ
C. patentiramea (Mont.) Kutz	UEZ	UEZ	LEZ	-	UEZ	-	UEZ	UEZ	-	UEZ	UEZ	-	UEZ	UEZ	-	UEZ	UEZ
C. saviniana Borgesen	-	-	-	-	-	-	-	LEZ	LEZ	UEZ	LEZ	LEZ	-	UEZ	-	-	LEZ
Cladophoropsis sundanensis Reinbold	UEZ	LEZ	UEZ	-	-	UEZ	LEZ	LEZ	-	-	-	UEZ	-	UEZ	-	-	UEZ
Ent. pho. kylinii Blinding sensu Dawson	-	UEZ	-	-	UEZ	-	-	LEZ	-	-	-	-	UEZ	UEZ	-	UEZ	UEZ
E. ramulosa (J.E. Smith) Hooker	-	UEZ	-	-	UEZ	-	UEZ	LEZ	-	-	-	LF	UEZ	LEZ	UEZ	LEZ	UEZ
Rhizoclonium grande	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ulva pertusa Kjellman	LEZ	LEZ	LEZ	LEZ	LEZ	-	UEZ	LEZ	-	-	-	UEZ	LEZ	UEZ	-	UEZ	LEZ
Ulva rigida C. Ag.	LEZ	-	LEZ	-	-	UEZ	-	-	-	-	-	-	-	-	-	-	LEZ
Valonia aegagropila C. Ag.	LEZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LEZ
V. fastigiata Harvey	-	-	-	-	-	-	-	LEZ	LEZ	-	-	-	-	-	-	-	LEZ
Position of base of cliff	LEZ	LEZ	LEZ	LEZ	LEZ	UEZ	LEZ	LEZ	UEZ	UEZ	UEZ	LEZ	UEZ	UEZ	UEZ	LEZ	

Table 5. The distribution of algae on platforms continuing from the exposed vertical cliffs. The description of the localities (study sites) are as described in Table 1.

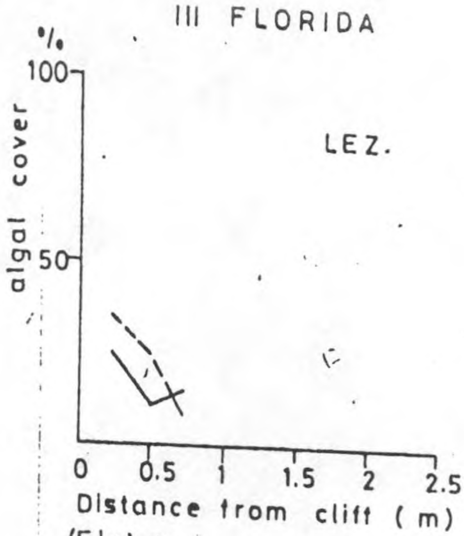
Species	Study sites			
Rhodophyta	VI	VIIa	VIIb	IX
Acrocystis nana	-	-	-	-
Bostrichia binderi	-	-	-	-
Bostrichia tenella	-	-	-	-
Caloglossa lepreurii	-	-	-	-
Catenella opuntia	-	-	-	-
Caulacanthus ustulatus	-	UEZ	-	-
Centroceras clavulatum	-	UEZ	UEZ	-
Ceramium camouii	-	-	UEZ	-
Gelidiella myriocladia	-	-	-	-
Gelidium pusillum	-	-	-	-
Gracilaria salicornia	-	UEZ	UEZ	-
Lophosiphonia reptabunda	-	-	-	-
Murayella periclados	-	-	-	-
Platysiphonia miniata	-	-	-	-
Pterocladia nana	-	UEZ	-	-
Chlorophyta				
Boergesenia forbesii	-	-	-	-
Caulerpa fastigiata	-	-	-	-
Cladophora mauritiana	-	-	-	-
Cladophora patentirameae	-	-	UEZ	-
Cladophora saviniana	-	UEZ	-	-
Cladophoropsis sundanensis	-	UEZ	UEZ	-
Enteromorpha kylini	LEZ	UEZ	-	-
Enteromorpha ramulosa	LEZ	UEZ	UEZ	-
Rhizoclonium grande	-	UEZ	UEZ	-
Ulva pertusa	LEZ	UEZ	UEZ	LEZ
Ulva rigida	-	-	-	-
Valonia aegagropila	-	-	UEZ	-
Valonia fastigiata	-	-	-	-

Table 6. The distribution of algae on platforms continuing from the vertical cliffs. The descriptions of the localities (study sites) are as stated in Table I.

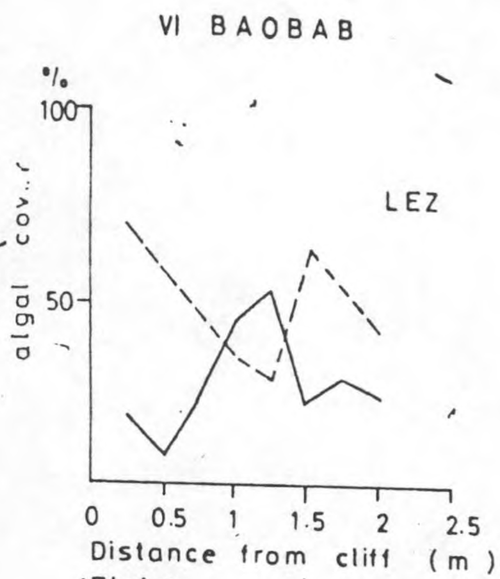
Species	Study sites					
Rhodophyta	I	III	VI	IX	Xa	Xb
Acrocystis nana	LEZ	-	LEZ	-	-	-
Bostrichia binderi	-	-	-	-	UEZ	-
Bostrichia tenella	-	-	LEZ	-	UEZ	UEZ
Caloglossa leprieurii	-	-	LEZ	-	-	-
Catenella opuntia	-	-	LEZ	-	UEZ	-
Caulacanthus ustulatus	LEZ	UEZ	LEZ	UEZ	-	UEZ
Centroceras clavulatum	-	-	-	-	-	-
Ceramium camouii	UEZ	-	LEZ	UEZ	-	UEZ
Gelidiella myrioclados	-	LEZ	-	-	-	-
Gelidium pusillum	LEZ	-	-	-	-	-
Gracilaria salicornia	-	-	-	-	-	-
Lophosiphonia reptabunda	-	-	-	UEZ	-	UEZ
Murrayella periclados	LEZ	-	LEZ	-	-	-
Platysiphonia miniata	-	-	LEZ	-	-	-
Pterocladia nana	-	-	-	-	-	-
Chlorophyta						
Boergesenia forbesii	LEZ	-	-	-	-	-
Caulerpa fastigiata	LEZ	LEZ	LEZ	-	-	-
Chaetomorpha spp	-	-	-	-	UEZ	-
Cladophora mauritiana	-	-	LEZ	-	-	UEZ
Cladophora patentiramea	-	-	LEZ	UEZ	-	UEZ
Cladophora saviniana	-	-	LEZ	UEZZ	-	-
Cladophoropsis sundanensis	LEZ	-	LEZ	UEZ	-	-
Enteromorpha kylinii	-	-	LEZ	UEZ	-	UEZ
Enteromorpha ramulosa	-	-	LEZ	UEZ	-	UEZ
Rhizoclonium grande	LEZ	-	UEZ	UEZ	-	-
Ulva pertusa	LEZ	LEZ	LEZ	UEZ	-	UEZ
Ulva rigida	LEZ	LEZ	-	-	-	-
Valonia aegagropila	-	-	-	-	-	-
Valonia fastigiata	-	-	LEZ	-	-	-



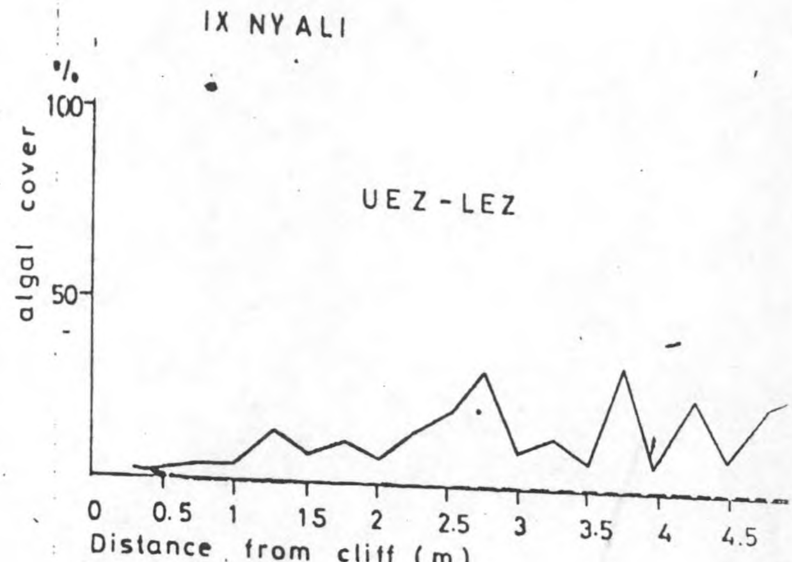
(Fig) 6a



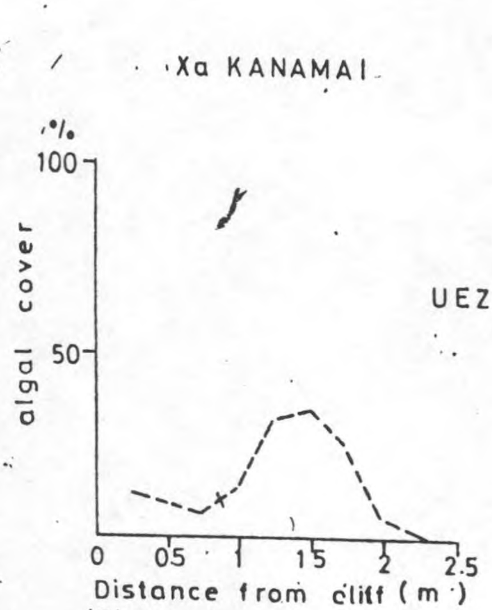
(Fig) 6b



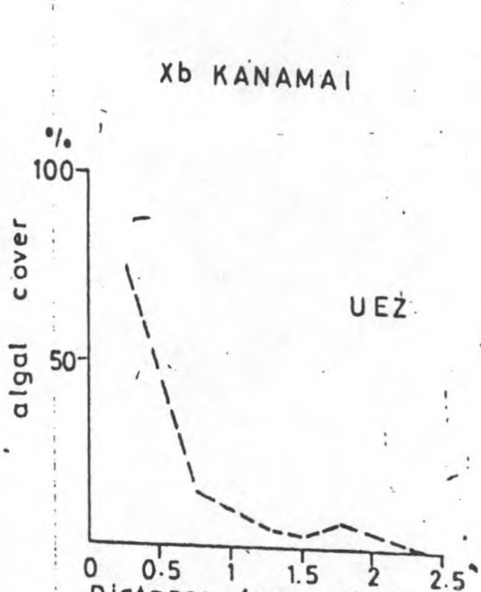
(Fig) 6c



(Fig) 6d



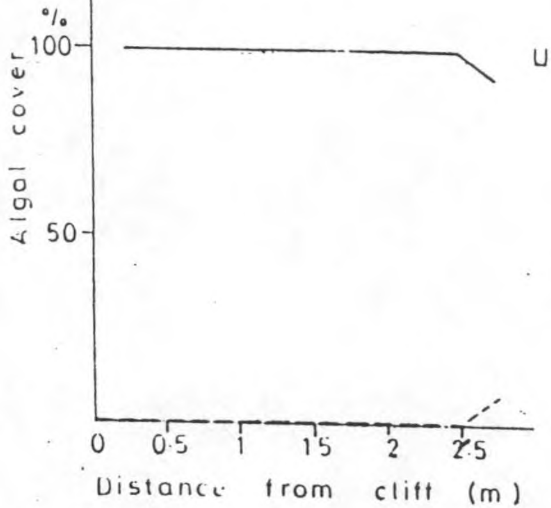
(Fig) 6e



(Fig) 6f

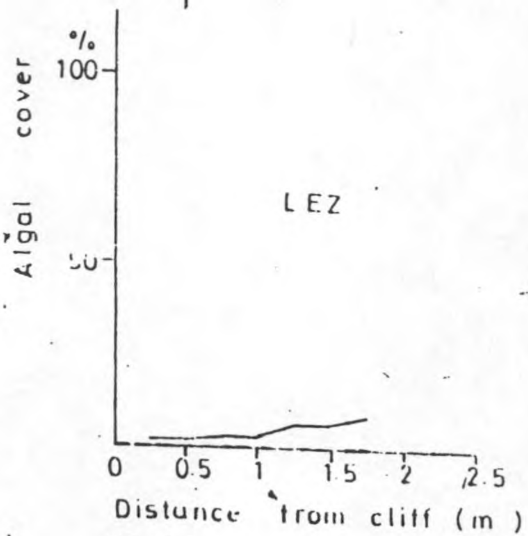
--- RHODOPHYTA

— CHLOROPHYTA



(Fig) 5c

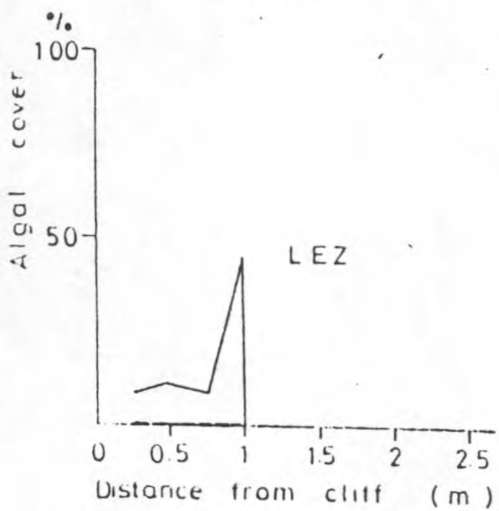
---- RHODOPHYTA



(Fig) 5d

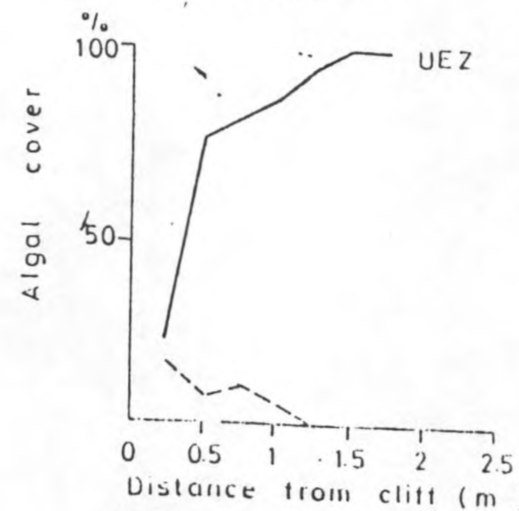
—— CHLOROPHYTA

VI BAOBAB



(Fig) 5a

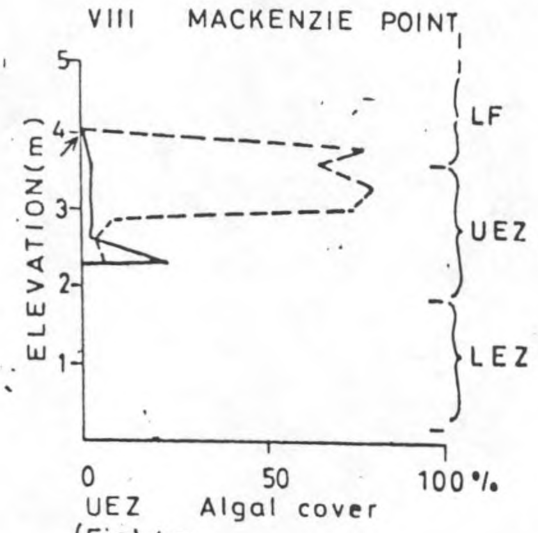
VIIa K.M.F.R.I.



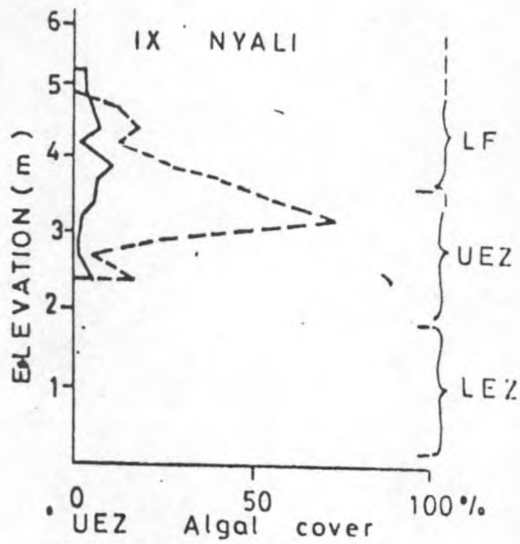
(Fig) 5b

VIIb K.M.F.R.I

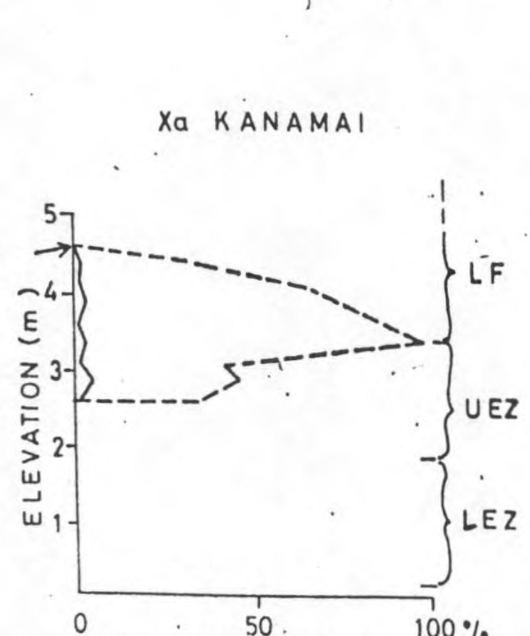
IX NYALI



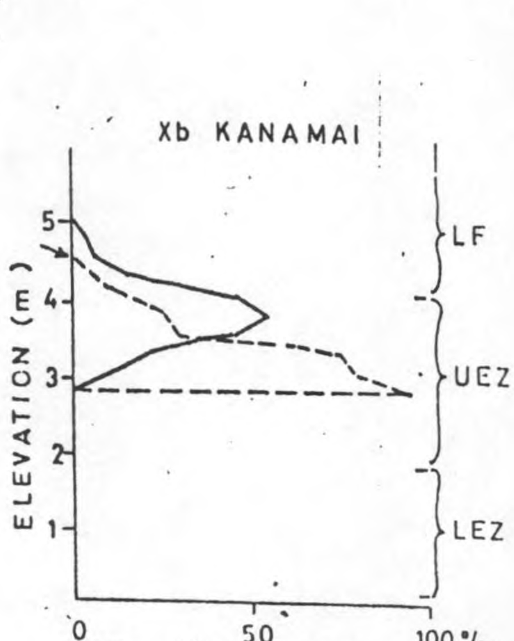
(Fig) 4 m



(Fig) 4n



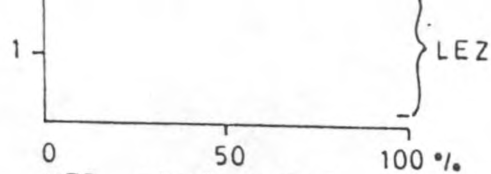
(Fig) 4p



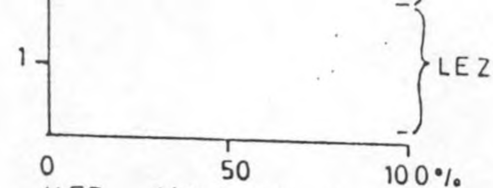
(Fig) 4q

--- RHODOPHYTA

—— CHLOROPHYTA

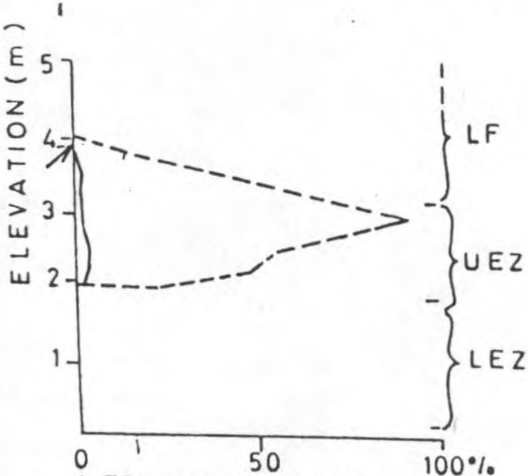


UEZ Algal cover
(Fig) 4i



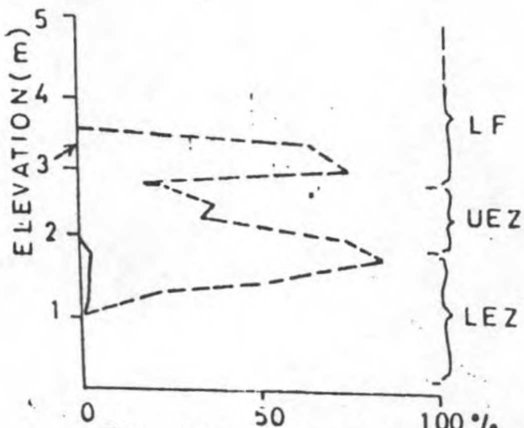
UEZ Algal cover.
(Fig) 4j

VIIe K.M.F.R.I.



UEZ Algal cover
(Fig) 4k

VIIf K.M.F.R.I.

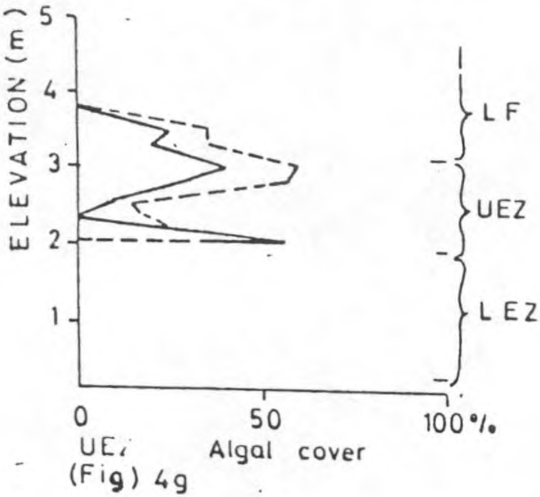


LEZ Algal cover
(Fig) 4l

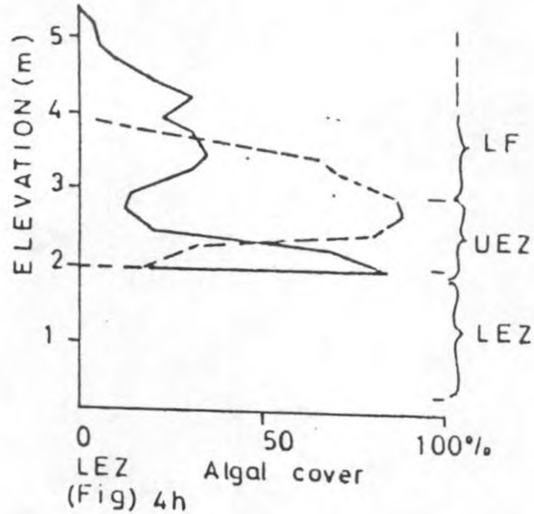
- - - - RHODOPHYTTA

—— CHLOROPHYTTA

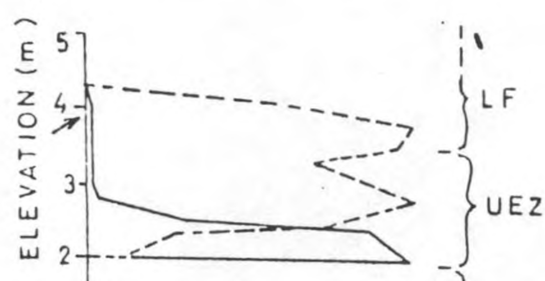
V FORT JESUS



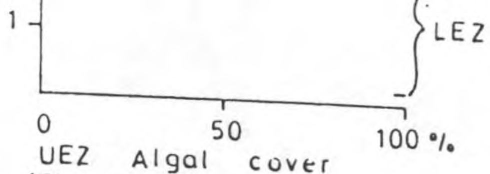
VI BAOBAB



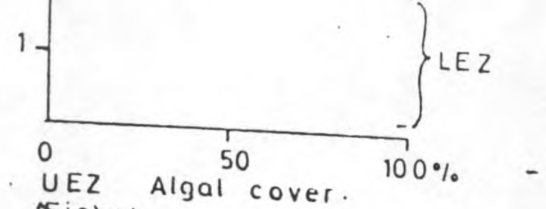
VIIc K.M.F.R.I.



VIId K.M.F.R.I.

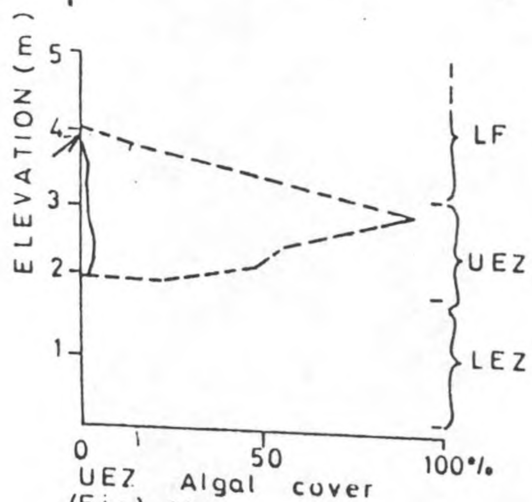


(Fig) 4i



(Fig) 4j

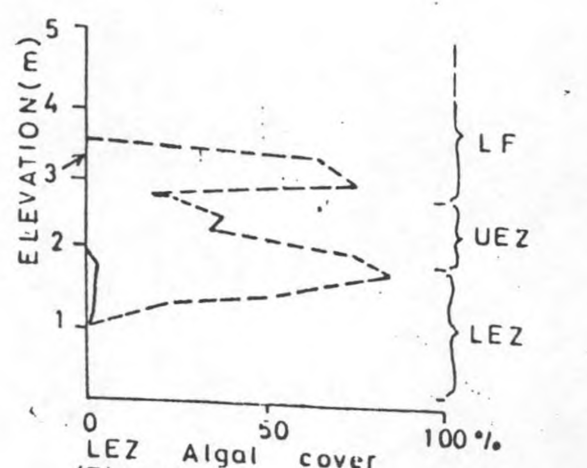
VIIe K.M.F.R.I.



(Fig) 4k

– – – RHODOPHYTTA

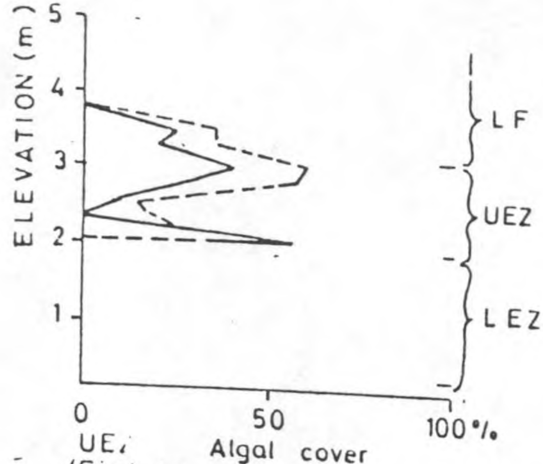
VIIf K.M.F.R.I.



(Fig) 4l

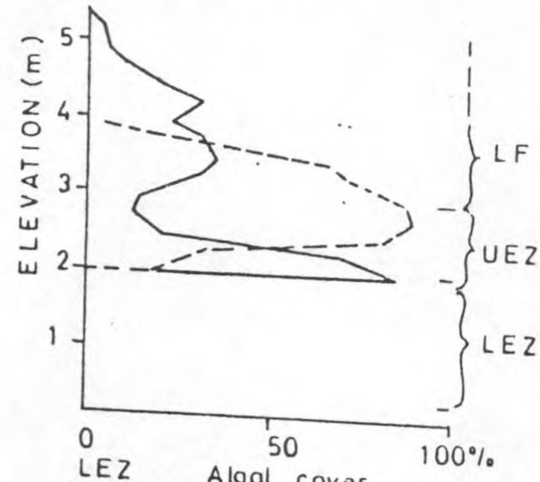
—— CHLOROPHYTTA

V FORT JESUS



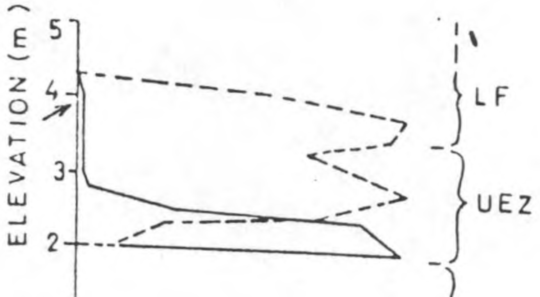
(Fig) 4g

VI. BAOBAB

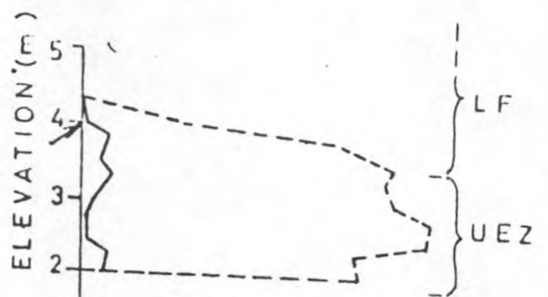


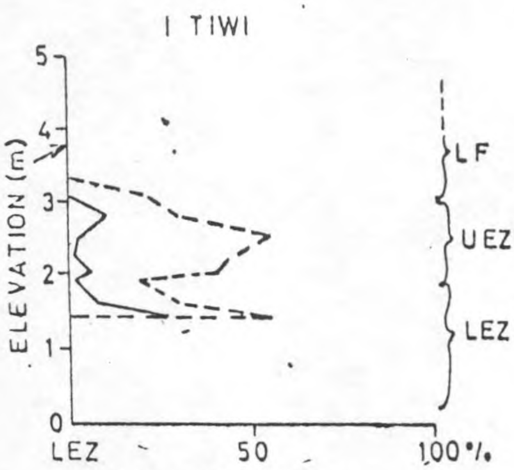
(Fig) 4h

VIIc K.M.F. R.I.

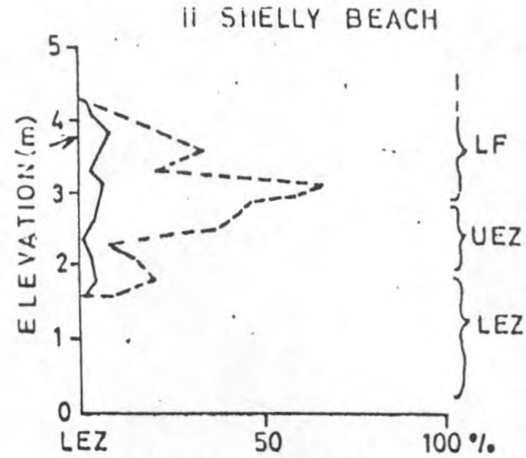


VIId K.M.F. R.I.

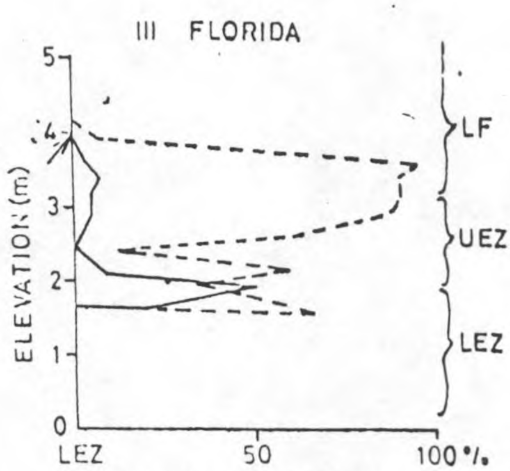




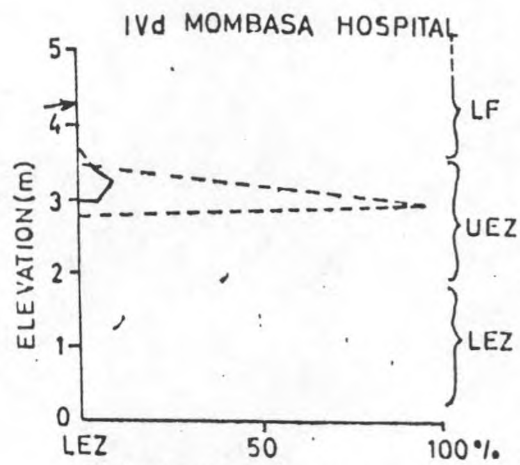
(Fig) 4a Algal cover



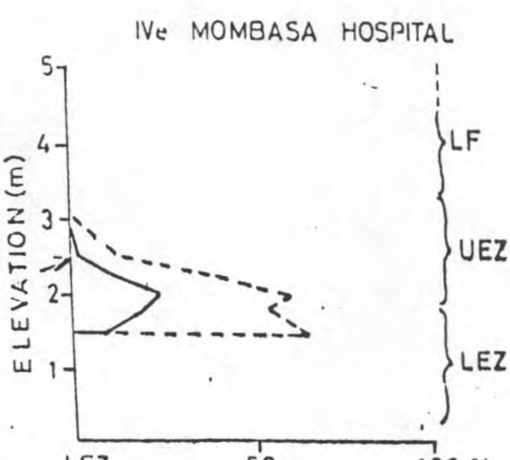
(Fig) 4b Algal cover



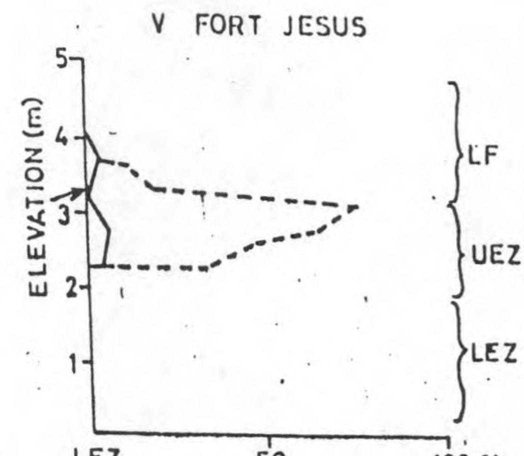
(Fig) 4c Algal cover



(Fig) 4d Algal cover

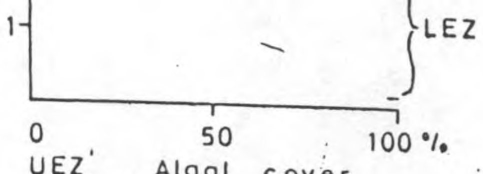


(Fig) 4e Algal cover

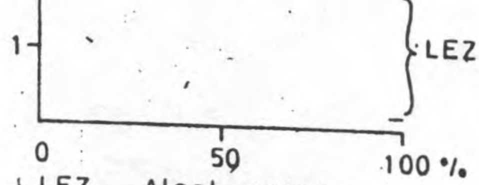


(Fig) 4f Algal cover

---- RHODOPHYTA　　　—— CHLOROPHYTA

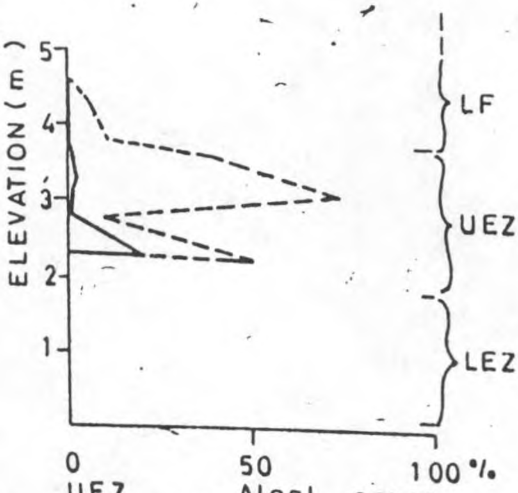


UEZ (Fig) 3i



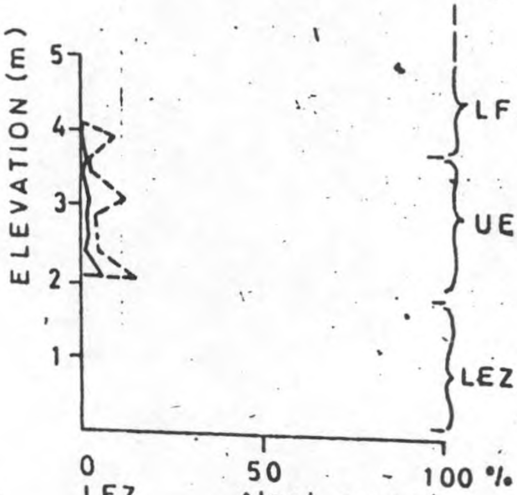
LEZ (Fig) 3j

VIII MACKENZIE POINT



UEZ (Fig) 3k

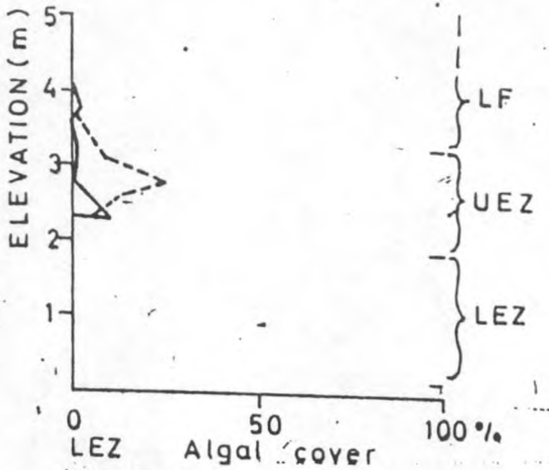
IX NYALI



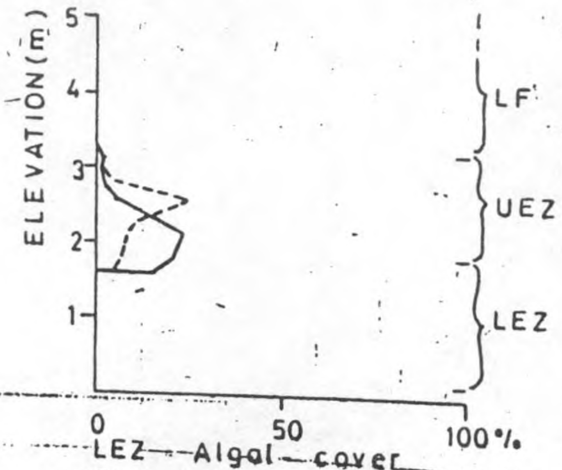
LEZ (Fig) 3l

---RHODOPHYTA —CHLOROPHYTA

VI BAOBAB

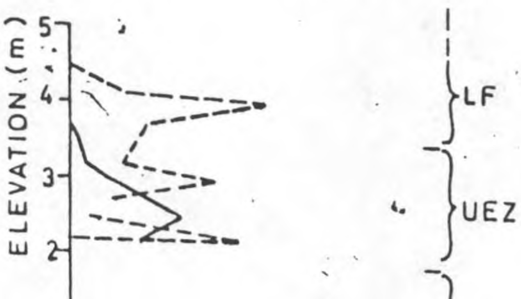


(Fig) 3g

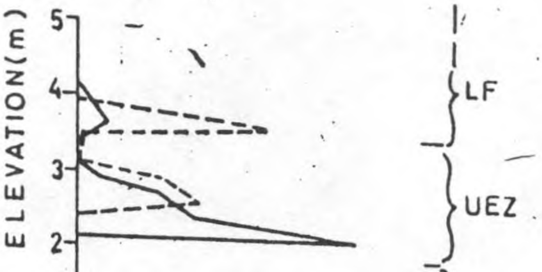


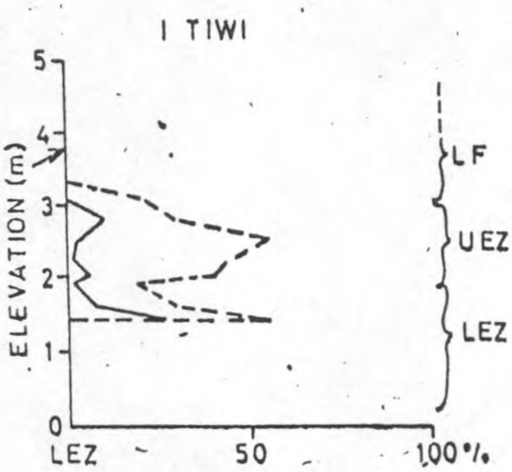
(Fig) 3h

VIIa K. M. F. R. I.

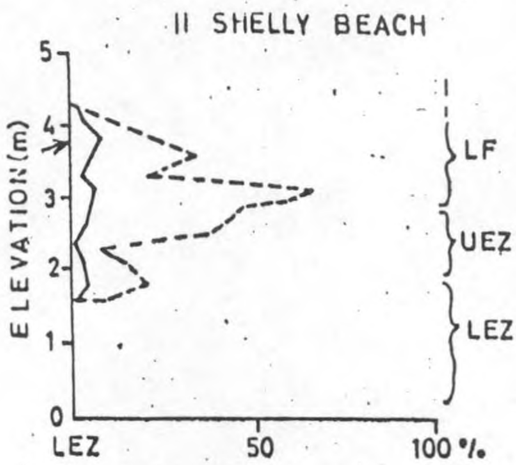


VIIb K. M. F. R. I.

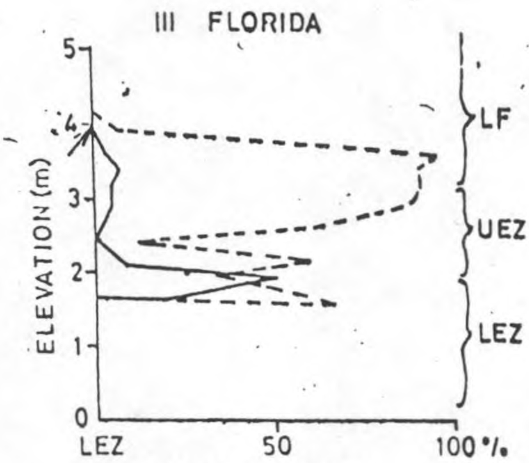




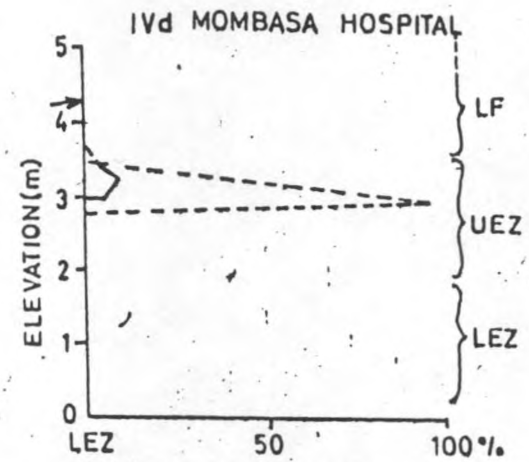
(Fig) 4a Algal cover



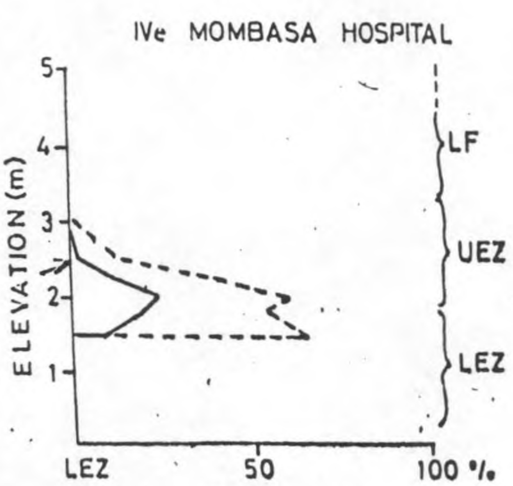
(Fig) 4b Algal cover



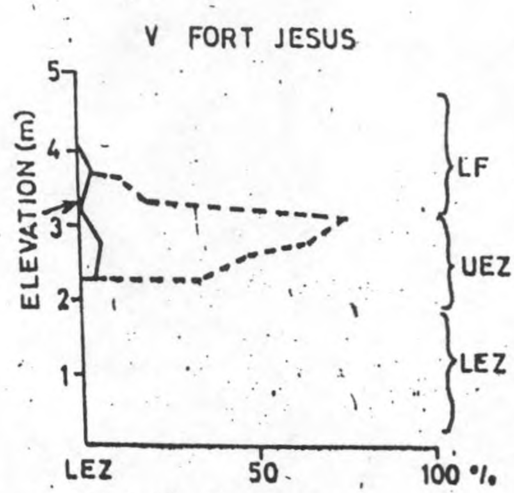
(Fig) 4c Algal cover.



(Fig) 4d Algal cover

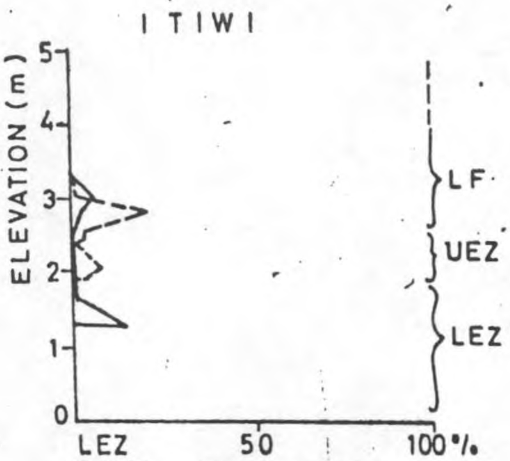


(Fig) 4e Algal cover

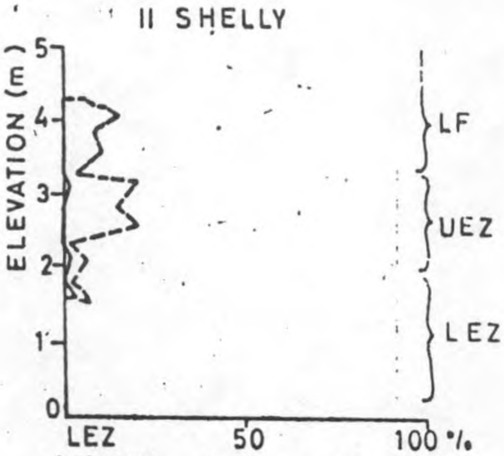


(Fig) 4f Algal cover

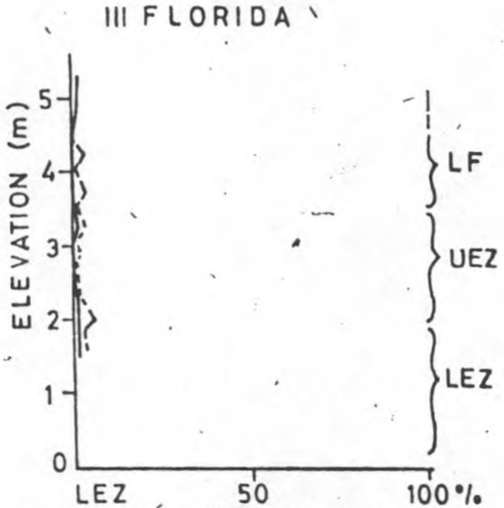
----RHODOPHYTA —— CHLOROPHYTA



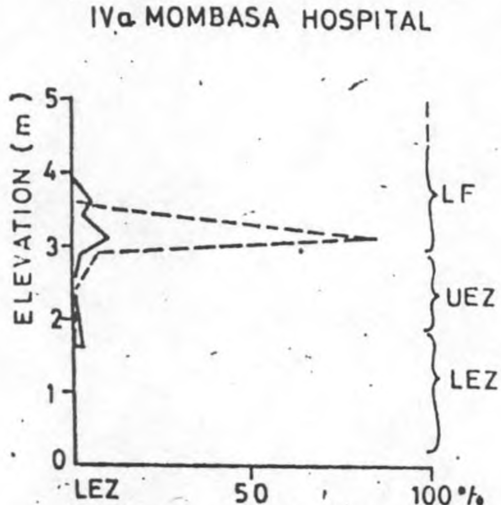
(Fig)3a Algal cover



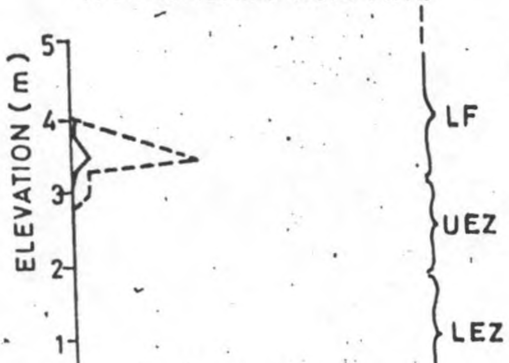
(Fig)3b Algal cover



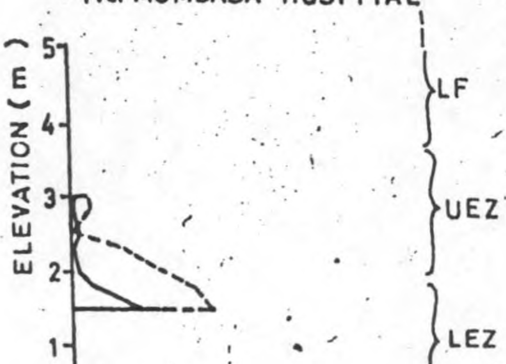
(Fig)3c Algal cover



(Fig)3b Algal cover



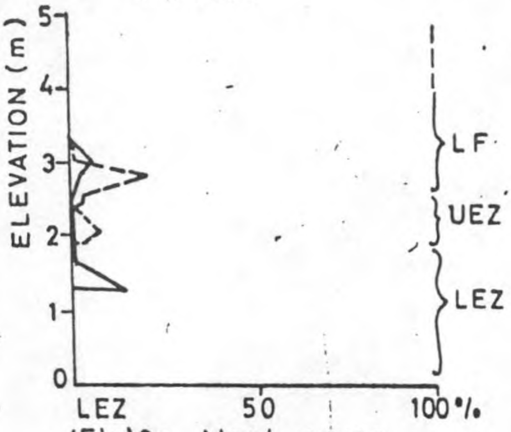
(Fig) 3e Algal cover



(Fig)31 Algal cover

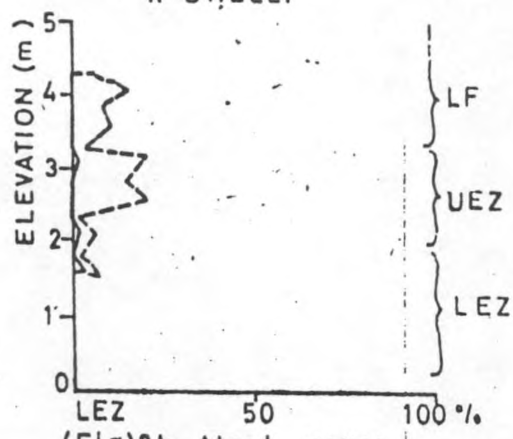
- - - RHODOPHYTA ——CHLOROPHYTA

I TIWI



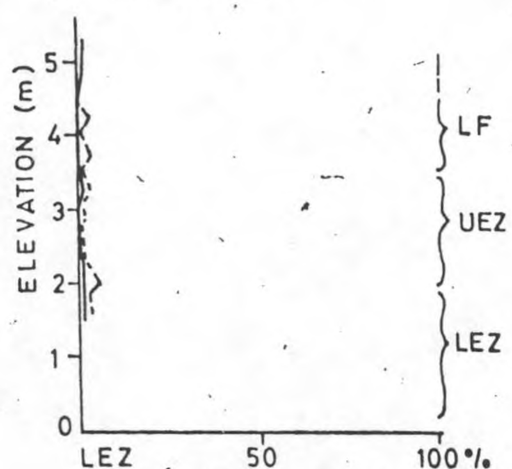
(Fig)3a Algal cover

II SHELLY



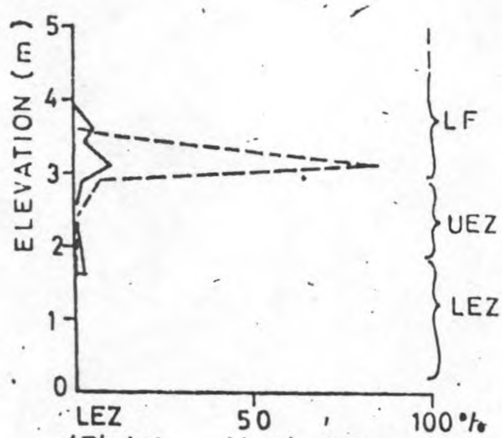
(Fig)3b Algal cover

III FLORIDA



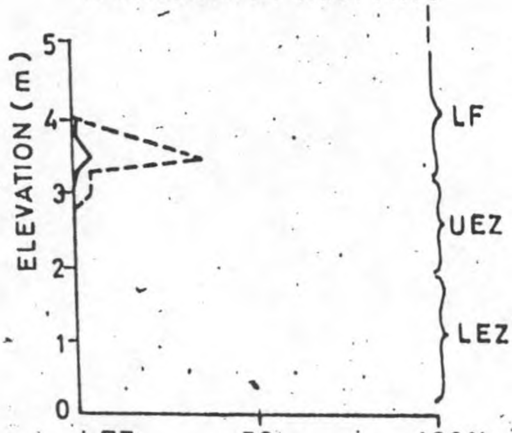
(Fig)3c Algal cover

IVa MOMBASA HOSPITAL



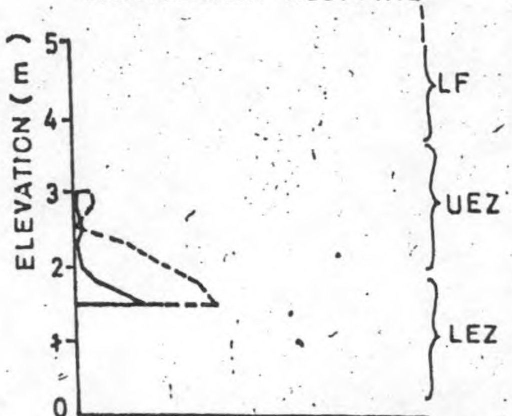
(Fig)3b Algal cover

IVb. MOMBASA HOSPITAL



(Fig) 3e Algal cover

IVc. MOMBASA HOSPITAL



(Fig) 3f Algal cover

- - - RHODOPHYTA ——CHLOROPHYTA

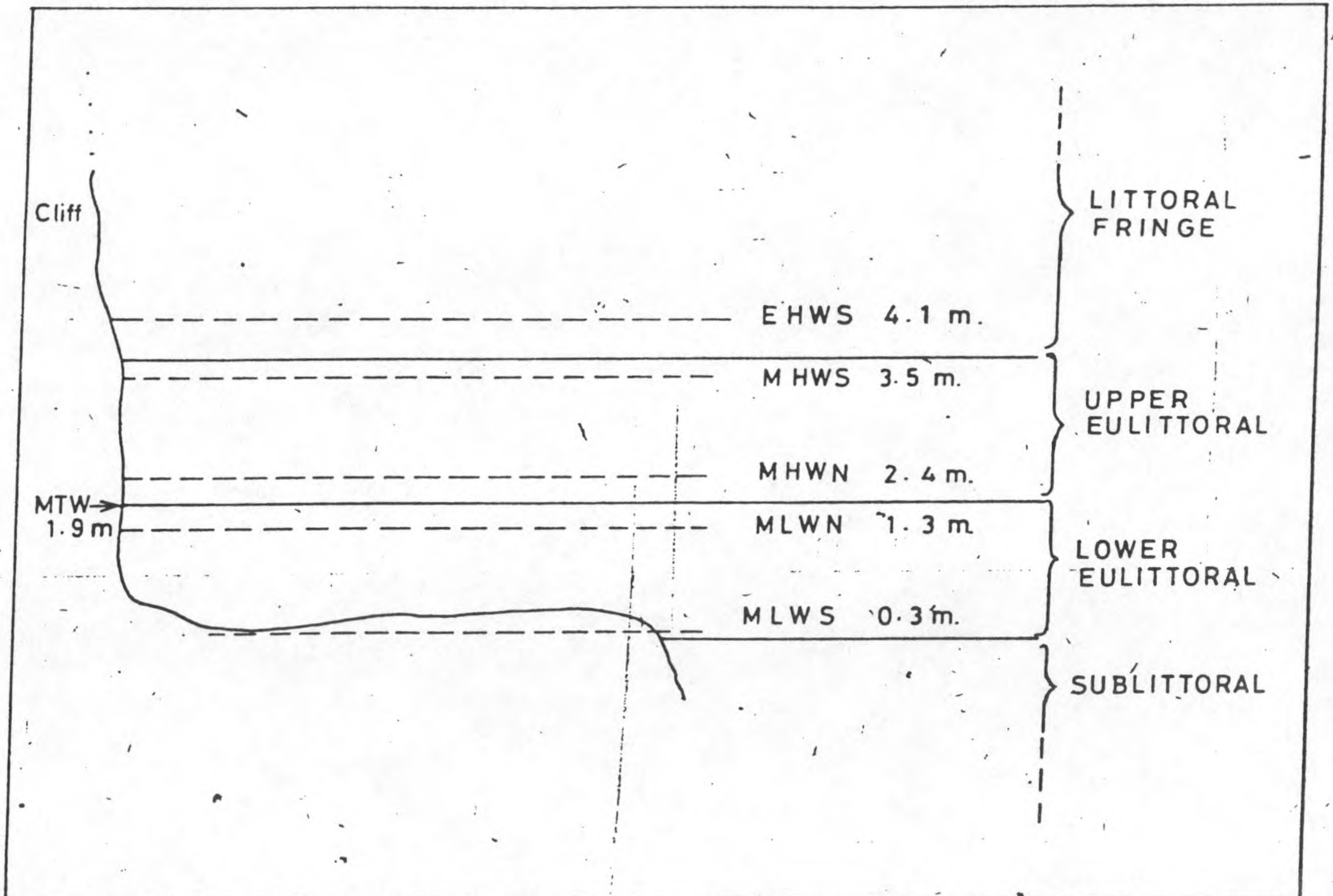

Cliff
EHWS 4.1 m.
MHWS 3.5 m.
MHWN 2.4 m.
MTW
1.9 m
MLWN 1.3 m.
MLWS 0.3 m.
LITTORAL FRINGE
UPPER EULITTORAL
LOWER EULITTORAL
SUBLITTORAL

Fig. 2

Annex 16

A BRIEF REVIEUW OF THE UNEP/UNESCO WORKSHOP ON CORAL TAXONOMY AND METHODS OF VISUAL CENSUS OF CORAL REEF FISHES.

12-25 th May 1986
Bolinao, Pangasinan,
PHILLIPINES.

N. Muthiga.

Introduction.

The workshop was organised on a cooperative basis by the UNESCO regional office for Science & Technology for South East Asia, the University of Phillipines Marine Science Institute, the Natural Resources Management center and the UNEP Project on coral reefs. It was mainly geared for researchers in the South East Asian and Pacific areas. Although participants from the East African region were included. The various organizations contributed money, equipment and accomodation.

The workshop was conducted in two parts:

Part I: Coral Taxonomy workshop: 12th - 21st May 1986.

Aims: a) To train participants in methods of coral identification in the field and loboratory.

b) to make a reference collection of coral species in the Bolinao area.

c) To access the status of coral taxonomy in the participants home countries.

Part II: Visual fish censusing methods 22nd-25 May 1986.

Aims : a) To train participants in an underwater method of Coral reef fish censusing.

b) To familiarize participants with coral reef fish identification

c) To introduce a computer method of data storage and processing.

Lecturers: Dr. Charlie Veron, Australian Institute of Marine Sciences: Coral taxonomy Workshop.

Dr. Carden Wallace, Australian Biological Resources centre: Coral Taxonomy Workshop.

Dr. Edgardo Gomez, University of Phillipines Marine Science institute: Coral Taxonomy Workshop.

Dr. Garry Rus, Australian Institute of Marine Sciences: Fish censusing workshop.

Participants:

Country	≠ of Participants.
American Samoa	1
Fiji	2
India	1
Indonesia	3
Kenya	1
Malaysia	3
Mozambique	1
New Caledonia	1
Peoples Republic of China	1
Phillipines	4
Sri - Lanka	1
Tahiti	1
Thailand	3
Vietnam	1

Part I: Coral Taxonomy Summary of Field and Laboratory Studies.

Lectures and laboratory studies were conducted at the Marine Science laboratory, University of Phillipines in Bolinao. The program of activities included lectures in the afternoon; dives in the morning; identification of corals in the laboratory in the early evening and group discussions and participant seminars at night.

Lectures:

Coral Structur and Morphology
Coral Taxonomic terminology
The history of coral Taxonomy
The ecomorph concept
Coral distributions patterns and what causes these patterns
The coral species consept
General coral reef ecology

Field studies:

Participants were divided into group and each group was responsible for collection and identification of coral families covered during the lectures. Seven dive sites were visited (see map) ranging in depth and to pography from shallow sitty sites (1 - 3m) to vertical drop (16 m) and deeper reefs (up to 30 m).

Dive site	Family collected
1	Merulinidae, Oculinidae, Favidae
2	Trachyphilliidae, Dendrophyllidae
3	Fungidae
4	Acroporidae
5	Poritidae, Siderastreidae
6	Pocilloporidae, Astroecoeniidae, Agariciidae
7	Mussidae, Pectinidae, Caryophyllidae

A total of 83 species were identified comprising 39 genera in 14 families (refer to Appendix I checklist). A comparison of coral species collected in the Bolinao areas with corals from participants home reefs gave the general idea that Bolinao reefs were more diverse than Kenyan, French Polynesian and Sri-lankan reefs. The genera Euphyllia, Plerogyra, Cynarina, Cataphyllia and Lobophyllia are also found deeper than they were on the Bolinao reefs. Since most of the participants did not have extensive reference collections or checklists it was quite difficult to make more detailed comparisons.

Participants reactions and comments.

1. Most participants including myself felt that they were more competent in coral identification especially in the laboratory and especially where groups like Acvopora, Montipora and Goniopora are concerned.

2. It was also generally felt that most participants could now start a reference collection and compile a checklist for their areas. This was felt to be important for a biogeographical picture of the Pacific areas especially to be seen.

3. Exposure to researchers from other countries was thought to be beneficial especially as exchange of contacts, publications and ideas could be encouraged.

4. However, problems associated with the ecomorph concept and complication of keys for individual areas was thought to require more time.

5. Many of the participants felt that they benefited greatly from the workshop although it was felt that the time was too short for assimilation

Part II: Methods of Visual Census of Coral Reef Fishes.

Summary of Field and Laboratory Studies:

Lectures: the technique of visual fish censusing
Lenght-estimation
Transect method
Introduction to data storage and analysis

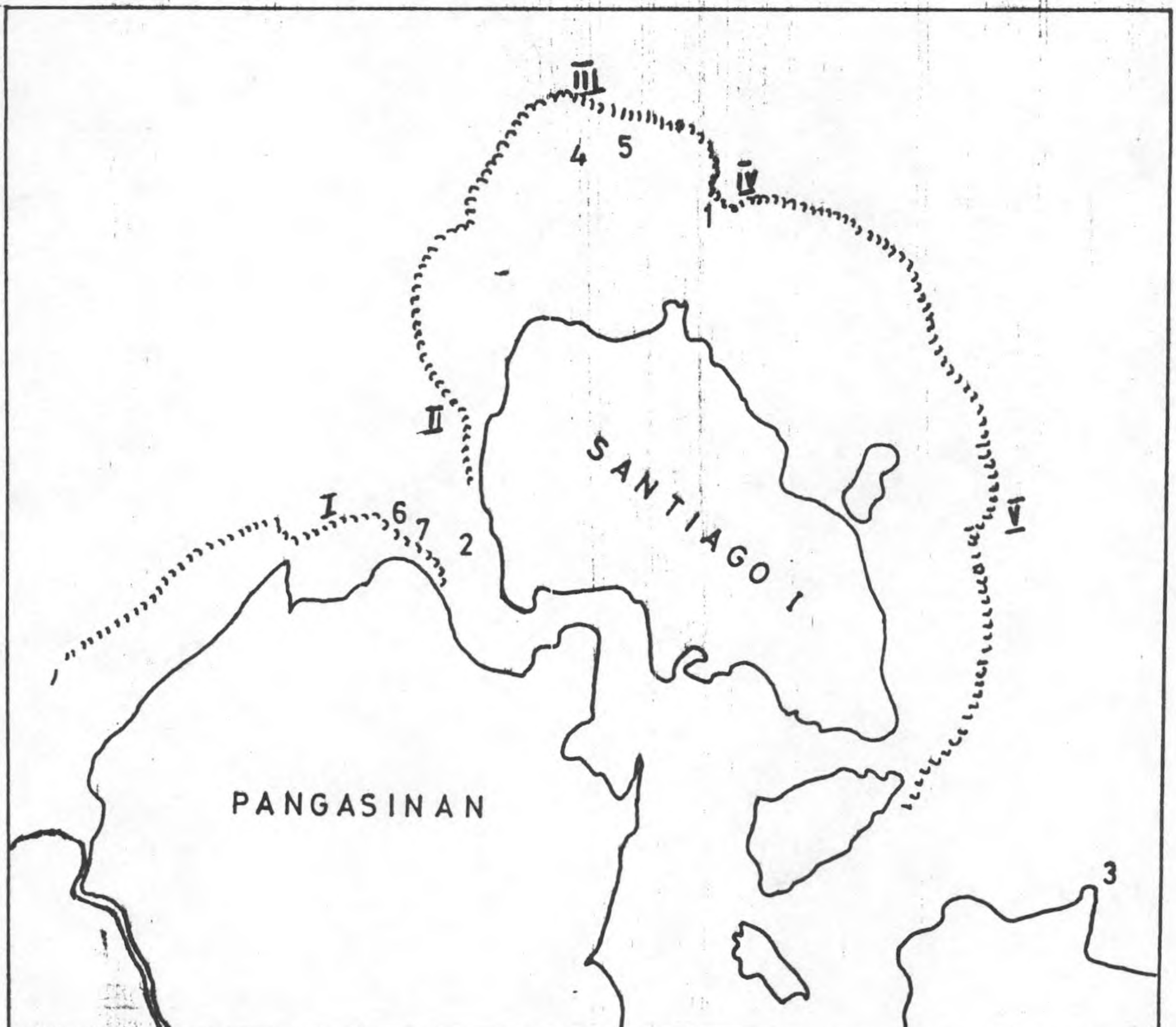
Field and Laboratory studies:

Laboratory studies included familiarization with identification of coral reef fish, lenght estimation training using models of various sizes. In the field a fish familiarization dive, followed by a lenght estimastion exercise was conducted. Actual data was collected along transects or reef slopes and reef flats (refer to map). More time was put into learning the technique of fish censusing than actually learning the fish themselves. This method was therefore felt to be more useful for researchers who are already familiar with the fish and want to study their abundance, distribution and access their stock. It is a simple method of swimming along a transect and recording (see data sheet, appendix II) all fish, or those one is interested in along a certain distance (2 -5m) from the line on either side of the line. This can be done snorkelling or with SCUBA.

Participants comments.

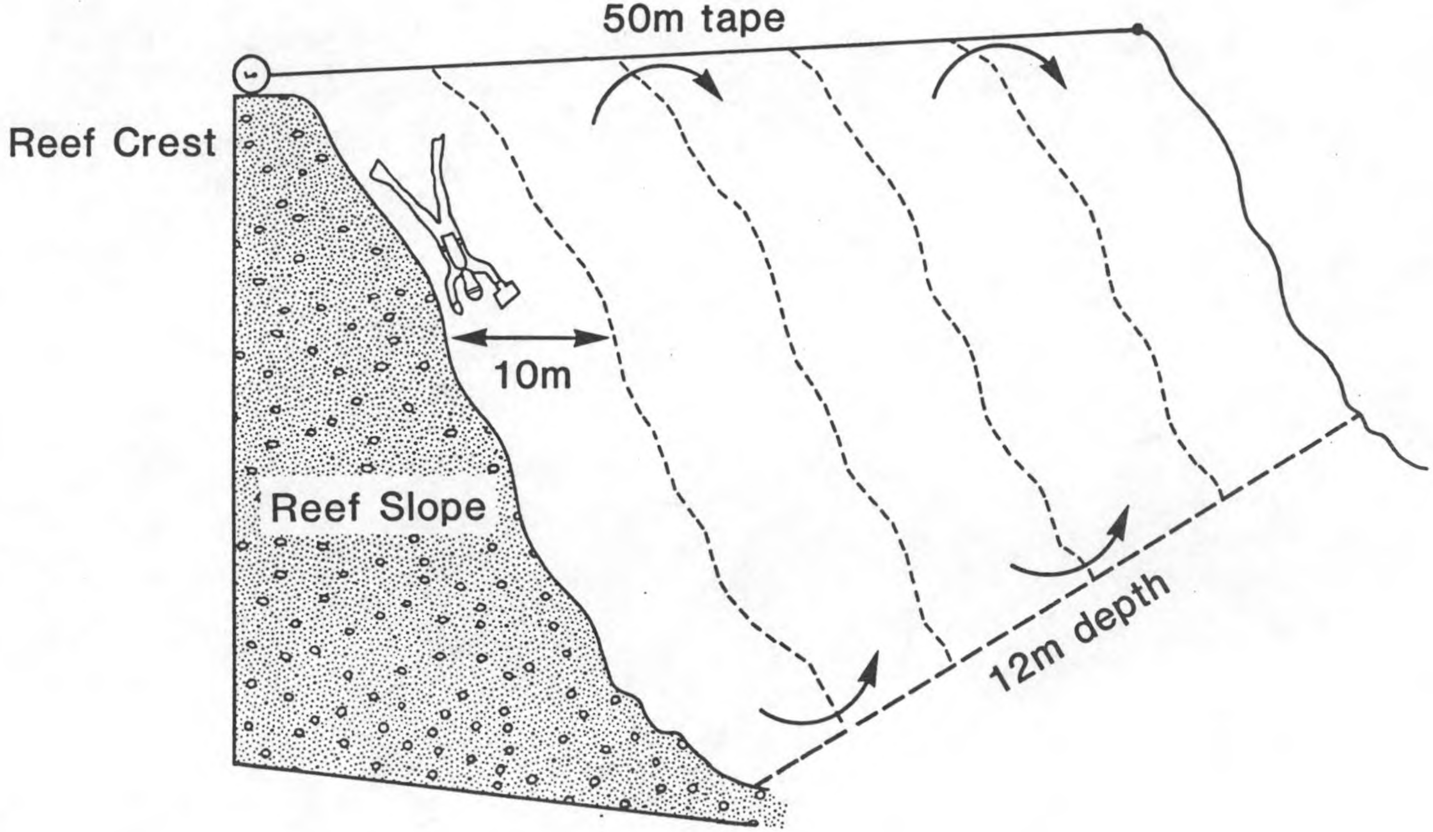
1. Most participants felt that they could use the method competently though more practise was needed for lenght estimations.

2. However, although the focus was on learning the technique of visual fish censusing rather than identification of the fish, it was felt that pore time was required for familiarization with the fish before the technique could be meaningful.

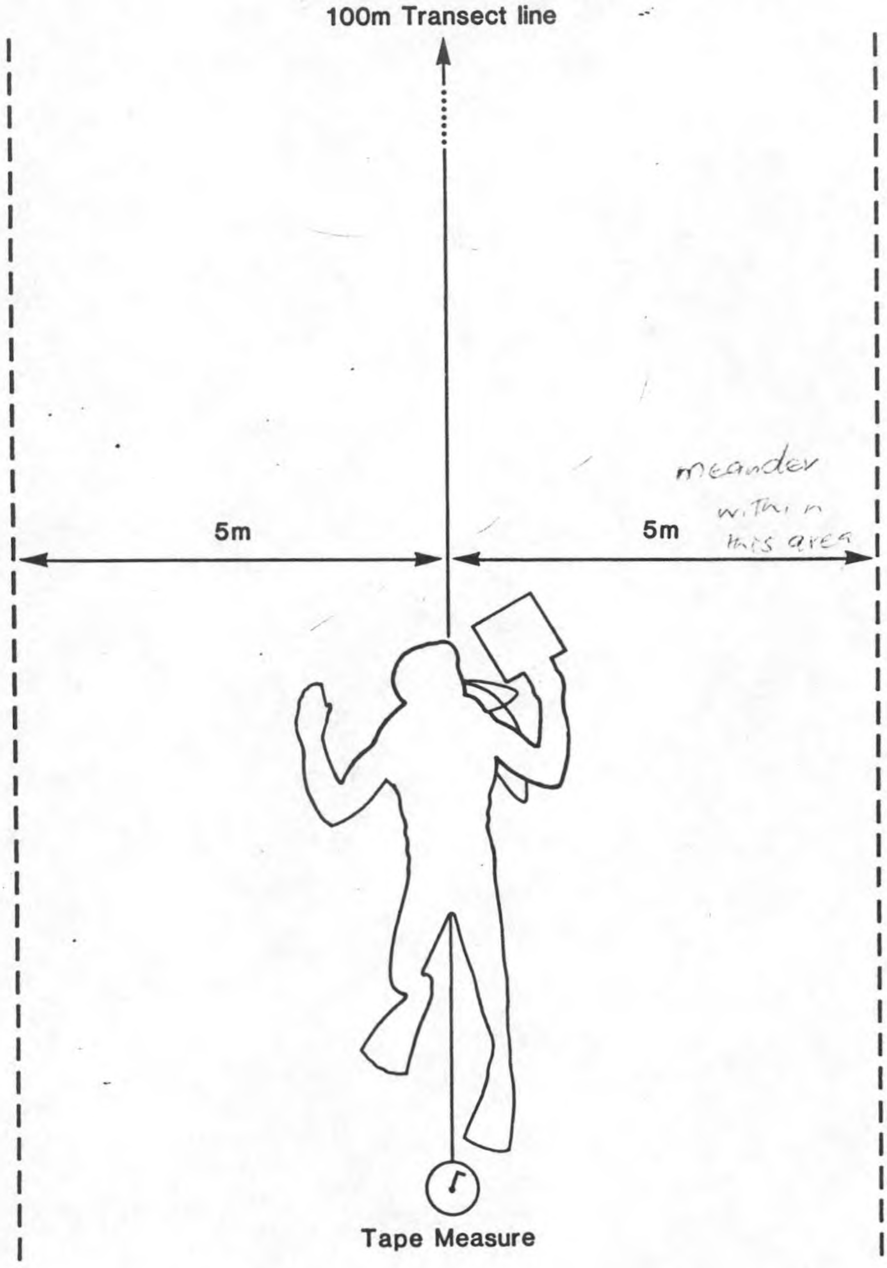


Map showing (1 – 7) the dive sites for the Coral Taxonomy workshop, and the Fish censusing work shop (I – V)

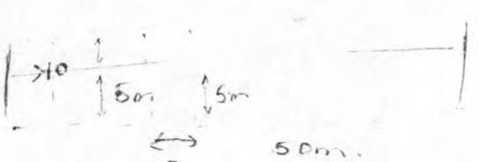
Method of Rapid Visual Census of Fishes on Reef Slopes



Line Transect Method of Census of Fishes to be used with Collection of Coral Data



Actual ~~exercis~~ exercise



travel along the line in blocks of 5m each.

(i). Lay line, move away from this area for 20 mins to allow fish to ~~get used~~ settle down again

APPENDIX I. CHECKLIST OF CORAL SPECIES COLLECTED FROM THE BOUNAO AREA.

Family Merulinidae

Genus Hydnophora

<u>H. exesa</u>

<u>H. rugosa</u>

Genus Merulina

<u>M. ampliata</u>

Family Oculiniidae

Genus Galaxea

<u>G. fascicularis</u>

<u>G. astreata</u>

Family Faviidae

Genus Favia

<u>F. rotumana</u>

<u>F. mathai</u>

<u>F. helianthoides</u>

<u>F. pallida</u>

Genus Favites

<u>F. halicora</u>

<u>F. chinensis</u>

<u>F. abdita</u>

Genus Goniastrea

<u>G. pectinata</u>

Genus Platygyra

<u>P. lamellina</u>

<u>P. sinensis</u>

Genus Montastrea

<u>M. valenciensis</u>

Genus Diploastrea

<u>D. heliopora</u>

Genus Leptastrea

<u>L. purpurea</u>

<u>L. pruinosa</u>

Genus Cyphastrea

<u>C. microphthalama</u>

<u>C. chalcidium</u>

Family Agariciidae

Genus Pavona

<u>P. explanulata</u>

<u>P. cactus</u>

Genus Leptoseris

<u>L. yabei</u>

<u>L. Mycetoseroides</u>

Genus Gardineroseris

<u>G. planulata</u>

Genus Pachyseris

<u>P. speciosa</u>

<u>P. rugosa</u>

Family Mussidae

Genus Scolymia

<u>S. vitensis</u>

Family Pectinidae

Genus Pectinia

<u>P. lactuca</u>

Genus Mucedium

<u>M. elephantotus</u>

Genus Echinophyllia

<u>E. echinopovoides</u>

Family Pocilloporidae

Genus Pocillopora

<u>P. verrucosa</u>

Genus Stylophora

<u>S. pistillata</u>

Genus Seriatopora

<u>S. hystrix</u>

Family Fungiidae contd

Genus Sandalolitha

<u>S. robusta</u>

Genus Lithophyllon

<u>L. lobata</u>

Genus Echinopora

E. lamellosa

E. gemmacea

Family Fungiidae

Genus Cycloseris

C. sommervellaei

Genus Fungia

F. paumatensis

F. echinata

F. fungites

F. corona

F. danae

F. granulosa

F. repanda

F. scabra

F. concinna

F. horrida

F. simplex

F. actinoformis

Genus Herpolitha

H. limax

Genus Polyphyllia

P. talpina

Family Caryophyllidae

Genus Euphyllia

E. ancora

Euphyllia sp.

Genus Plerogyra

P. sinuosa

Family Dendrophylliidae

Genus Turbinaria

T. frodens

Turbinaria sp.

Family Poritidae

Genus Porites

P. rus

Genus Goniopora

G. minor

G. stokesi

G. djiboutiensis

Genus Podabacia

P. crustacea

Family Trachyphyllidae

Genus Trachyphyllia

T. geoffreyi

Genus Wellsophyllon

W. radiata

Family Acroporidae

Genus Acropora

A. nasuta

A. florida

A. aspera

A. digitifera

A. divaricata

A. aculeus

A. excelsa

A. nobilis

A. nana

A. valencienensi

A. selago

A. variabilis

A. Hyacinthus

A. formosa

Acropora sp.

Genus Montipora

M. digitata

M. stellata

M. peltaformis

M. arguituberculata

Family Caryophyllidae

Genus Euphyllia

E. ancora

Euphyllia sp.

Genus Plerogyra

P. sinuosa

Family Dendrophylliidae

Genus Turbinaria

T. frodens

Turbinaria sp.

Family Poritidae

Genus Porites

P. rus.

Genus Goniopora

G. minor

G. stokesi

G. djiboutiensis

APPENDIX II

FISH CENSUS DATA SHEET

Reef: **Habitat:** **Depth:** **Date:** **Time:** **Tide:**

Other Information:

/ length

	'Target Species'	Estimate total lng.(cm) and/or actual counts							
I.	SERRANIDAE (Groupers)								
1.	Cephalopholis urodelus								
2.	C. pachycentron								
3.	C. sexmaculatus								
4.	C. miniatus								
5.	C. argus								
6.									
II.	LUTJANIDAE (Snappers)								
1.	Lutjanus decussatus								
2.	Lutjanus spp.								
3.	Macolor niger								
4.									
5.									
6.									
III.	LETHRINIDAE (Emperor Bream)								
1.	Lethrinus harak								
2.	Lethrinus spp.								
3.									
4.									
5.									
IV.	HAEMULIDAE (Sweetlips)								
1.	Plectrophychus chaetodontoides								
2.	P. goldmani								
3.	P. orientalis								
4.									
5.									
V.	CARANGIDAE (Jacks)	SCOMBRIDAE (Tunas)							
1.									
2.									
3.									
VI.	ACANTHURIDAE (Surgeonfishes)								
1.	Acanthurus bleekeri								
2.	A. mata								
3.	A. olivaceus								
4.	Acanthurus spp.								
5.	Naso lituratus								
6.	Naso spp.								
7.									
VII.	SIGANIDAE (Rabbitfishes)								
1.	Siganus spinus								
2.	S. corallinus								
3.	S. vulpinus								
4.									
VIII	MULLIDAE (Goatfishes)								
1.	Parupeneus trifasciatus								
2.	P. barberinus								
3.									
IX	LABRIDAE (Wrasses)								
1.	Choerodon anchorago								
2.	Hemigymnus melapterus								
3.	H. fasciatus								
4.	Cheilinus celebicus								
5.	C. diagramma								
6.	C. rhodochrous								
7.	C. trilobatus								
8.									

'Indicator Species'

X.	CHAETODONTIDAE (Butterflyfishes)	Actual Counts							
1.	Chaetodon adiergastos								
2.	C. baronessa								
3.	C. bennetti								
4.	C. citrinellus								
5.	C. kleini								
6.	C. mertensii								
7.	C. punctatofasciatus								
8.	C. speculum								
9.	C. trifascialis								
10.	C. vagabundas								
11.	Forcipiger longirostris								
12.	Heniochus acuminatus								
13.	H. chrysostomus								
14.	H. varius								

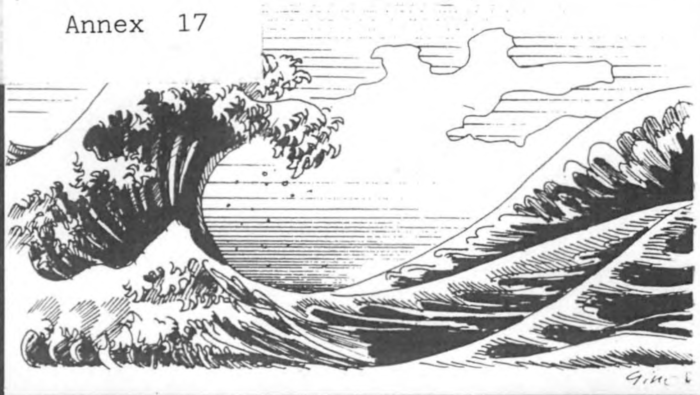
Numerically dominant

	'Major Families	1	2-4	5-16	17-64	65-256	257-1024	1025-4096	4097-16384
XI.	ACANTHURIDAE (Surgeonfishes)								
1.	Ctenochaetus striatus								
2.	C. binotatus								
3.	A. glaucoparienus								
4.	A. thompsoni								
5.	Zebrasoma scopas								
6.									
7.									
XII.	CAESIONIDAE (Fusiliers)								
1.	Pterocaesio pisang								
2.	C. cuning								
3.									
4.									
XIII	POMACENTRIDAE (Damsels)	LABRIDAE (Wrasses)							
1.	Chromis lepidolepis								
2.	C. margaritifer								
3.	C. ternatensis								
4.	Neopomacentrus spp.								
5.	P. thoracotaenniatus								
6.	P. lacrymatus								
7.	P. amboinensis								
8.	P. bankanensis								
9.	P. flavicauda								
10.									
11.									
12.									
13.									
1.	Anthias								
2.									
1.	Cirrhilabrus spp.								
2.	Epibulus insidiator								
3.	Gomphosus varius								
4.	Thallasoma hardwickei								
5.	T. janseni								
6.	T. lunare								
7.									
8.									
9.									
10.									
XIV	SCARIDAE (Parrotfishes)								
1.									
2.									
XV.	POMACANTHIDAE (Anglefishes)								
1.	Centropyge vrolicki								

Other information

ie: % coral cover along line
% hard substrate
% Soft corals etc.

Annex 17



F.A.M.E.

POSTGRADUATE
TRAINING COURSE
ON **F**UNDAMENTAL
AND **A**PPLIED
MARINE
ECOLOGY

ORGANIZATION :

F.A.M.E. is an interuniversity postgraduate training course for scientists from developing countries, sponsored by A.B.O.S., the Belgian Organization for Development Cooperation. Courses are given by specialists in marine ecology from different universities and institutes. The Free University of Brussels (V.U.B.) is the host institution. The courses are given in English and are organized every 2 years.

PROGRAM :

During the first year, the students attend a number of theoretical courses on various ecological topics (see list). Visits to different laboratories and contacts with specialists allow the students to become acquainted with the different specializations in the field of marine ecology. The second year, students carry out a research program related to the requirements and possibilities of their own country. This leads to the writing of a thesis. At the end of the program, students obtain a degree of «Master in Fundamental and Applied Marine Ecology».

REGISTRATION :

Candidates can obtain information and application forms at the belgian diplomatic office in their own country. Further information may be obtained at the **F.A.M.E.** secretariat :

V.U.B. (Fac. WE)
Laboratory of Systematics
and Ecology – V.U.B.
Pleinlaan 2
1050 Brussel – Belgium
Tel : (0)2/641.34.02 or 641.34.09

CONDITIONS OF ADMITTANCE :

- Applicants should at least have B.Sc. degree plus experience or a M.Sc.
- Maximum age in principle 30.
- Good knowledge of English is required.

PERSPECTIVES :

It is envisaged that, having obtained the Master's Degree, trainees return to their country to become employed in marine ecological research or management activities.

LIST OF COURSES AND RESEARCH FIELDS :

First Year	**Hours**
1. General Oceanography	30
2. Biological Oceanography	15
3. Legislation and Ocean	15
MARINE CHEMISTRY	
4. Biochemical Cycles	15
5. Analytical Chemistry	15
6. Water-Sediment Interactions	15
MARINE BIOLOGY	
7. Population Dynamics	15
8. Marine Bacteriology	15
9. Phytoplankton	15
10. Zooplankton	15
11. Marine Macrophytes	15
12. Marine Invertebrates	15
13. Benthos	15
FISHERIES	
14. Importance and Evolution of Fisheries and Fishery Techniques	15
15. Population Dynamics of Exploited Fish Stocks	15
16. Population Dynamics of Commercial Invertebrates	15
PHYSIOLOGY	
17. Endocrinology	15
18. Ecophysiology	15
POLLUTION	
19. Ecotoxicology	15
20. Biological Aspects of Pollution	15
21. Chemical Aspects of Pollution	15
ESTUARIES	
22. Biology of Estuaries	15
23. Hydrodynamics of Estuaries	15
24. Chemistry of Estuaries	15
MARICULTURE	
25. General Aspects of Mariculture	15

26. Culturing of Algae and Mollusks	15
27. Biology and Culturing of Artemia	15
28. Culturing of Fishes	15

MARINE GEOLOGY

29. Marine Stratigraphy	15
30. Sedimentology	15
31. Applied Oceanology	15

STATISTICS, COMPUTER SCIENCE AND MODELLING

32. Introduction to Computer Science	15
33. Introduction to Computer Programming	30
34. Modelling and Management	15
35. Ecological Modelling	15
PRACTICAL EXERCICES AND FIELD WORK	100

Second Year

- 200 hours of courses chosen among the curricula of the organizing universities and approved by the organizing committee.
- 400 hours of thesis work chosen among the topics that will be proposed.

ANNEX 18

Training courses for laboratory technicians

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
KENYA-BELGIUM COOPERATION IN MARINE SCIENCES

Part I

Instruction Manual on Field and Laboratory Sampling work for Lab Assistants

by: Dr. Els Martens
kmfri,mombasa
july 1986

I. Equipment needed on the field for a total sampling.

1/ - Cool-box with ice
- Thermometer
- Secchi disc
- Refractometer
- Oxygen meter
- Tissue paper
- Paper, labels, pencil, water-proof marker pen.

2/ Primary production
- 50 or 100 ml BOD bottles:-
  - 3 for time 0
  - 3 black pointed bottles
  - 3 bottles for each depth : all these for incubation in situ,
- Strings and floater for the incubation in situ
- Magnesium sulphate (MnSO4) and Iodium (KINaOH) solution
- 2 pipettes with pear (1 ml)

- Small-box to store the fixed samples.

3/ Chlorophyll
- i. If the filtration has to be done afterwards in the lab :
  - 1 l plastic bottle
- ii. If the filtration can be done immediately in the field :
  - millipore syringe
  - measuring cylinder of 500 ml
  - glass-fibre filters (Ø: 4.7 cm)
  - pincet (without sharp points)
  - aluminium foil and labels
  - plastic bag

  - distilled water to rinse the syringe after each sampling

4/ POC
- i. If the filtration has to be done afterwards in the lab :
  - 500 ml plastic bottle
- ii. If the filtration can be done immediately in the field :

  - idem as for 3/ (ii).

5/ Seston
- clean 1 l glass bottles

- lugol solution

6/ Nutrients
- 250 ml plastic bottles (2 for each analysis; when samples can be taken in duplicate then 6 bottles)
- Mercuric chloride solution for nitrate-nitrite fixation
- Phenol solution for ammonia fixation
- Chloroform and pipette of 1 ml with pear for phosphate-silicate fixation.

7/ Salinity
- 250 ml plastic bottles (2)

8/ Plankton
- Plankton nets
- Sieve 55 micron
- Formalin 5%

- Specimen bottles.

II. Primary Production

1/ Field-work

i. Rinse the 50 ml or 100 ml BOD bottles twice with seawater just before sampling

ii. Fill the bottles with the seawater

iii. Close well without air bubbles

iv. For time 0 (to) fix immediately :
   - +0.2 ml (0.4 ml for 100 ml sample) $MnSO_4$
   - +0.2 ml (0.4 ml for 100 ml sample) KINaOH

   Pipette just under water surface !
   Shake well after closing the bottle

v. For incubation in situ at several depths, fix the string with the bottles (at the raft) with floater.

vi. Fix the samples after 2 hours incubation for Gazi creek and 4 hours for Tudor creek (see 4).

vii. After fixation the bottles should be kept in the dark.

2/ Lab work

i. After settlement of the precipitation, add 0.2 ml (0.4 ml) concentrated H_2SO_4

ii. Close bottle and shake well

iii. Titrate 50 mlwith $Na_2S_2O_3$ (0.01 N) to light yellow

iv. Add some starch : the solution becomes blue. Put a white blank paper under the Erlenmeyer to see better the colour change by further titration

v. Titrate slowly further until colourless (one drop $Na_2S_2O_3$ can be too much and will change the measurement)

III. Chloropyhlles

1/ Field-work

i. Rinse twice the 500 ml plastic bottle with sea-water
ii. Fill the bottle with sea-water
iii. Store sample in cool-box with ice

2/ Lab-work

i. Filter sample on glass fibre filter with millipore vacuum pump
ii. Put filter into centrifuge tube (use a pincet !) + 10 ml 90% acetone
iii. Store in a fridge for 24 hours
iv. Centrifuge the tubes for 10 minutes at 3000 rpm (see report by M. Tackx for use of centrifuge or manual)
v. Take supernatant with pipette out of centrifuge tube and fill a spectrophotometer cell
vi. Measure extinction of the sample at 630 , 645, 665 micron wavelengths

Reference and sample cuvet must always be placed in the spectrophotometer with same side facing the light beam (see rport by N. Daro for use of spectrophotometer)

If filtration can be done immediately in the field with a millipore-syringe, then :-

i. Take 500 ml sea-water with measuring cylinder
ii. Put carefully with pincet one glass fibre filter in the filter holder (take care for the 2 orange rubber rings !)
iii. Open the syringe and fix it on the filter holder
iv. Fill the syringe with sample water
v. Filter this volume slowly, holding the system at the syringe and not at the filter holder (top of syringe will break off by moving)
vi. Take the emptied syringe off and open it again
vii. Repeat 3-6 till the 500 ml are filtered over the same glass fibre filter
viii. Put the filter with the pincet in aluminium foil and label : date, time of sampling, and volume filtered.
ix. Store the filters enveloped in aluminium foil in a plastic bag in the cool-box.

IV. POC

1/ Field-work

i. Rinse the 250 - 1000 ml plastic bottles with sea-water
ii. Fill the bottle
iii. Store sample in cool-box with ice.

2/ Lab-work

i. Filter sample on glass fibre filter (Ø=4.7 cm)
ii. Pack filter in aluminium foil. Label : date, time of sampling, tide, and volume filtered)
iii. Store in deep-freeze in petri-dish
Further analysis will be done by Mr.Kazungu, so inform him about the sampling.

* If filtration can be done immediately in the field with a millipore syringe then :-
i. Take 300 ml sea-water with measuring cylinder
ii. See (III), filtration method for chlorophyll

V. Seston

1/ Field-work

i. Rinse the 1 l glass bottle several times with sea-water
ii. Fill the bottle with sea-water taken at about 0.5 m beneath water-surface
iii. Add 2-3 ml lugol solution for fixation and shake, to give a light brown colour
iv. Store samples in cool-box with ice

2/ Lab-work

i. The samples have to be stored for a minimum of 3 days in a fridge for sedimentation of detritus and particles
ii. Remove supernatant with pump, with tube-end just below the water surface in the bottle.
Reduce the volume to less than 100 ml
iii. Shake and pour into 100 ml measuring cylinder. Rinse bottle with tap-water (few mls) and add this to the measuring cylinder
iv. Adjust the volume to 100 ml with tap-water
v. Cover cylinder with aluminium foil (+ label !)
vi. Store in fridge for a minimum of 2 days
vii. Reduce volume to 10 ml (see 2)
viii. Store sample of 10 ml in closed glass container in the dark in the fridge (= label !)
ix. Add some extra lugol every two weeks
x. If stored for a longer period, (more than 2 months) add 1 ml 40% formaline

VI. Nutrients

The analysis of the samples should be carried out immediately after sampling. If this is not possible, they should be fixed and deep-frozen (well labelled).

1/ Field-work

Rinse the 250 ml plastic bottles several times with the sea-water.

i. Nitrate-Nitrite
   - a) Fill 250 ml bottle with sea-water
   - b) Add about 5 drops of Mercuric chloride solution
   - c) Store sample in cool-box with ice

ii. Ammonia
   - a) Fill 250 ml bottle with sea-water
   - b) Add 1 ml chloroform (with pipette)
   - c) Store sample in cool-box with ice

iii. Phosphate and Silicate
   - a) Fill 250 ml bottle with sea-water
   - b) Add about 5 drops Phenol solution
   - c) Store sample in cool-box with ice

2/ Lab-work

The samples should be deep-frozen immediately once back from the field. The analysis will done by Mr Kazungu, so inform him about the samples.

VII. Salinity

1/ Field-work

i. Rinse a 250 ml bottle several times with sea-water
ii. Fill the bottle with sea-water
iii. Store sample in cool-box with ice

2/ Lab-work

The analysis should be done in the lab immediately after sampling.

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
KENYA BELGIUM COOPERATION IN MARINE SCIENCES

Training courses for Laboratory Technicians

Part II/1.

KMFRI, 1986

Course written by :

Mr.P.Pissierssens

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
KENYA BELGIUM COOPERATION IN MARINE SCIENCES
Training course for Laboratory Technicians

CONTENTS :

Introduction

During this training course you will become acquainted with different kinds of equipment , commonly used in Scientific Laboratories .
We will make distinction between Glassware , Small equipment and Heavy Equipment

CHAPTER 1 : GLASSWARE

1.1 Glass

There are 2 types of glass used for glassware : normal glass and heat-resistent glass (also known under the brand-name PYREX) .
You can always easily find out the type of glass a piece of glassware is made out : heat-resistent glassware is marked with a white circle or rectangle . Sometimes you find the 'PYREX' mark printed on the glassware .
In not heat-resistent glass you should never pour hot liquids or dilute strong acids or bases . (This because heat is produced with the dilution process) .

1.2 Glassware

We will divide the glassware in 8 types :

1.2.a Bottles
1.2.b Beakers
1.2.c Kolves
1.2.d Volume flasks
1.2.e Measuring cylinders
1.2.f Burettes
1.2.g Pipets

We will also look at some special glassware :

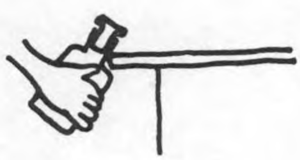
1.2.h Filtration equipment

1.2.i :To end some miscellaneous glassware

1.2.a Bottles

Bottles are used to keep liquid chemicals or to preserve samples . They are made of glass (usually normal glass , transparent or brown) or plastic (e.g Polyethylene) . The stopper can be a plastic stopper or a glass stopper. For chemicals , glass bottles and glass stoppers are preferred , especially with corroding liquids (acids !!). Organic solvents (e.g acetone,hexane , toluene , ...) should not be kept or poured into plastic recipients , as the plastic will 'melt' .
When carrying a bottle , never carry it only by the neck ! Always support the bottom of the flask ! Otherwise , the neck might break of ,the chemical + the bottle landing on your feet and legs !!

Sometimes , glass stoppers get stuck in the neck of the bottle .
In this case , knock the neck of the bottle and the stopper **GENTLY** against the edge of the table , while rotating the bottle .



If this doesn't help , put the bottle upside down in a beaker and leave it that way for a night . Next day , turn the beaker with the bottle and try to remove the stopper , if necessary with the ' knock method ' .
When heating a liquid , never shut a bottle with a stopper completely. The internal presure might cause the explosion of the bottle .

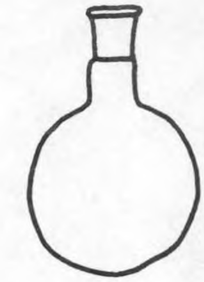
1.2.b Beakers

Beakers are used to take a volume of liquid , when the precision of the volume is not important . We have sizes of glass beakers : and sizes of plàstic beakers .

1.2.c Kolves

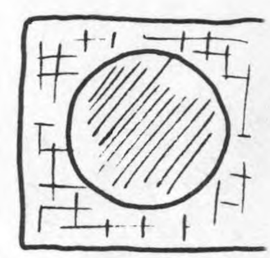
Kolves are used as reaction vessels . They come in 3 forms :
1/ Round kolve with round bottom
2/ Round kolve with flat bottom
3/ Erlenmeyer kolve

1.2.c.1 Round kolve with round bottom



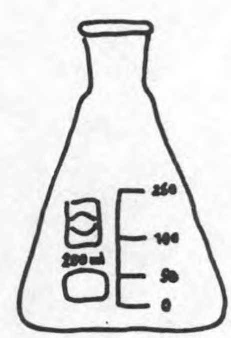
These are used to heat or boil liquids with gas burners or electric muffles (e.g distilling processes). Remark : When boiling liquids for distillation , it is advisable to use 'boiling stones' . These are small pieces of e.g porcelain . This will prevent outbursts in the boiling process, which might damage the glassware.

1.2.c.2 Round kolve with flat bottom



These can be used for heating or boiling liquids with gas burners or electric hot plates.
For heating these kolves with a gas burner , it is advisable to use asbestos frames , to protect the kolve against local overheating . This is not necessary when heating with electric hot plates .

1.2.c.3 Erlenmeyer kolves



These are used for all purposes in the lab .They come in two types : the normal type and the vacuum erlenmeyer (for reaction under negative atmospheric pressure or for filtration (see 1.2.h) .

All the above kolves exist with two neck-types : normal and . The latter are used in combination with other glassware , which fits into the neck of the kolve .

1.2.d Volume flasks

Volume flasks are used to take a very precise quantity of a liquid .For example : We have a volume flask for 50-55 ml : the precision is 0,01 ml. Furthermore , with this volume flask you can choose between two volumes : 50 or 55 ml (see the marks)
Remark : remember the meniscus when reading the volume !!
Remark : only use these flasks when you need to take a very precise volume : do not use them as storage flasks .
Preferably , do not use strong acids or bases.

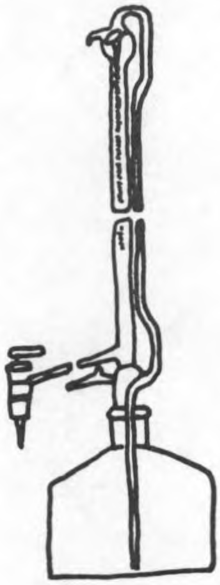
1.2.e Measuring cylinders

Measuring cylinders are used to measure a volume of a liquid with a precision of ± 0.75% . They are available in plastic or glass .
Remark : When working in the field , it is advisable to use plastic measuring cylinders . (They don't break as easily as glass !!)

Making precise measurements :
Example : you have a volume of ± 170 ml . In which type of cylinder should you measure it ? You can choose between a cylinder of 500 , 1000 or 250 ml . Answer : use the 250 ml cylinder . If you use the 500 ml cylinder , the precision will be smaller .

1.2.f <u>Burettes</u>

Burettes are used for titrations . We have two types : simple buret and automatic buret .



1.2.f.1 Simple buret

Remark : the tap of the buret has to be greased with vaseline .
Warning : When using strong acids or bases , remember that the vaseline will be destroyed :the buret will then start leaking . So , when you finished your work , do not forget to grease the tap . Be careful though not to put grease in the liquid path as the tap will then be blocked .

1.2.f.2 Automatic buret

In this type of buret , the liquid is tored in a reservoir . The buret can be filled with that liquid by pressing the pear.

1.2.g Pipettes

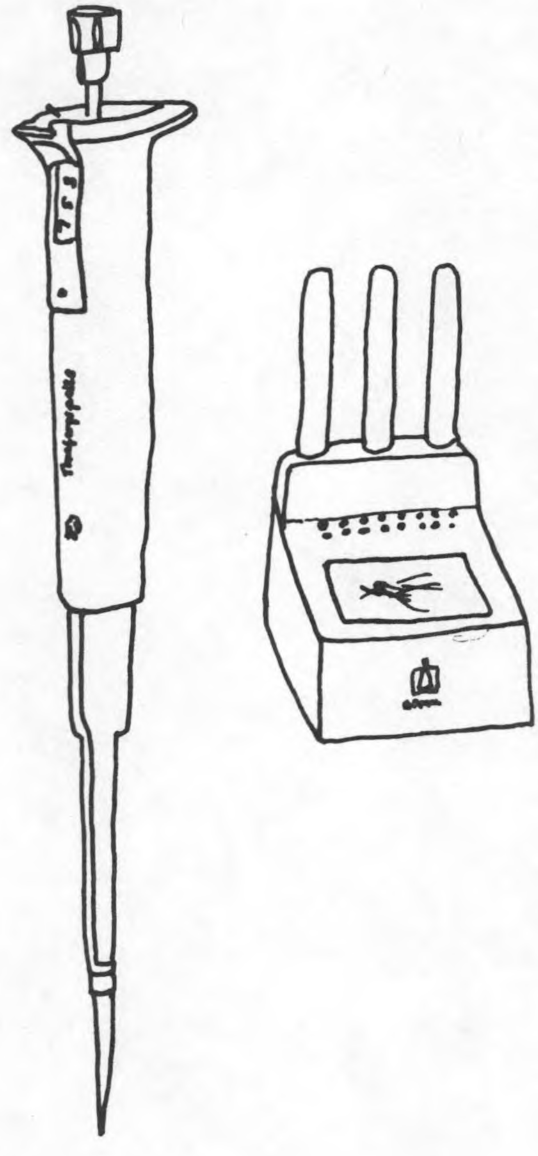
Pipets come in two materials : plastic (can only be used once : disposable) and glass (which have to be cleaned).

There are three different pipet types :

- Measuring pipet
- Bulb pipet
- Automatic pipet

Measuring pipet

Bulb pipet



Automatic pipet

The automatic pipet is the most accurate (if used the proper way !), the measuring pipet the least accurate . The accuracy of the pipet is always printed on the pipet .
Measuring pipets or bulb pipets are preferably to be filled and emptied with a pipet pear . Especially if you are working with strong acids or bases , organic solvents (acetone , hexane , ...) or poisonous liquids in general .

Automatic pipets

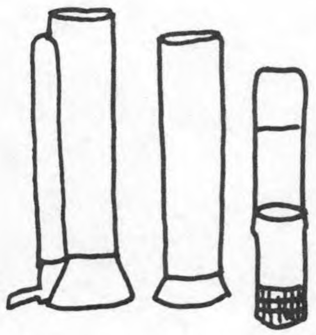
The automatic pipet has a 3 digit digital read-out . Turning the wheel you can set the volume you want to use . To avoid changes in the setting during use , you can lock the pipet by moving the lever .
Warning : If you want to change the setting and the weel is hard to turn , then probably the lever is still in lock position . First move the lever to unlock before turning the wheel !!!

Automatic pipets are used with pipet-points , which are disposable .
For every size of automatic pipet , there is an appropriate point :
For example : pipet 20-100 microliter : yellow point
pipet 200-1000 microliter : blue point
Do not exchange the types of pipet points .

Pipet stand (ref. SPIPAHOL): always use automatic pipets with there pipet stand when you are not using the pipet and there is still a point attached to the pipet .
WARNING : never lay a pipet , filled with strong acids or bases horizontally on a table : the liquid will leak into the pipet mechanism ,damaging the mechanics beyond repair .
REMARK : it is advisable not to use automatic pipets with organic solvents . The fumes might damage the mechanics .

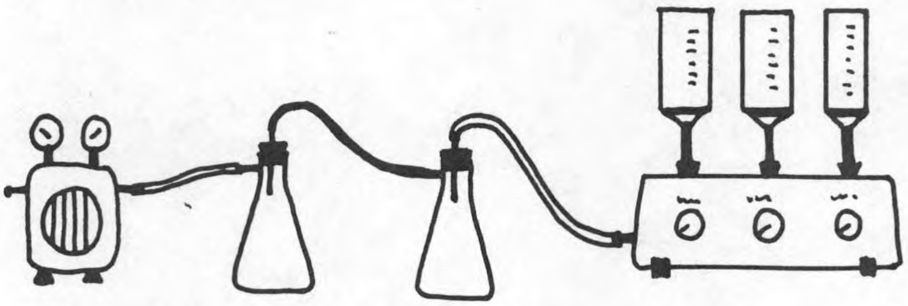
Cleaning pipets

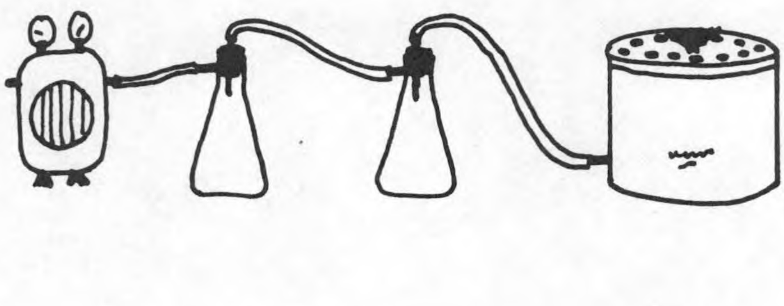
Plastic pipets are not be cleaned .
Pipet cleaning has to be performed in 3 steps :



1/ In both labs , you will find a container for the pipets , which has to be filled with water and a detergent . In this container , a pipet basket will be placed .
When you have finished using a pipet , put it into the basket in the first container . In this container , the pipet will be cleaned by the detergent . After a day , the basket is taken out of the first container , and put into the rinsing container .
This container is connected to the water supply .
The container , when completely filled with water is automatically emptied . Leave the system running for an hour or so . Then remove the basket from the rinsing container . Take out the pipets .
The pipets have now to be dried . This can be done in an oven at a temperature of about 80 degrees Celsius .

1.2.h <u>Filtration equipment</u>





As shown in the above figure , there are four filtration systems :
1/ Gelman filtration set
2/ Millipore filtration set
3/ Millipore filtration manifold
4/ Millipore syringe filtration system

1/ Gelman filtration set

This is used with a Millipore vacuum pump . connected to **two** Erlenmeyer kolves of 2000 or 5000 ml . We stress on two Erlenmeyer : one to collect the filtrate , the second to avoid water coming into the pump if you forget to empty the collector Erlenmeyer on time .
WARNING : if water should come into the pump , notify **immediately** the Chief Technologist !! He will dismount the pump and clean it thorougly . Do not try to do this yourself .

The Gelman filtration set enables you to filter 3 samples at a time .
Filters to use : Whatman GF/C (glassfibre) , 47 mm diameter.
Analysis : Chlorophyl , POC (if the POC concentration is high compared to the background of the contamination of the filter)

2/ Millipore filtration set

This system is used with a Millipore vacuum pump . The Filtration set , composed of 3 parts is mounted onto a filtra tion Erlenmeyer (1000 or 2000 ml) . It is advisable to use a safety Erlenmeyer (see 1/).

The Millipore filtration system is used for filtration where no contamination is to occur .
Filter to use : Any 47 mm filter (Glass-fibre,Polyacetate,...)
Analysis : POC,heavy metals , ...

WARNING : Do not use the filtration set without a filter : the fritted glass support will get contaminated .

Cleaning of the fritted glass support :

Put the fritted glass support upside down into a strong acid (e.g Sulphuric acid , Hydrochlorid acid , ...) for a night . Then , rinse the support in running water thoroughly . Then , put the support upside down into a large beaker with distilled water and leave for a night .

3/ Millipore Filtration Manifold

The Millipore filtration Manifold is used with a Millipore vacuum pump . It enables you to filter 12 samples at a time . It can be used in e.g Primary Production experiments .

Filters to use : Whatman GF/C (25 mm) or Polyacetate filters (25 mm)

To filter , first block all the holes with rubber stoppers . Unblock the hole in which you are going to filter .Switch on the pump. Then pour in the sample . When the sample has passed the filter completely (filter looks dry) ,pull out a second stopper and block the first one .Repeat this process for all holes .

REMARK : with this system , you can also keep the filtrate of all samples separately : Put in the filtration house a glass vial (see fig .)

4/ Millipore syringe filtration system

This system is perfect for in situ filtrations : you don't need a pump : Open the filtration system and insert a filter (glass-fibre or Polyacetate) . Close the system (firmly) . Now fill a syringe (volume 20 or 50 ml) and connect to the filtration set . Now press the syringe : the liquid will be filtrated on the filter .

1.2.i Miscellaneous glassware

1.2.i.1 Spectrophotometric cuvettes

There are two sizes : 10 mm or 40 mm . The 40 mm cuvettes are used when the concentration of the light absorbing liquid is very low .
They can be found in two materials : glass or quartz . The glass type can only be used in the visible light range (400-800 nm) . The quartz should be used only when you are working in the Ultra Violet range (< 400 nm) . Preferably do not use them when working in the visible range (Quartz cuvettes are very expensive)
Remark : When the sides of the cuvettes are frosted glass , then there is no problem . If , however , they are not , then make sure you are inserting the cuvettes into the spectrophotometer correctly : On the windows , in the light beam direction , the size of the cuvette is printed . Do not insert the cuvette sideways : this might scratch the windows of the cuvette , making it useless !!