

No. 51

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL COMMISSION FOR WILDLIFE CONSERVATION AND DEVELOPMENT
(NCWCD), KINGDOM OF SAUDI ARABIA

**THE STUDY ON
COASTAL / MARINE HABITAT AND BIOLOGICAL
INVENTORIES
IN THE NORTHERN PART OF THE RED SEA COAST
IN THE KINGDOM OF SAUDI ARABIA**

FINAL REPORT

MAIN TEXT

MARCH 2000

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JAPAN WILDLIFE RESEARCH CENTER

SHIN-NIPPON METEOROLOGICAL & OCEANOGRAPHICAL CONSULTANT CO., LTD.

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Foreign Currency Exchange Rates Applied in the Study.

Currency	Exchange Rate (/J.Yen)
Saudi Arabian Riyal (SR)	36.01

(Average rate from May 1989 to March 1999)

Note : Following numerical notation is adopted in the Report.

Decimal marker : “ . ” (period)

Digit separator : “ , ” (comma)

PREFACE

In response to a request from the Government of the Kingdom of Saudi Arabia, the Government of Japan decided to conduct the Study on Coastal / Marine Habitat and Biological Inventories in the Northern Part of the Red Sea Coast in the Kingdom of Saudi Arabia and entrusted the study to the Japan International Cooperation Agency.

JICA selected and dispatched a study team headed by Dr. Noboru Matsushima of Japan Wildlife Research Center and composed of Japan Wildlife Research Center and Shin-Nippon Meteorological & Oceanographical Consultant Co., Ltd. to the Kingdom of Saudi Arabia, five times between December 1997 to February 2000. In addition, JICA set up an advisory committee headed by Mr. Daizaburo Kuroda, Environment Agency Japan, between December 1997 to February 2000, which examined the Study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Kingdom of Saudi Arabia, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Saudi Arabia for their close cooperation extended to the study.

March 2000



Kimio Fujita

President

Japan International Cooperation Agency

**THE STUDY ON COASTAL / MARINE HABITAT AND BIOLOGICAL
INVENTORIES IN THE NORTHERN PART OF THE RED SEA COAST IN
THE KINGDOM OF SAUDI ARABIA**

March 2000

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the final report entitled "The Study on Coastal / Marine Habitat and Biological Inventories in the Northern Part of the Red Sea Coast in the Kingdom of Saudi Arabia". This report has been prepared by the Study Team in accordance with the contracts signed on 12 December 1997, 11 May 1998 and 21 May 1999 between the Japan International Cooperation Agency and the Joint Study Team of Japan Wildlife Research Center and Shin-Nippon Meteorological & Oceanographical Consultant Co., Ltd.

This report examines the current status of the biological environment and the social environment of the northern part of the Red Sea coast of Saudi Arabia, and also examines the detailed status of the identified Model Area. Based on the examined data, it identifies the important biological habitats and presents the critical areas for the conservation of the biodiversity in a form of maps, and also suggests an action plan to conserve the biodiversity of the Study Area.

The report consists of the Summary, Main Text, Appendices, Biological Inventory (CD-ROM), Habitat Maps of the Study Area, Habitat Maps of the Model Area and Geographical Information System / Database (CD-ROM).

All members of the Study Team would like to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Environment Agency and Embassy of Japan in Saudi Arabia, and also to officials and individuals of the Kingdom of Saudi Arabia for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the Study will contribute to the conservation of biodiversity of the northern part of the Red Sea coast of Saudi Arabia and that friendly relations of both countries to be promoted further by this occasion.

Yours faithfully,



Noboru Matsushima
Team Leader

الملخص

مقدمة:

بناء على اتفاقية التعاون المشترك المبرمة في الرياض بتاريخ ٢٤ مارس ١٩٩٧م بين الهيئة الوطنية لحماية الحياة الفطرية وإنمائها والوكالة اليابانية للتعاون الدولي (جايكا)، قام الفريق العلمي المشترك للهيئة وجايكا بتنفيذ مشروع دراسة البيئات الساحلية والبحرية وكائناتها في الجزء الشمالي من الساحل السعودي للبحر الأحمر والتي استغرقت سنتان بدأت في ٢٢ ديسمبر ١٩٩٧م وانتهت في ٢٤ نوفمبر ١٩٩٩م. ويهدف مشروع الدراسة إلى التالي:

- ١- دراسة البيئات الساحلية والبحرية وكائناتها في الجزء الشمالي السعودي من ساحل البحر الأحمر من أجل توفير المعلومات الأساسية لغرض المحافظة والإدارة المناسبة للبيئات الطبيعية والتنوع الأحيائي لها.
- ٢- نقل التقنيات إلى فريق المشاركين السعوديين خلال الدراسة. ولقد تمت الدراسة على مراحل أربعة كالتالي:
 - المرحلة الأولى : جمع وتحليل المعلومات المتوفرة
 - المرحلة الثانية : خواص منطقة الدراسة ميدانياً وتحديد المنطقة النموذجية
 - المرحلة الثالثة : دراسة تفصيلية للمنطقة النموذجية المرشحة للمحافظة
 - المرحلة الرابعة : إعداد الدراسات البيولوجية/ الخرائط بصفة عامة وللمنطقة النموذجية بصفة خاصة.

منطقة الدراسة:

يغطي المسح الجزء الشمالي من البحر الأحمر وبامتداد ١٠٠٠ كيلومتر ويبدأ من شمال مدينة جدة إلى مدينة حقل، ويبلغ عرض المنطقة من حد الماء والمسافة كيلومتر تقريبا على اليابسة، وحتى عمق ١٥م داخل مياه البحر، وقد تتغير هذه الأبعاد لمنطقة الدراسة لمسافة أكبر لكي يضم بيئات أخرى لا تقع ضمن هذا الإطار. كذلك تم دراسة الجزر القريبة وأيضا البعيدة عن الشاطئ والواقعة على امتداد الساحل.

النتائج:

تمت دراسة المرجان في ١٤٥ موقعا لعدد ٨٦ من الشعاب في منطقة البحث. وتوصلت الدراسة إلى تسجيل ٢٥٠ نوع من المرجان الساحل السعودي للبحر الأحمر منها ٤٠ نوعا مستوطنا تمثل ٥٨ رتبة و١٤ عائلة منها ٣٠ نوعا من المرجان الطري. وتتضمن الأنواع المسجلة ٦ أنواع جديدة على نطاق العالم. تمت دراسة ١٩٧ موقعا للحشائش البحرية والطحالب في منطقة الدراسة، ولقد تم تسجيل ١٨٨ نوعا منها ٨ أنواع من الحشائش البحرية و ١٨٠ نوعا من الطحالب تضم ٦٨ نوع من الطحالب الخضراء و ٢٠ نوع من الطحالب البنية و ٨٢ من الطحالب الحمراء. ولقد وجد أن التنوع للطحالب يتصاعد خلال الحيود والقطع المرجانية. كما وجد أن العديد من الحشائش البحرية تنمو في الممرات المائية حيث يقل أو ينعدم تراكم حبيبات السلت (حبيبات قطرها أقل من ٦٣ ميكرون) غير الملائمة لنمو هذه النباتات. وتنتشر الحشائش البحرية بشكل عام في المنطقة الداخلية من الحيود المرجانية وفي البحيرات الواقعة خلف الشعاب المرجانية والشروم والممرات المائية.

تم دراسة الأسماك في ١٢١ موقعا في ٢٥ منطقة في نطاق الدراسة، وتوصلت الدراسة إلى تسجيل ٣٧٨ نوعا من الأسماك تمثل ١٧٥ جنسا وتقع تحت ٦٥ عائلة وضمن هذه الأنواع ٣٤ نوع من الأسماك المستوطنة. وتم خلال الدراسة تسجيل ٥ أنواع من الأسماك لأول مرة في البحر الأحمر.

تم دراسة الأحياء القاعية في ٩٦ موقعا في ٢٥ منطقة داخل نطاق الدراسة. ودلت دراسة الأحياء القاعية على وجود وتسجيل ٣٤١ نوعا تقع تحت ١٢٣ عائلة. أظهرت دراسة الأنواع السائدة من الأحياء القاعية على عدم وجود اختلاف جوهري في توزيعها الجغرافي، كما دلت الدراسة على وجود تنوع عالي للأحياء القاعية في الجزء الشمالي من منطقة الدراسة. كما أن الأحياء القاعية متوفرة بكميات كبيرة في كل من ضفة الوجه وخليج العقبة.

أثبتت دراسات الثدييات البحرية والسلاحف البحرية المعتمدة على الاستبيان والمقابلات الشخصية على وجود عرائس البحر في كل من مدخل خليج العقبة، وضفة الوجه وشرم هبان وفي المنطقة الواقعة بين رأس بريدي وينبع وبعض الشروم جنوب ضبا وبالقرب من جزيرة برقان. بينما دلت المسوحات الجوية على مشاهدة ٧ قطعان من عرائس البحر، في ستة منها يضم القطيع حيوانان أو أقل، وأكبر قطعان ضم ٤ حيوانات من عرائس البحر. كما دلت الاستبيانات الخاصة بالصيادين وحرس الحدود على أن السلاحف البحرية تنتشر من عند شمال مدينة جدة إلى خليج العقبة.

ولقد دلت المسوحات الجوية على وجود حفر السلاحف أو آثار لزحفها على رمال الشاطئ في جزر صنابير وشوشه، وجزر النعمان والشيخ مريبط وبريم والوچادي، وأربع جزر صغيرة أخرى إلى الغرب من مركز حرس حدود الخرج، وستة جزر صغيرة إلى الغرب من مركز حرس حدود القراير، وسبع جزر صغيرة تقع إلى الغرب من مركز حرس حدود الحرة، وجزر جبل حسان ولبنه ومليحه. كما ترتاد السلاحف البحرية الأرض اليابسة حيث شوهدت آثارها على شواطئ منطقة رأس بريدي، وخريم وجنوب حرس حدود المويلح وجنوب حرس حدود الحرة وشمال ضبا وشمال شرم جبا وجنوب حرس حدود زبيده وشمال رأس عبيد ورأس مريج (جنوب شرم عنتر) ورأس مريبط ورأس أبو مله (جنوب الوجه).

تم دراسة النباتات الساحلية في ٢٦ موقعا في منطقة الدراسة كان من ضمنها ثلاث جزر بعيدة عن الشاطئ. ولقد دلت دراسة الغطاء النباتي في ٦٩ مربعا على أن هناك ٨ نماذج نباتية، تضم ٢٩ مجتمعا من النباتات. ولقد لوحظ تمناطق الغطاء النباتي من عند الشاطئ وباتجاه اليابسة في جميع المواقع تقريبا.

دلت الدراسات النباتية دلت على أن هناك ١٥٩ نوعا من النباتات الوعائية تقع تحت ٤٢ فصيلة منها نوعان من المانجروف. وتضم المنطقة نباتات ملحية ونباتات جفافية وتحتوي هذه الأنواع على ١٢ نوع مستوطن.

كما تمت دراسة الطيور في ٢٤ موقعا في منطقة الدراسة. ودلت الدراسة على أن هذه المواقع تشكل ٦ طرز من البيئات المختلفة ونظرا لقساوة الطقس في منطقة الدراسة خلال فصل الصيف، فإن العديد من الطيور الأرضية لا تعشش في هذه المنطقة بالشكل المتوقع، ومع ذلك تعد المنطقة موقعا هاما للطيور المهاجرة والطيور الشتوية. ويعتمد التنوع في المواقع المختلفة على بيئة المنطقة وكثافة الغطاء النباتي لها ويعد الموقع في منطقة الدراسة، وتعد بيئات الوديان وبيئات المانجروف أكثر المناطق التي تضم تنوعا عاليا من الطيور. كما أن وفرة الأعداد للطيور تعتمد أكثر على نوعية النباتات وكمية الغطاء النباتي المتوافر لها.

المنطقة النموذجية:

تم اختيار "ضفة الوجه" كمنطقة نموذجية لدراساتها تفصيليا نظرا لأنها غنية بالأحياء وتضم جميع أنواع البيئات المختلفة الموجودة في ساحل البحر الأحمر السعودي، كما أن الجزء الجنوبي منها غني بالتنوع المرجاني وهام لبيئات المانجروف، إضافة إلى أن "ضفة الوجه" منطقة مقترحة للحماية من قبل الهيئة.

ونظرا لكبر مساحة المنطقة النموذجية "ضفة الوجه" وحتى يتمكن فريق الدراسة القيام بإجراء دراسة أحيائية تفصيلية، فقد تم تحديد قطاع في جنوب "الضفة" يضم أكبر عدد من البيئات. كما دلت الدراسة التفصيلية على أن المنطقة النموذجية تضم بقعا لتراكيب من الشعاب المرجانية متكاملة مع بعضها البعض بدرجة عالية. تتشكل هذه التراكيب من الحيويد المرجانية الشاطئية والحيويد المرجانية حول الجزر، والتراكيب المرجانية المستوية، القطع المرجانية، والحواجز المرجانية. وتتميز "ضفة الوجه" بوجود أطول حاجز مرجاني شبه متصل يقع في منطقة الدراسة بامتداد ١٠٠ كم. ويتقطع الجزء الخارجي منه بواسطة عدة قنوات (عرضها ٢٠٠م). وتم تسجيل ٢٠٠ نوع من المرجان الصلب في المنطقة النموذجية يضم ٥٨ جنسا تقع تحت ١٤ عائلة، إضافة إلى ٢٠ نوعا من المرجان الطري. وتمثل مجاميع المرجان الأربعة الرئيسية في المنطقة النموذجية نفس مجاميع المرجان الموجود في منطقة الدراسة.

دلت دراسة الحشائش البحرية والطحالب على تسجيل ٨٢ نوعا تتضمن ٩ أنواع من الحشائش البحرية و ٧٣ نوعا من الطحالب. وأكبر عمق وجدت فيها الحشائش كانت في ممر مائي يقع عند عمق هو ١٢ر٢م. ولقد سجل في ساحل الخواره "بضفة الوجه" نوع يسمى *Enhalus acoroides* والذي كان يعتقد من قبل بأنه من الحشائش البحرية المحصورة على ساحل مدينة جدة فقط.

تختلف أعداد وأنواع الطحالب قليلا في فصل الصيف مقارنة بفصل الربيع وتتغير مساحة غطاء الأعشاب البحرية حسب الفصول حيث تقل أعداد وأنواع الطحالب في فصل الصيف مقارنة بفصل الربيع. يكثر نوع *Turbiraria* في الربيع ويبدأ بالتناقص في فصل الصيف، أما الطحالب جنس *Sargassum* و *Cysloceria* فتكون متوفرة في فصل الصيف مقارنة بفصل الشتاء.

تم مسح ٢٩ موقعا عند أعماق مختلفة تقع في ٢٤ منطقة في إطار الدراسة، وخلال هذا المسح تم تحديد ٣٢ نوعا من الأسماك لدراستها تفصيليا ولقد لوحظ أن ٢ أنواع من الأسماك (أسماك أم عطية *Heniochus intermelius* والحريد *Hipposcarus harid* والأسماك الملائكية ذات البقعة الصفراء *Pomacanthus maculosus*، تسود في جميع المواقع.

ولقد دلت كثرة ملاحظة خيوط النايلون الخاصة بالصيد التقليدي وشباك الصيد إضافة إلى تهشيم المرجان الناتج من خطاطيف الزوارق البحرية عند رسوها في معظم المواقع على أن هناك بعض الضغوط البشرية ناتجة من جراء عمليات الصيد هذه.

تم مسح ٤٨ موقعا تقع في ١٧ منطقة في إطار الدراسة بغرض الأحياء القاعية تم تعيين ١٩ نوعا من الأحياء القاعية السائدة في ساحل البحر الأحمر السعودي لدراستها في البيئات المختلفة بالمنطقة النموذجية. تعتبر بيئة نباتات المانجروف الواقعة في منطقة "دقم سبق" من أهم أنواع البيئات الخاصة بالأحياء القاعية الموجودة في المنطقة النموذجية وهذا عائد إلى احتوائها على السرطانات جنس *Macrophthalmus* و *Uca* الهامين للنظام البيئي الخاص بالمسطحات المدجزرية، وعدم توفرهما في البيئات المشابهة في المنطقة النموذجية، ولحدوديتهما في منطقة الدراسة. لذا تعد منطقة بيئات المانجروف الموجودة في منطقة "دقم سبق" من أهم بيئات الأحياء القاعية نظرا لاحتوائها على النوعان المشار إليهما من السرطانات لما لهما من أهمية للنظام البيئي لهذا النوع من البيئات.

وتقل وفرة الأنواع في منطقة المد والجزر داخل المنطقة النموذجية مقارنة بالمناطق الأخرى بشكل عام، وهذا عائد إلى أن معظم هذه المنطقة هي رملية أو سلتية. وتميز المنطقة بشكل عام بأعداد قليلة من الأحياء القاعية وذات وفرة ضئيلة و "حجم البصر" *Tridacna maxina* هنا أصغر منه مقارنة بالمناطق الأخرى. وتعد بيئة ضفة الوجه بيئة مناسبة للأحياء القاعية التي يبلغ حجمها ٥.٠ مم والتي تعيش داخل الرمل والسلت عن الأحياء التي أحجامها أكثر من اسم.

قدر عدد حيوان عرائس البحر في ضفة الوجه بـ ٢٣٥ حيوان. ولقد لوحظ أن الحيوان يتغذى بالحشائش البحرية من نوع *Syringodium isoetifolium*، وتعد البيئة البكر في المنطقة النموذجية عامل مهم في بقاء هذه الكائنات تحت هذه الظروف البيئية القاسية. لذا يجب أن تعطى بيئة الحشائش البحرية عناية خاصة لحمايتها وإدارتها إدارة صحيحة. ويعيش في المنطقة نوعان من السلاحف البحرية هما السلحفاة الخضراء وسلحفاة صقرية المنقار.

ولقد تم اختيار جزيرتي "جبل حسان" و"الوجداني" لدراستهما ضمن المنطقة النموذجية. وتم رصد أثر لعدد ١٥ سلحفاة صقرية المنقار خلال هذا الموسم في جزيرة جبل حسان ورصد أثر ٢٨ سلحفاة خلال هذا الموسم ورصد ٣٩ أثرا في موسم العام الماضي (١٩٨٨م).

دلت دراسة قطاعات البيئات الساحلية على أن هناك تمنطق واضح للنباتات في كل قطاع والتغير في تمنطق النباتات من حافة الماء على الشاطئ وباتجاه اليابسة كان كالآتي، نباتات المانجروف منتشرة في القنوات المائية والمناطق الشاطئية الضحلة وخلف المانجروف تنمو نباتات المستنقعات الملحية والتي تضم مجموعة عجيرمان *Halocnemum strobilaceum* وشوع *Arthrocnemum macroslachyum* في شكل حزام ضيق غزير موازى للشاطئ، ويلى هذا النطاق نباتات حريز *Halopeplis perfoliata* وتكون مجموعة قليلة الغطاء تنمو في المراوح الفيضية الرملية ويحل محلها تدريجيا مجموعة نباتات الهرم - الرطريط *Zygothallum album*.

تنمو نباتات المانجروف من جنس الشورة والقندل في شرق وجنوب الموقع النموذجي، وهذا عائد إلى تأثير الرياح السائدة والتي تهب من الشمال، وتنمو نباتات القندل والتي تعد قليلة الانتشار في ساحل البحر الأحمر السعودي على ضفاف القنوات في الجزر وتمثل نباتات القندل الموجودة في جزيرة أم رومة (٤٤ ٢٥ ش) أقصى امتداد لهذه النباتات في المنطقة العربية من جهة الشمال.

دلت دراسة الطيور على أن الطيور قليلة في البيئة الصحراوية، أما بيئة مستنقعات النباتات الملحية فتكثر بها الطيور ولكن بأنواع محدودة. وتوجد في الوديان أنواع مختلفة من الطيور مقارنة بتلك الموجودة على الساحل وتكثر الطيور في هذه الأودية في فصل الشتاء. وتشكل نباتات المانجروف أماكن استراحة للطيور المهاجرة.

أظهرت الدراسات الاقتصادية الاجتماعية على أن المنطقة الواقعة بين مركز حرس حدود الخرج ومدينة أمّالج تقع تحت ضغط رعي جائر. ولوحظ أن عملية الزراعة الجارية في الوديان في المنطقة النموذجية ليس لها مردود اقتصادي، ولقد أدى اتساع المدن إلى زيادة في نشاط حرفة الصيد نظرا لزيادة الطلب المحلي على الأسماك.

ولقد دل الاستبيان للعاملين في ٢٠ قارب صيد أن ثمانية قوارب منها يعمل أصحابها عليها وأن ١٢ قارب يملكها رجال أعمال لكل فرد منهم اثنان إلى ثلاث قوارب. كما دل الاستبيان على أن هنالك ضغوط بيئية من جراء الصيد للأسماك تقع في الجزء الجنوبي من منطقة الدراسة وهذا عائد إلى الكثافة السكانية المستهلكة في هذه المنطقة.

الخرائط البيئية:

تم من خلال تحليل تدرج الألوان في الصور الجوية والتي تم تصويرها في الفترة من ٣ يونية إلى ١٢ يولية ١٩٩٨م لأجل عمل الخرائط البيئية لمنطقة الدراسة بمقياس رسم ١:١٠٠.٠٠٠، كما تم عمل خرائط بيئية تفصيلية مستقلة للمنطقة النموذجية بمقياس رسم ١:٥٠.٠٠٠، ونظرا لعدم تمكن فريق الدراسة من تصوير خليج العقبة والمنطقة الواقعة جنوب رابع، فقد تم الاستعانة بصور الأقمار الصناعية في إكمال عمل الخرائط البيئية لمنطقة الدراسة. وتم تحسين عملية تحليل خرائط البيئات من خلال المعلومات التأكيدية الحقلية وخصوصا أثناء دراسة المنطقة النموذجية.

نظام المعلومات الجغرافية وقاعدة المعلومات:

يبين نظام قاعدة المعلومات الجغرافية وقاعدة المعلومات العلاقات بين مصادر المعلومات المختلفة وعلى سبيل المثال يمكن إيجاد العلاقة بين البيئة الاجتماعية والمصادر الحيوية، كذلك يمكن من خلالها هذا النظام عمل مقارنة لمعرفة التغيير الحاصل للبيئات أو أحيائها عن طريق مقارنة المعلومات المستجدة بالمعلومات المسجلة سابقا على قاعدة المعلومات.

ولقد تم اختيار بعض المناطق المحمية في منطقة الدراسة تبعا للتالي:

١- مناطق حماية ذات أولوية:

- ومن خلال هذا التقييم تم اختيار ثلاث مناطق بحرية كبيرة لحمايتها وهي:
- من مدخل خليج العقبة إلى منطقة تيران.
- "ضفة الوجه" وجنوب أمليج إلى شرم شعبان.
- الحجر (شمال رأس مستورة).

٢- إدارة المناطق ذات الاستراتيجية بيئيا:

توجد هذه المواقع ضمن بقية مناطق الدراسة ويستثنى منها المدن والقرى، وهي ذات قيمة بيئية متكاملة عالية للإقليم. وتكمن أهمية بيئات هذه المناطق نظرا لاحتوائها على الجامع القاعية في الخلجان المفتوحة والشبه مغلقة (الشروم) والجزر البعيدة عن الشاطئ والتي تعد مناطق مهمة للتكاثر.

٣- مناطق متعددة الاستخدام:

تضم هذه المناطق المدن والقرى الساحلية في الإقليم حيث تكثف العمليات الإنمائية، واستحوذ على الأراضي، وإقامة محطات التحلية والصرف الصحي ومواقع رمي النفايات الصلدة وتتطلب مثل هذه النشاطات مراقبة دقيقة بما في ذلك توفير بيئة جيدة للقاطنين في هذه المدن ولتقليل الضغوط البشرية للمناطق ذات الأولوية في الحماية والمناطق الاستراتيجية لإدارة بيئتها.

التوصيات:

- ١- إقامة بعض المناطق البحرية المحمية الكبيرة ثم تعيينها تبعا للأولويات الخاصة بالحماية والتي رشحت لها منطقة تيران "وضفة الوجه" ومنطقة الحجير.
- ٢- البدء في إجراء برامج إدارية تتضمن إدارة النطاقات الهامة في المناطق ذات الأولوية في الحماية وإدارة المناطق ذات الاستراتيجية بيئيا .
- ٣- تطبيق الاستخدامات المتعددة في المناطق المحمية، ودرج وتضمين المناطق البيئية المختلفة وذلك لزيادة فعالية إدارتها.
- ٤- إجراء المزيد من الدراسات المستقبلية والمراقبة.
- ٥- الحث على انضمام المملكة لبرنامج المراقبة الدولي للشعاب المرجانية.
- ٦- تعزيز ودعم برامج التعليم والتوعية البيئية لأجل حماية البيئات الساحلية والبحرية.



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SEPARATE VOLUMES

Separate Volume 1: Biological Inventory (CD-ROM)

Separate Volume 2: Habitat Maps of the Study Area (1:100,000)

Separate Volume 3: Habitat Maps of the Model Area (1:50,000)

Separate Volume 4: Geographical Information System / Database (CD-ROM)

Abbreviations and Acronyms

GIS	Geographical Information System
GPS	Global Positioning System
JICA	Japan International Cooperation Agency
MEPA	Meteorology and Environmental Protection Administration
NCWCD	National Commission for Wildlife Conservation and Development
SCUBA	Self-contained underwater breathing apparatus

1. INTRODUCTION

1.1. STUDY

1.1.1. BACKGROUND

The Red Sea Coast is home to a rich and valuable biological diversity of global importance. The Kingdom of Saudi Arabia recognises the value of this biodiversity as a national and international asset and, in collaboration with international conservation NGOs and various international bodies, has undertaken a series of research programmes to determine the exact nature of this natural wealth and the most appropriate means for its conservation.

Over the past few decades, most of the coastal areas of the entire Red Sea region have been undergoing increasing industrial and tourism-related development, which is having an inevitable impact on the marine ecosystems. The one thousand kilometre long stretch of the Red Sea coastline from Jeddah northward to the Jordanian border is characterised by sparse human population and low levels of infrastructure (particularly north of Yanbu'), and the impact of development has been less severe. However this very remoteness has also inhibited research activities, and the true state of this precious coastal and marine habitat is not yet fully understood.

The Study aims to shed more light onto this region by conducting a thorough study of the northern portion of the Red Sea coast of Saudi Arabia. The results of the Study will be utilised to devise a framework for the conservation and sustainable management of this coastal marine environment.

A JICA study team, headed by Dr. Noboru Matsushima of the Japan Wildlife Research Centre, was organised by the Japan International Cooperation Agency (JICA) in 1997. The team has been conducting this study with the National Commission for Wildlife Conservation and Development (NCWCD) of Saudi Arabia, on the basis of the Scope of Work agreed upon and signed by NCWCD and the JICA Preparatory Study Team in Riyadh

on 24 March 1997.

The Study aims to achieve the two objectives stated in the Scope of Work, which are:

1. to conduct a basic inventory survey of the coastal and marine habitats and biota in the northern part of the Red Sea coast, in order to provide basic information regarding conservation and the appropriate management of the natural environment and its biological diversity; and
2. to transfer technologies regarding the survey methods to the Saudi counterpart personnel during the course of the Study.

1.1.2. STUDY FRAME AND OBJECTIVES OF EACH PHASE

The Study consists of the following four phases.

- | | |
|------------|--------------------------------------------|
| Phase I: | Gathering Existing Data |
| Phase II: | Inventory Study of the Entire Study Area |
| Phase III: | Model Area Study |
| Phase IV: | Preparation of Biological Inventory / Maps |

The objectives of Phase I are to accumulate and review references and existing data, to carry out a reconnaissance field survey in the Study Area and to obtain an overview of the entire Study Area.

The objectives of Phase II are to conduct an inventory survey and a socio-economic survey of the Study Area, categorise the habitats, analyse aerial photographs in order to draft a habitat map for the entire Study Area, digitise 1:150,000 maps as the base map for the GIS, and input some of the results of the inventory and socio-economic surveys. This phase is

considered the preparatory stage for Phases III and IV.

Phase III aims to supply basic information on the conservation and appropriate management of the natural environment of representative area in the Study Area and its biological diversity based on collected information and the results of the analysis in Phase II.

In Phase IV, all data collected during Phases I, II and III are analysed and this information presented as GIS database and habitat maps of both the entire Study Area and the Model Area.

In order to achieve successfully the objectives of the Study, the Study Team is divided into the following four groups, each with its own specific role and objectives.

Biological Inventory, covering each aspect of marine and terrestrial ecosystems. The following teams conducted the surveys:

Marine team: coral, seagrasses / algae, fish and benthos

Marine mammals / marine turtles team

Terrestrial team, mangroves / terrestrial vegetation and birds

Social Environment, dealing with social and economic considerations that either influence, or are influenced by the natural resources of the Study Area.

Habitat Map, to compile all biological and socio-economic data into maps.

GIS / Database, to arrange and present the mapped data into a database accessible to a wide range of user organisations and agencies.

1.1.3. PARTICIPANTS

The National Commission for Wildlife Conservation and Development (NCWCD) of Saudi Arabia is the counterpart organisation for the Study and respective personnel from NCWCD have been working with the Study Team as counterparts. Appendix 1 is the list of the participants including the members of the Study Team and their counterparts from NCWCD.

1.1.4. SCHEDULE

In Phase I, the Study Team carried out work in Saudi Arabia on two separate visits: from 22 December 1997 to 2 January 1998 for preparatory work; and from 6 February 1998 to 11 March 1998 to conduct a reconnaissance field survey of the Study Area.

Phase II, Inventory Study of the entire Study Area, was conducted from May 1998 to November 1998, based on the results of Phase I. An inventory survey and socio-economic survey were conducted by the Study Team and the Saudi counterparts in the Study Area. For the habitat map component, in Japan the Study Team categorised all habitats based on the results of Phase I, and in Saudi Arabia analysed and assessed aerial photographs. For the GIS / Database component, all necessary maps were digitised, and hardware and software were installed at NCWCD. Two Saudi counterparts were trained in Japan to obtain the necessary know-how regarding GIS and databases. Some of the data collected by the Biological Inventory Team were input to the database for GIS.

Phase III started at the beginning of February 1999. The first stage of Phase III was conducted in February and March, and the second stage was carried out from May to July. A workshop on Phases II and III was held at NCWCD on 9 February. Field surveys on both biological and socio-economic components were conducted in February and June. For the habitat map component, the Study Team re-organised the legends of the habitat maps of the

Model Area and its surrounding areas. The habitat maps of the entire Study Area were revised using all re-organised legends. Fine adjustment of the maps was done using 1:50,000 marine charts provided by MEPA. For the GIS / Database component, information collected by biological teams was put into the GIS database which had been prepared in Phase II. Training in use of the GIS database, as customised for the Study, was conducted for the Saudi counterparts as part of the technology transfer, to improve their understanding and operation of the system. The digitised 1:50,000 marine charts by MEPA were incorporated into the GIS database.

Phase IV started just after the completion of Phase III. All data collected during Phases I, II and III were analysed and all this information was incorporated into the GIS database. Habitat maps of the entire Study Area and detailed habitat maps of the Model Area were prepared. The draft final report was written based on the results of the surveys and analysis carried out. A seminar on the Study was held on 21 and 22 November in Riyadh to present the results of the Study, i.e., the Biological Inventory, the GIS database and the Habitat Maps.

Table 1. Principal activities in each phase of the Study.

Phase	Schedule	Principal activities
I	December 1997 – March 1998	Gathering Existing Data <ul style="list-style-type: none"> • Preparatory work • Preparation and discussion of the Interim Report • Preparatory arrangements • Formulation of work plan • Rapid biological assessment • Preparatory visit for socio-economic survey • Examination of aerial photographs • Aerial verification • Preparation of GIS • Preparation and submission of Progress Report (1)
II	May 1998 – November 1998	Inventory Study of the Entire Study Area <ul style="list-style-type: none"> • Habitat categories • Inventory survey • Socio-economic survey • Analysis and assessment of aerial photographs • GIS database format • GIS base map and input of data • Preparation and submission of Progress Report (2) • Analysis and assessment of survey data • Draft habitat maps of the entire Study Area • Preparation of the Interim Report
III	February 1999 – June 1999	Model Area Study <ul style="list-style-type: none"> • Submission and discussion of the Interim Report • Workshop on the Model Area Study • Detailed biological study of the Model Area • In-depth socio-economic survey • Preparation and submission of Progress Report (3) • Analysis and assessment of survey data • Drafting of habitat map of the Model Area • Input of data to GIS database
IV	July 1999 – January 2000	Preparation of Biological Inventory / Map <ul style="list-style-type: none"> • Analysis and assessment of survey data • Installation of GIS • Preparation and submission of Progress Report (4) • Finalisation of the biological inventory, the socio-economic data, the habitat maps and the GIS database • Compilation and evaluation of all data • Preparation of the Draft Final Report (DFR) • Presentation and discussion of the DFR • Seminar on the Study • Preparation of the Final Report (FR) • Submission of the FR

1.2. STUDY AREA

1.2.1. STUDY AREA

The Study shall cover the northern part of the Red Sea coast, encompassing approximately 1,000 kilometres (excluding the coastal area of Jeddah city) (Fig. 1). The range of the area to be studied extends from the water's edge out to one kilometre from the shore, and down to a depth of 15 metres.

The actual width of this zone may vary in practice, in order to accommodate certain species whose distribution does not fall exactly within the geographic limits of the Study Area. Islands and their coasts will chiefly be surveyed using aerial photographs and visual observation from aircraft.

1.2.2. GENERAL DESCRIPTION

The following description is based on EDWARDS ed. (1987).

1.2.2.1. Marine Environment

The Red Sea is 1,932 km long and has an average width of 280 km. It is connected to the Mediterranean Sea by the Suez Canal in the north, and to the Indian Ocean at Bab al-Mandab in the south. The Red Sea is a part of the Red Sea and East African Rift System, where the African and the Arabian plates diverge from each other. The effect of the divergence has been to make the sea very deep (2,850 m) and produce high mountains on both sides of the sea.

The Red Sea has dried up several times in its history. In terms of its biological composition, evaporation during the Miocene Period was one of the most important events. In the early Miocene Period, although there was some flow into the Red Sea from the Mediterranean Sea, the sea was almost completely dried up and there existed very little marine life. The land rise at the very end of the Miocene cut off the connection to the

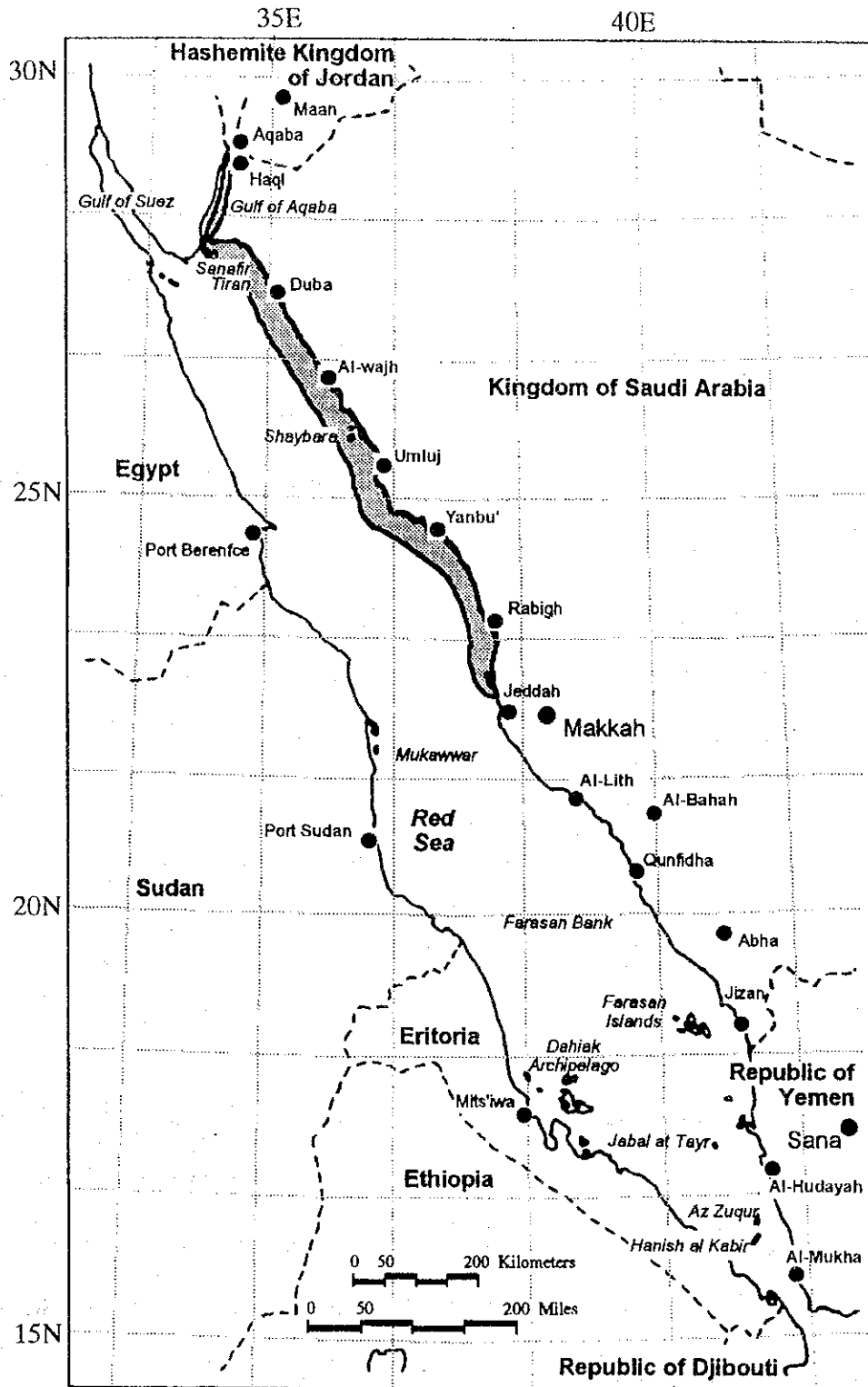


Fig.1. Map of the Red Sea and the Study Area (shaded area).

Mediterranean Sea, and opened up a mouth to the Indian Ocean at Bab al-Mandab, bringing Indo-Pacific marine fauna and flora into the Red Sea. During the Ice Ages, the sea level dropped to about 100m below its present level, which had a tremendous impact on its biological resources. The sea recovered its present level about 5,000 years ago.

A distinctive physical feature of the Red Sea is its high salinity. Global average salinity of seawater is about 35. The salinity of the Red Sea is about 36.5 at the Strait of Bab al-Mandab and increases northwards to about 40.5 at the mouth of the Gulf of Aqaba. At the same latitude, the west side of the sea generally is of a higher salinity. The average water temperature in the Study Area is 21 – 26°C in February, 26 – 30°C in June, and 25 – 30°C in October. The tidal cycle is about 12 hours and the difference between high tide and low is about 0.6m in the north and about 0.9m in the south. The current is very weak offshore, and is dependant on wind along the coastline.

1.2.2.2. Terrestrial Environment

There are two main seasons, according to temperature change: summer (second half of April – first half of October) and winter (second half of October – first half of April). The average monthly high temperature in Yanbu' in June is 42°C and January – February the minimum is 9°C. It is cooler in summer and warmer in winter than in the capital of Riyadh, which is located in the middle of Saudi Arabia where a continental desert climate prevails. Northwest winds prevail in summer and north-east winds prevail in winter. Generally, the wind is weak throughout the year. Humidity is usually rather high at around 75%, and it exceeds 90% in some. Precipitation is extremely low and in most parts of the Study Area there is no rainfall throughout the year.

1.3. ACKNOWLEDGEMENTS

This Study has been conducted in the hope that it will help the Kingdom of Saudi

Arabia to develop the most scientific and effective conservation management programmes for marine protected areas in the Red Sea. More than most studies, this Study is a work of collective effort and enthusiasm.

First of all, our most sincere thanks are due to H.R.H. Prince Saud Al Faisal, the Managing Director of NCWCD, and H.E. Prof. Dr. Abdulaziz H. Abuzinada, for their understanding and support. Mr. Takahisa Kusano, Regional Representative of JICA, is gratefully acknowledged for his kind help and advice. The following deserve special mention for supporting the Study and for supplying information and suggestions: Dr. Iyad A. Nader, Mr. Yusuf Al-Wetaid, Dr. Eugene Joubert, Dr. Friedhelm Krupp, Tarik M. A. A. Al-Abbasi, and Qutaibah Al-Sa'don, NCWCD; Mr. Ahmad H. Badah, Ministry of Petroleum and Mineral Resources; Mr. Shosuke Mohri, JICA Expert; Dr. Shaukat Ali Chaudhary, Ministry of Agriculture and Water; Mr. Mohammed S. Al Yami, Ministry of Defence and Aviation; Mr. Ernst-Detlef Gruebel, and Mr. Joost Strater, Hansa Luftbild German Air Surveys; Mr. Junji Wakui, JICA Office in KSA; Mr. Kazunobu Suzuki, JICA; Mr. Daizaburo Kuroda, Mr. Akitoshi Kawamoto, and Dr. Hiroshi Kidono, JICA Advisory Committee; Dr. J.E.N. Veron, Australian Institute of Marine Science; Dr. C.C. Wallace, Museum of Tropical Queensland; Dr. M. Guillaume, Curator of corals, Museum of Natural History, Paris, France; and Dr. G. De'ath.

The field surveys were accomplished with with the valued assistance of the Coast Guard Stations at Rabigh, Umluj, Al-Wajh, Duba, Maqna and Haql and various field bases. The Saudi Arabian Navy dive rescue team provided valuable safety back-up and use of their zodiac during the February-March 1999 field surveys.

The Study researchers and collaborators deserve a special mention. Their enthusiasm and commitment contributed significantly to the success of the Study.

2. BIOLOGICAL INVENTORY

2.1. BIOLOGICAL INVENTORY OF THE STUDY AREA

2.1.1. INTRODUCTION

Biological inventory surveys in the following fields were conducted throughout the Study Area from May – July and from September – November 1998 (Phase II).

Coral, seagrasses / algae, fish, benthos, marine mammals / marine turtles,
mangroves / coastal vegetation and birds

One of the main objectives of the surveys was to collect as much basic data on each component as much as possible. Each component except for the birds survey collected specimens for the further references.

In this chapter, physical /geomorphological and ecological characteristics of the marine and terrestrial survey sites are described in order to illustrate the environmental features of the Study Area. Temperature loggers were placed in the sea in the Study Area and the findings of the data analysis are also discussed here.

In the following chapters, survey methods and results of each component of Phase II are described, and the Study Area is assessed from the point of view of each component. The assessment will be described mainly from the point of view of species diversity, threatened / endemic species and biomass. Other criteria may be employed for some special components.

The locations of marine team survey sites are shown in Fig.2 and the terrestrial team survey sites are shown in Fig.3.

2.1.1.1. Physical / geomorphological and ecological features of the marine environment

1. General description

The Study Area can be divided into six areas, according to of its physical /

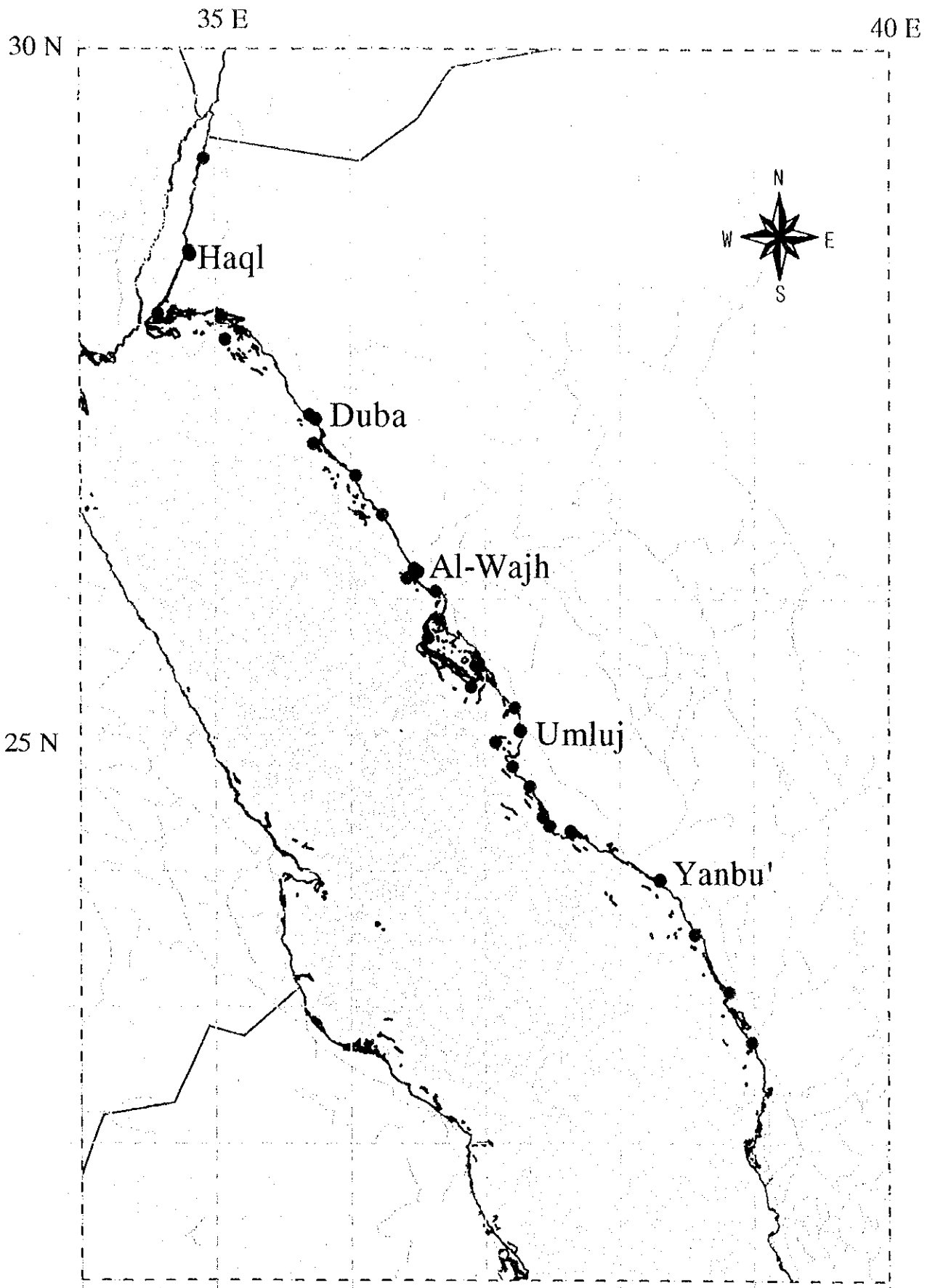


Fig. 2. Locations of the marine survey sites.

100 0 100 200 300 400 500 Kilometers

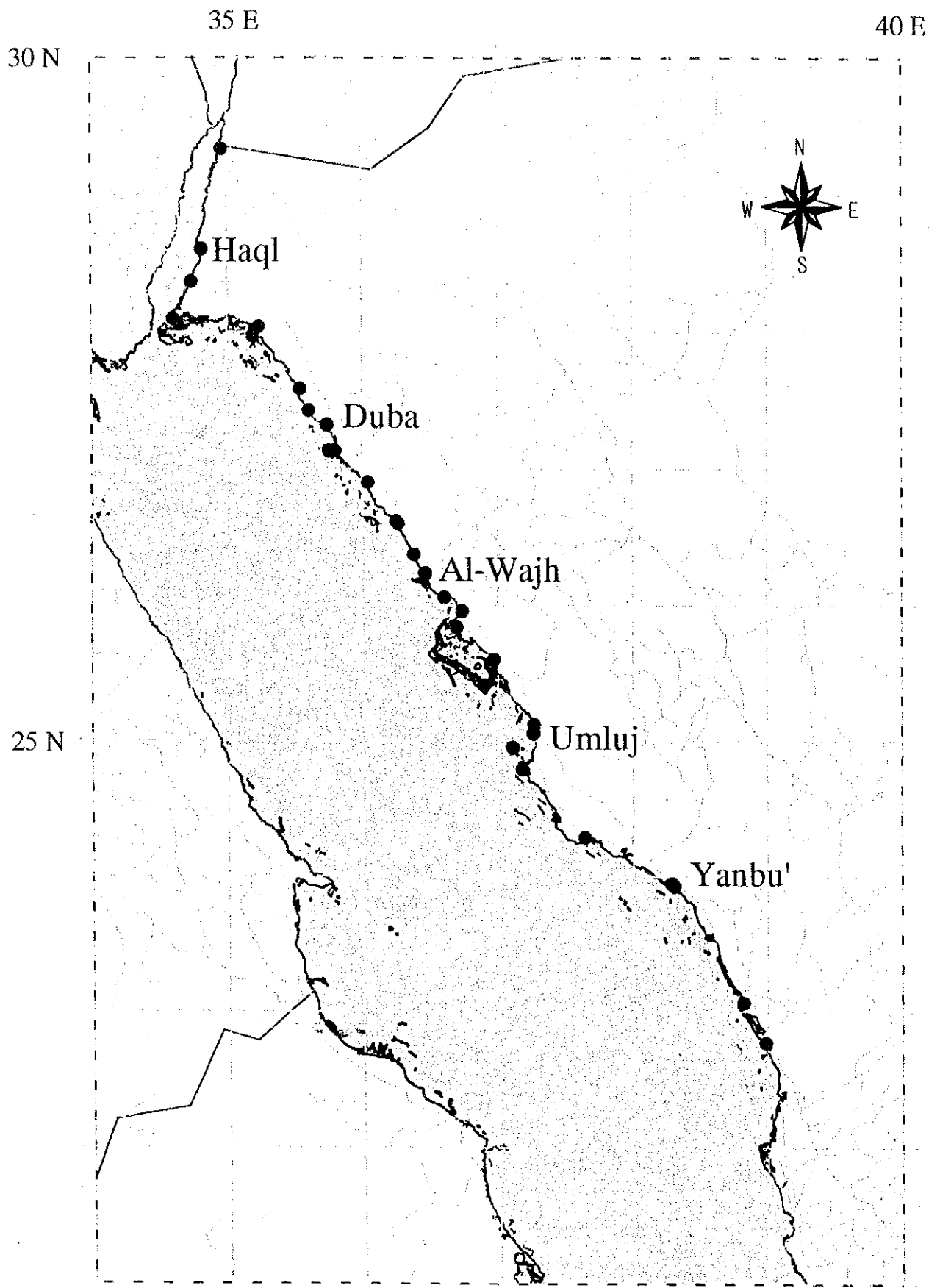


Fig. 3. Locations of the terrestrial sites.



geomorphological features. The features including some ecological characteristics of the six areas from north to south, are delineated as follows:

Gulf of Aqaba

The northern part of the Red Sea has clear water and moderate water temperature compared to the southern part. Up-welling of cold water from the deep bottom is observed at several sites in the Gulf of Aqaba (Site 1,3). Different or less range of coral reef types are observed there. Some coral species are restricted to or absent from the Gulf of Aqaba. The distribution range of turf and small algae is restricted because of the narrow width of flat reefs. Large communities of fishes are sometimes observed.

Tiran

There are many isolated islands in this deep sea, each of which rises steeply from the water. Since this area supports a wide range of reef types, species richness, abundance and coverage of coral is high. This area also has a great biomass of seagrass and benthos.

A large area around Tiran Island was not surveyed in this study because of political restrictions.

Duba / Al-Wajh

A comparatively straight coastline leads to the northernmost point of Al-Wajh Bank. In front of Al-Wajh there is Jazirat Muraykhah, an isolated island in the deep sea with a large lagoon. There are small bays (sharms) providing various types of habitat, each of which has high coral coverage and supports many fish species.

Up-welling of cold water from the deep bottom is observed at Ra's Haramil (Site 10).

Al-Wajh Bank

The area supports the greatest range of reef types and other marine and coastal habitats in the Study Area. The area has a high level of ecological integrity. It also contains many islands and tidal flats. Since these are isolated from severe physical conditions such as

high waves, Al-Wajh Bank is a good area for small fishes. Al-Wajh Bank also has a great biomass of seagrasses, algae and benthos.

Umluj / Yanbu' (Ra's Baridi)

Large groups of patch reefs are located north of Umluj and leading to Jazirat Jabal Hassan. This area has many different habitats, such as Sharm al-Hisay.

Up-welling of cold water from the deep bottom is observed at Ra's al-Luqayq (Site 20).

Yanbu' / Jeddah

This area has less variety in habitat than other areas. Human impact is comparatively high.

Water temperature and turbidity in this area are comparatively high. Sargassum beds are conspicuous. Fewer fish species are observed than in the other areas.

Major coral breaching was observed in this area during this study.

2. Temperature and water level measurement

2-1. Introduction

To gain an understanding of physical phenomena in the Study Area, 15 temperature loggers and four water level recorders were set at several spots. Fig. 4 and Appendix 2 show the locations of the survey spots. At the end of the study period, 12 temperature loggers and all water level recorders were retrieved.

Data from only nine temperature loggers were analysed, and no data from water level recorders were used for analysis. This is because the instruments were damaged.

After recovery of the data, a further eight temperature loggers were set at six spots (eight layers) as shown in Appendix 3 and Fig. 4.

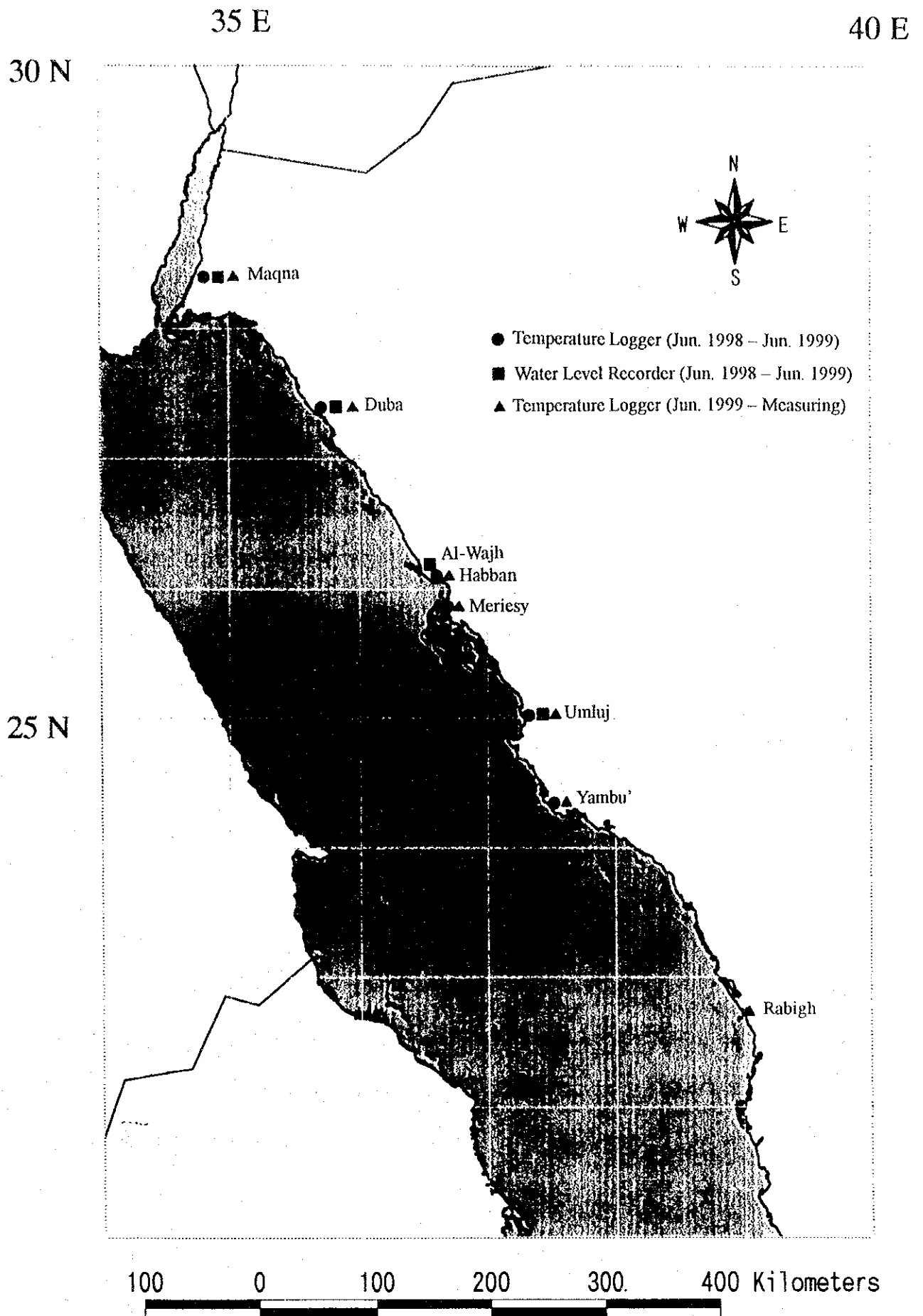


Fig 4. Locations where temperature loggers and / or water level recorders were set up.

2-2. Water temperatures

Loggers measured the temperature every hour for almost one year from 14 June 1998 to 21 June 1999. However, since some of the data, during the period from January 1999 to June 1999 are unstable and doubtful, analysis of water temperature was conducted on the data recorded during the period from 4 July 1998 to 31 December 1998.

Water temperature measurements (Appendix 4, Fig. 5, Fig 6) show that temperatures at each spot were as follows. The spots are listed from north to south.

Maqna :	22.7 - 30.6 °C at 1m depth
	22.6 - 28.8 °C at 10m depth
Duba :	23.9 - 30.6 °C at 11.5m depth
Sharm Habban :	20.5 - 33.8 °C at 0.5m depth
	25.9 - 32.4 °C at 10m depth
Al-Muraysi :	17.1 - 33.8 °C at 1m depth
	15.1 - 32.0 °C at 9m depth
Yanbu' :	20.3 - 36.6°C at 1m depth
	24.6 - 32.1 °C at 9m depth.

EDWARDS (1987) shows that the surface temperature ranges between 20 and 27 °C near the mouth of the Gulf of Aqaba, 23 - 30 °C at latitude 26 °N (Habban) and 24 - 31 °C at latitude 24 °N (Yanbu'). He also mentions that temperatures of 36 -38 °C are very probable in the extensive shallow waters of the lagoons behind the fringing reefs.

Table 2 shows the annual variation in average sea temperatures (°C). (MORCOS 1970) Those values fit well with the results of this study.

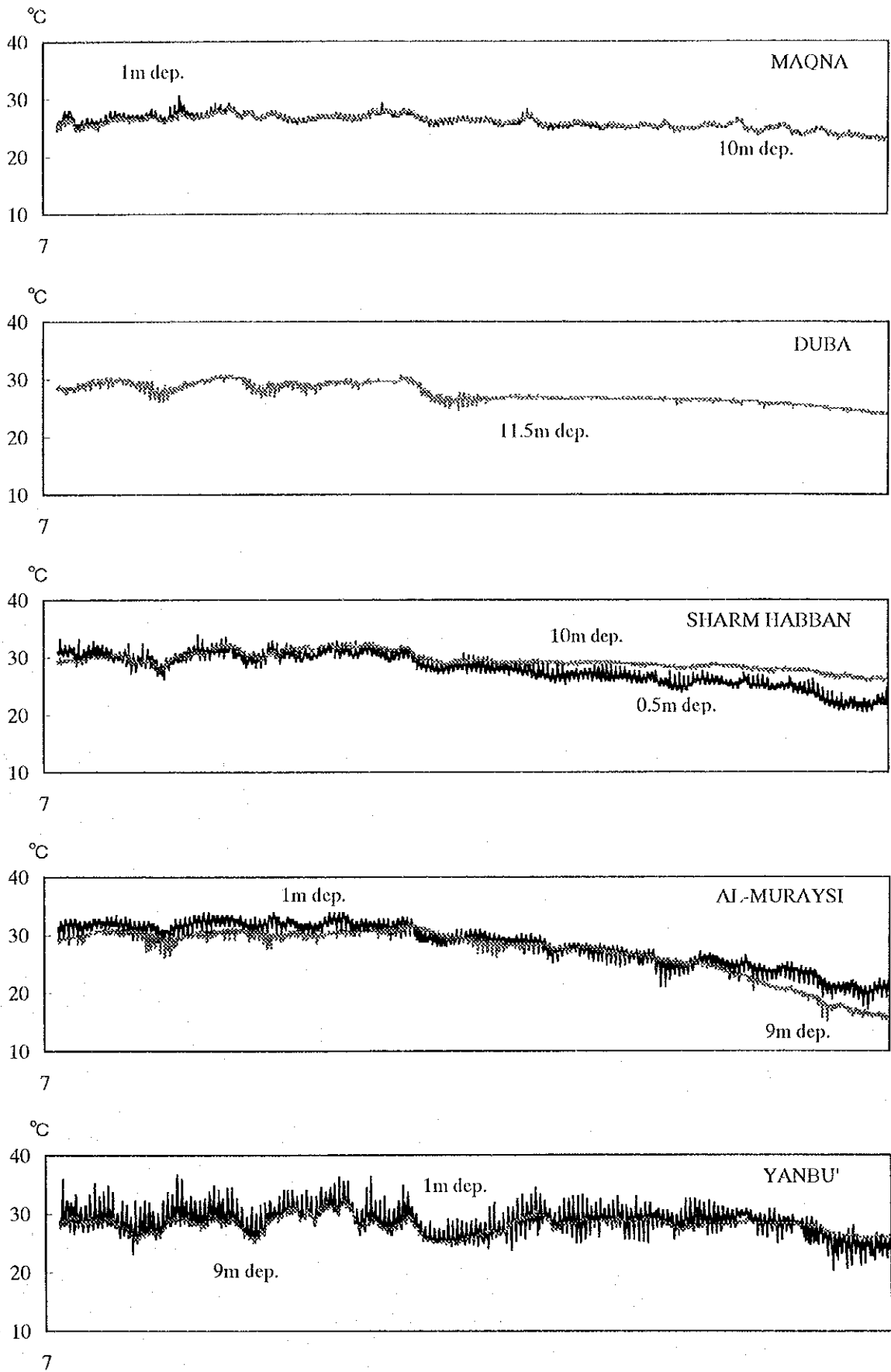


Fig. 5. Longterm fluctuations in water temperature (raw data : July 4 - Dec.31.1998).

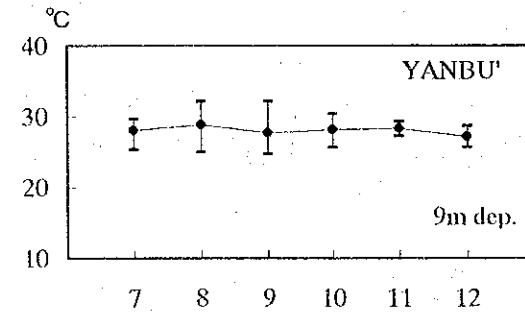
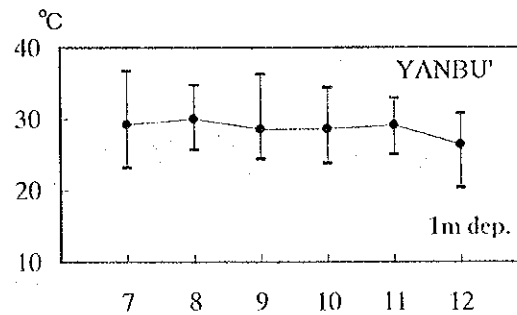
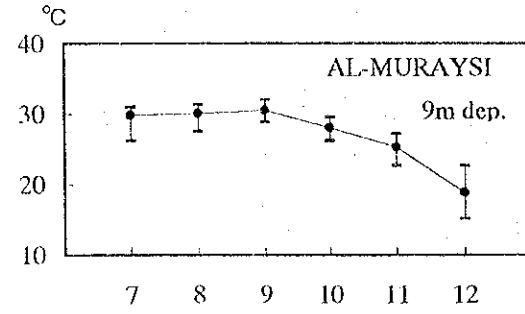
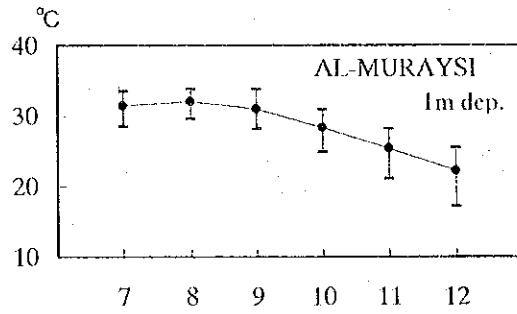
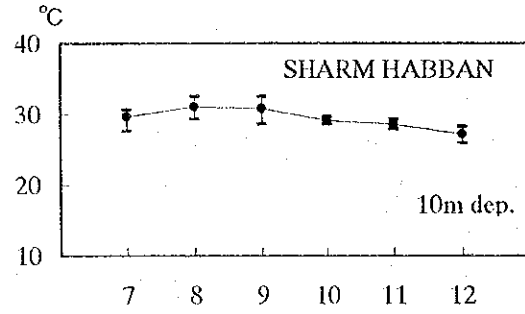
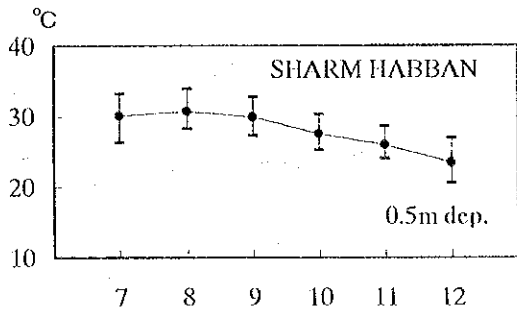
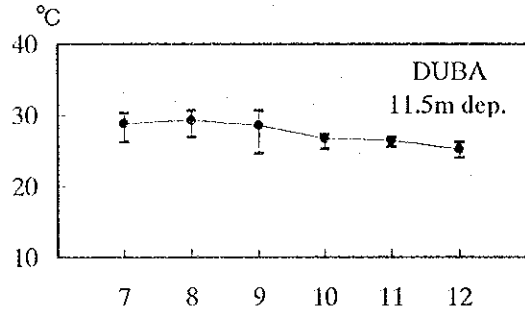
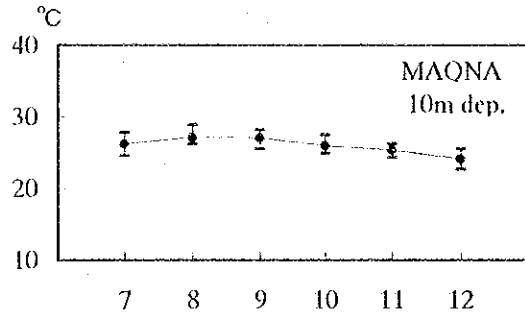
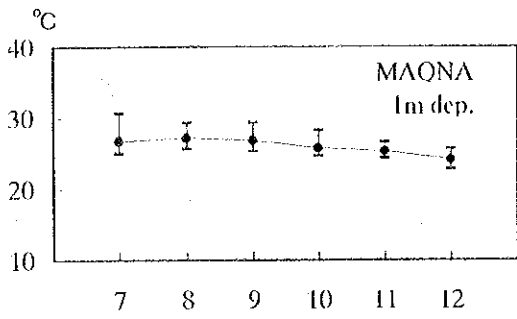


Fig. 6. Fluctuations in monthly mean water temperatures and range of fluctuation (July 4 -Dec.31.1998).

Table 2. Annual variations in average sea temperature (°C) recorded by ships passing through the Gulf of Aqaba and down the Red Sea (unpublished, by G. A. TUNNELL).

Latitude °N	28-30	26-28	24-26	22-24	20-22
Longitude °E	32-34	33-35	34-36	37-39	38-40
January	18.4	21.9	22.7	24.8	25.8
February	17.9**	21.3**	22.3**	24.0**	24.9**
March	18.2	21.7	22.7	24.3	25.3
April	20.0	22.7	23.8	25.3	26.6
May	22.1	24.4	25.6	27.3	28.3
June	23.8	25.4	26.7	27.9	28.8
July	25.2	26.6	27.9	29.4	30.1
August	26.5*	27.9*	29.1*	30.3*	30.9*
September	25.7	26.8	28.3	29.8	30.6
October	24.6	26.2	27.3	29.3	30.3
November	23.1	25.2	25.9	28.1	28.9
December	20.4	23.1	24.1	26.1	27.1
Max.-Min.	8.6	6.6	6.8	6.3	6.9
Annual Mean	22.2	24.4	25.5	27.2	28.1

Notes: * maximum values; ** minimum values

The values are based on observations made from 1855 to 1943 and collected by the British Meteorological Office.

2-3. Water level

As no data on water level was obtained, information on this section is extended from available literature.

Fig. 7 shows a schematic representation of the mean sea level in the Red Sea according to LISITZIN's computations. Mean sea level in the Red Sea decreases continuously from south to north. The difference in the mean sea level between the southern edge of this Study Area (Jeddah) and the northern edge (Gulf of Aqaba) is about 15 cm. (MORCOS 1970)

EDWARDS (1987) notes that the range of the spring tide is about 60cm near the mouth of the Gulf of Suez and about 90cm in the south between the Dahlak Archipelago and Kamaran Island. He also states that the level of the water in the Red Sea is strongly influenced in the long term by the rate of evaporation and the balance between inflowing and outflowing water. The range is from a maximum depression of 20 – 30 cm in August and September, to an elevation of 10 – 20 cm in December and January.

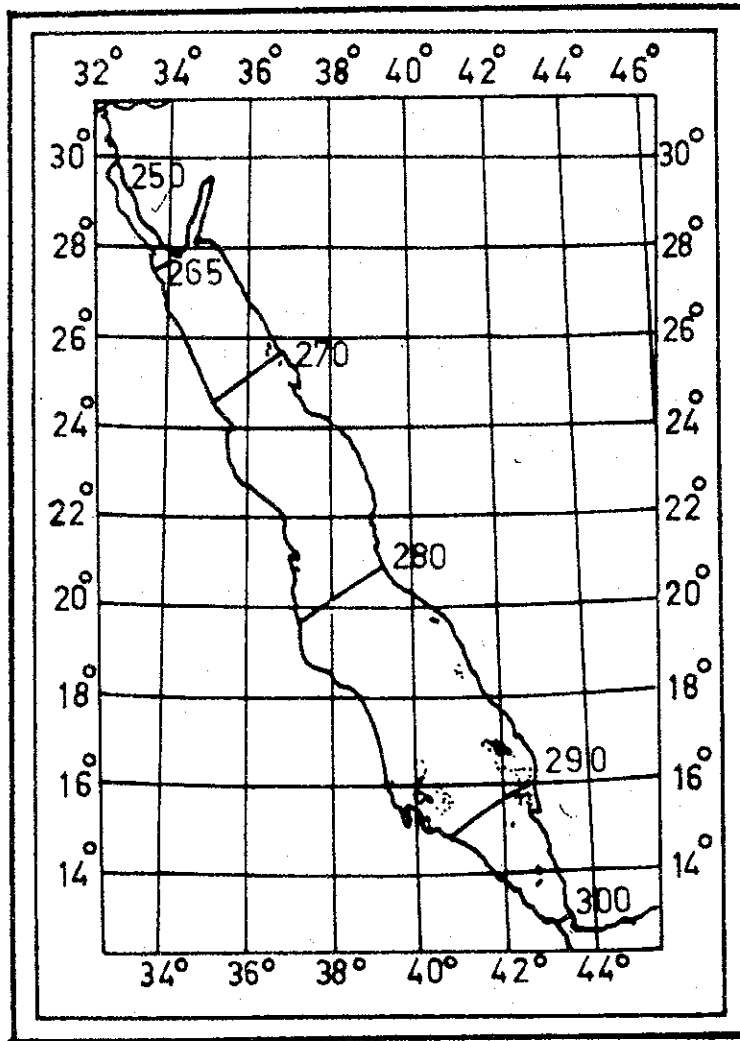


Fig. 7. The mean sea level (cm) in the Red Sea (after LISITZIN 1965).

2-4. Discussion

At all spots and throughout the period of measurement, the minimum temperature was 17.1°C (Al-Muraysi, December) at the upper layer (1m depth) and 15.1°C (Al-Muraysi, December) at the lower layer (9m depth). The maximum temperature was 36.6°C (Yanbu', July) at the upper layer (1m depth) and 32.4°C (Sharm Habban, August and September) at the lower layer (10m depth).

At the upper layer, however, the mean temperature throughout the period of measurement tends to be higher in the north (Maqna) than in the south (Yanbu'). EDWARDS (1987) also points out that the increase in temperature with decreasing latitude is both well marked and fairly regular.

At the lower layer, the mean temperature tends to be higher in the north (Maqna) than in the south to Sharm Habban, with the lowest mean temperature at Al-Muraysi, which is north of Yanbu'. The mean temperature rises again at Yanbu'. The temperature at Al-Muraysi fell during December, which suggests the fall in temperature at Al-Muraysi may be due to upwelling.

In the temperature fluctuations during the month from 1 to 31 August 1998 (Fig. 8), a daily cycle of water temperature fluctuations at the upper layer was observed at all spots, with the daily temperature differences tending to be greater at the southern spots. The difference in the upper layer at Yanbu' was about 7°C in August. Maximum temperature was recorded between 2 and 4 o'clock in the afternoon, and minimum temperature was recorded between 4 and 7 o'clock in the morning. At every spot, daily temperature differences at the lower layer were not marked. (Fig.9).

At both upper and lower layers at Yanbu', as shown in Fig. 8, marked water temperature fluctuations were observed in a cycle of about 15 days, and the temperature tends to be higher at the spring tide on 8 and 22 August and to be lower at the neap tide on 15 and 30

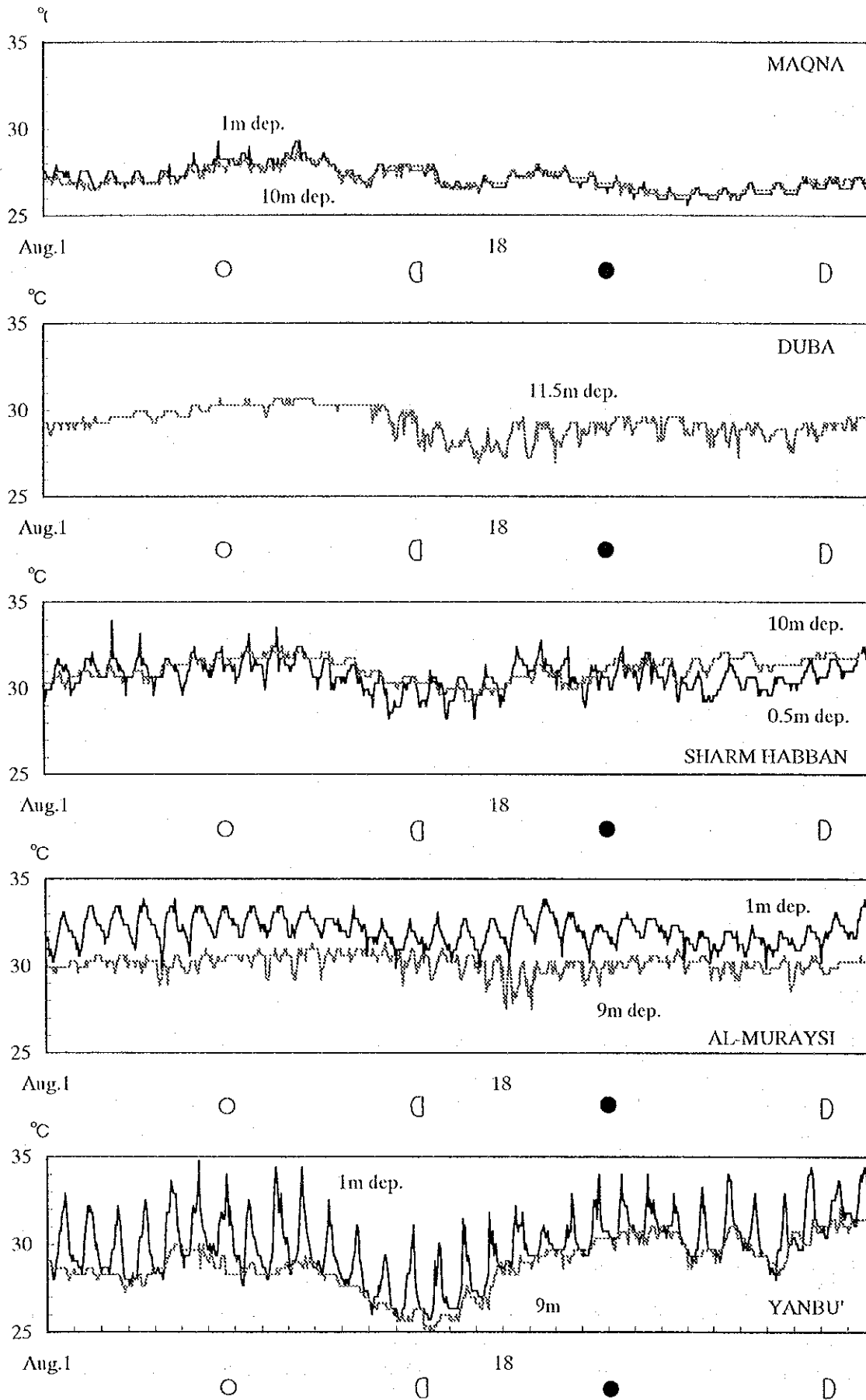


Fig. 8. Daily fluctuations in water temperature over one month (raw data : August 1-31.1998).

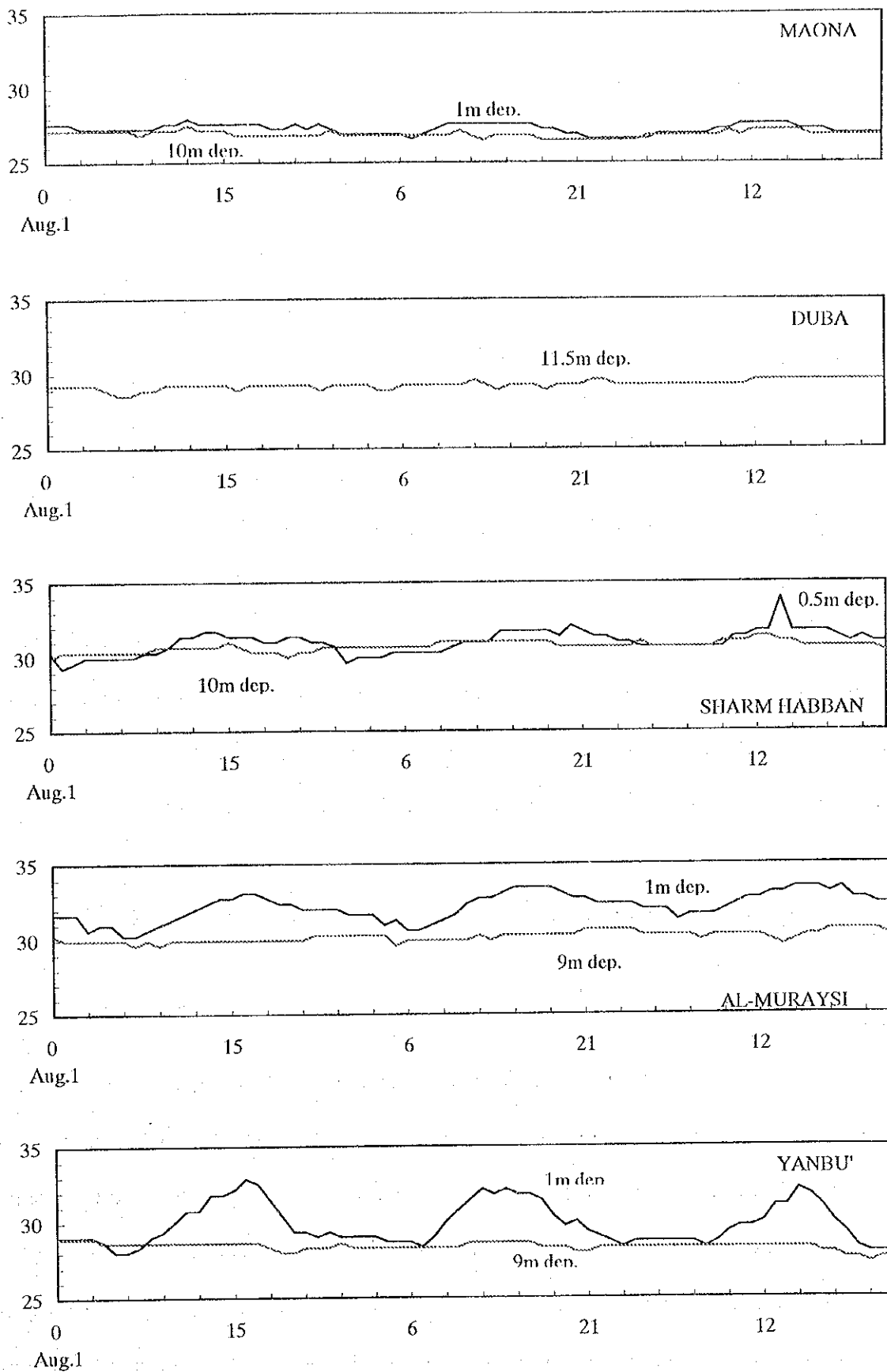


Fig. 9. Time by time fluctuations in water temperature (raw data : August 1-3,1998).

August. This may suggest the marine environment around Yanbu' is influenced by the tide action in the Indian Ocean coming through Bad al-Mandab Strait.

2.1.1.2. Physical / geomorphological and ecological features of the terrestrial environment

The coastal zone of the Study Area is mostly composed of quaternary alluvial sediments, and its soils are mainly sands. The alluvial sandy flats along the seashore are wider in the southern part of the Study Area than in the northern part. The coastal area in the Gulf of Aqaba is occupied by hills and/or mountains of coral fossil rocks. The Study Area can be divided into six areas, on the basis of their physical / geomorphological features. The features of the six areas from north to south are delineated as follows:

Gulf of Aqaba

The coastland of this area facing the Gulf of Aqaba is generally comprised of steep mountainous slopes and pediments of sedimentary rocks and coarse sands forming gentle slopes below the mountainsides. Level coastal plains are so limited that there are few salt marshes or other arid plant communities along the seashore. *Phoenix dactylifera* or *Hyphaene thebaica* assemblages are found on sandy beaches located in the mouths of large wadis. A very small patch of *Nitraria retusa* shrubs also can be seen near the seashore line. There are no mangrove thickets in this area.

Tiran

The littoral zone of this area consists mainly of wadis and gentle foothills, with alluvial sandy flats continuing along the seashore in narrow belts less than 1 km in width. At the mouths of some wide wadis, salt marshes and dry sabkhas are present on alluvial sandy flats. Salt marshes dominated by *Halocnemum strobilaceum* are widespread, especially in Sharma. There are a few inlets at the mouths of small wadis in the area between Al-Muwaylih and Duba. *Avicennia marina* forms a community at the edge of a sheltered inlet with shallow water in Rawd az Zayan, located 8 km north of Duba.

Duba / Al-Wajh

Alluvial sandy flats and gentle slopes stretch along the littoral zone in the northern part of this area, with variation in the width from the seashore to the back-slopes. *Avicennia marina* mangrove thickets and salt marshes dominated by *Halocnemum strobilaceum* and *Arthrocnemum macrostachyum* are found in parts as a narrow belt along the seashore, especially in Al-Quff and Zubaydah. In the southern part of this area, there are sheltered inlets surrounded by fossil coral cliffs (10-30m in elevation). Inlets are usually connected to small wadis, and communities of plants such as *Salvadora persica* shrubs are present on sandy or rocky flats around the inlets.

Al-Wajh / Umluj

Alluvial sandy flats are widespread along the mainland coast in this area. A few salt marsh communities are distributed on the saline sandy flats along the seashore. Wide wadi drainage systems run across the coastal land in some places, where *Tamarix* shrubs and *Acacia* shrubs grow together densely (especially in Wadi al-Hamd).

Al-Wajh Bank has flat off-shore islands of various sizes. The three main islands of Jazirat Umm Rumah, Jazirat Birrim and Jazirat Shaybarah are located in outer barrier reefs, facing the open Red Sea. Jazirat Qumma'an is also a relatively large flat island, located in the middle of Al-Wajh Bank. Almost all of these islands are sandy flats, nearly sea level in elevation, on which *Avicennia marina* thickets, salt marshes and Cyanophyceae are found. Jazirat Jabal Hassan, located about 17 km from Umluj town, is a mountainous island with steep slopes.

Umluj / Yanbu'

Alluvial sandy plains and low hills stretch along the coastal zone in this area. The width of the alluvial fan between foot of the mountains and the seashore is more than 10km. There is little vegetation cover on the plains compared with other regions. However in some

places along the seashore, salt marshes widely cover the sandy flats. On the inland side of the littoral zone, scattered shrubs of *Acacia* sp. grow on the sandy low hills and wadis. *Avicennia marina* grows in certain places with shallow water, but consists mostly of young shrubs.

Yanbu' / Jeddah

The geomorphological features of this area are almost the same as those of the previous area, but tidal flats and lagoons with shallow water are more abundant and extensive in this area. *Avicennia marina* thickets and salt marshes represented by *Halocnemum strobilaceum* are found in these places. There is a conservation area near the desalinization plant in Yanbu'. Masturah, located in the mouth of a wide wadi, is very rich in vegetation. Jeddah is the second biggest city in Saudi Arabia, and residential and industrial areas occupy the city, some of which is reclaimed land.