Geomorphological Nomenclature: Reef Cover and Zonation on the Great Barrier Reef

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Great Barrier Reef Marine Park Authority

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TECHNICAL MEMORANDUM GBRMPA-TM-8

GEOMORPHOLOGICAL NOMENCLATURE: REEF COVER AND ZONATION ON THE GREAT BARRIER REEF

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SUMMARY

A glossary of generally accepted coral reef geomorphological nomenclature has yet to be developed for reef features on the Great Barrier Reef (GBR). A survey of GBR literature for trends in usage of terms describing surface reef covers and zonation allows a proposal for geomorphological nomenclature. Such a nomenclature is needed for the labelling and comparison of Landsat and aerial photograph interpretation maps of coral reefs of the GBR.

The various coral reef geomorphological terms used by scientists in published literature on the GBR are researched. The terms are then assessed for their appropriateness to different scales of mapping until a term is selected for the nomenclature. A full listing of the literature is included.

Illustrations of the coral reef features or zones proposed for the nomenclature are generally not given here, but are listed in Technical Memorandum TM-7, "Reef cover and zonation classification system for use with remotely sensed Great Barrier Reef data". As a secondary reference document, this paper has subsidiary relevance to data collection operations.

This work draws heavily on the research for, and content of, Kuchler's "Geomorphological separability, Landsat MSS and aerial photographic data: Heron Island Reef, Great Barrier Reef, Australia", (1984). Two of the Figures referred to here may be found in Kuchler, 1984.

KEYWORDS: nomenclature, remote sensing, GBR, reef morphology.

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TABLE OF CONTENTS

FIGURES

TABLES

Here is what we're up against when we try to think about a nomenclature for coral reef features of the Great Barrier Reef, Australia:

> "The problem of definition of terms and of statements of theory is like the problem of writing a menu. It is rather easy to say what it is one thinks s/he has eaten, rather more difficult to decide what to order, and most difficult to write the menu before the groceries have been delivered from the market, especially if one orders from a whimsical grocer who seldom delivers what you order. In many cases in science, one cannot know beforehand what will be found out, or even what will be interesting at a better informed tomorrow."
>
> **Crovitz, 1970.**

1. INTRODUCTION

The rapid growth in coral reef science and the great increase in the number of known geomorphological reef features have given rise to difficulties in terminology, especially when a standard terminology is required. By about 1978, it had become evident that the nomenclature of coral reefs, in the absence of any guidance, was becoming uncontrolled. Individual workers were naming reef features, while in many instances the same features were becoming known by several other names. Conversely there are instances in which the same name is given to different features.

Many of the names conveyed little or no suggestion of the nature of the features identified, and similar names were sometimes given to features of quite a different type. To alleviate this situation, various attempts to bring order into the general nomenclature of coral reef features were made by individuals or groups of specialists. Of the resulting nomenclatures however, none have met with general approval.

Consequently, a generally accepted and field tested geomorphological nomenclature has yet to be developed for coral reef features on the Great Barrier Reef (GBR). Interpreters of aerial photography and field surveyors from varied disciplines have produced a diversity of GBR maps, but no standardised nomenclature has been developed for their labelling and comparison. Communication has been hindered between GBR scientists themselves and with other scientists. This became clearly evident in a pilot study to determine how well a reef scientist could label classes mapped on a satellite reef image. The problem is well illustrated in the following survey on the definition of micro-atolls:

> "Early descriptions of microatoll were given by Darwin (1842), Dana (1872), Semper (1880, 1899) and Guppy (1886), using general names such as coral head and coral block. Guppy (1886) spoke of 'miniature atolls', Agassiz (1895) of 'diminutive atolls' and Krempf (1927) of 'dwarf atolls' .... The term microatoll was first used by Krempf (1927) but without concise definition. It was widely adopted and variously defined. Kuenen (1933) used it for 'a colony of corals' with 'a raised rim, more or less completely surrounding a lower, dead surface'. MacNeil (1954) used it for 'massive colonial corals growing peripherally in shallow areas and whose dead

> upper surface ... is exposed at low tide'.... Newell and Rigby (1957), Kornicker and Boyd (1962) and Garrett et al. (1971) have adopted the term, inconsistent with early usage, to refer to patch reefs consisting of many corals which develop a structure having a raised growing rim and a low, commonly dead or sand-filled centre. Scheer (1972) suggests ... mini-atoll ... for such patch reefs. The term 'faro' is in common use for large ring-shaped patch reefs at atoll margins."
>
> Scoffin and Stoddart, 1978.

A standardised nomenclature for surface covers and geomorphic zones on reefs of the GBR is immediately required for a major reef study, the Barrier Reef Inventory and ANalysis (BRIAN) project (Jupp et al., 1981a; Kuchler, 1984).

BRIAN is evaluating the cost-effectiveness of Landsat Satellite Multispectral Scanner (MSS) and aerial photographic data for detecting and monitoring geomorphological reef features and zones on the GBR. The delineation and definition of such features is a prime need of the project, since interpreted features within the remotely sensed data and mapped features on the ground have to be consistently labelled to allow cross-comparison. Stoddart (1969) also believes standardised procedures are needed 'to ensure comparability of all reef studies and the identification of variations in reefs both on local and regional scales.... and through time' (Longman, 1981). Similarly, Radke (1983) adds: 'Without standardisation of terms there is little scope for meaningful comparative analysis of reefs beyond that of the nomenclature itself'.

A nomenclature which standardises terms for surface covers and zonation on Great Barrier reefs is proposed and presented here.

Since field verification for this nomenclature is still unavailable and was not achievable within the time constraints of the BRIAN project, it has been based on an analysis of the frequency of reef term usage by publishing scientists.

This paper was designed as a secondary reference document to the accompanying Technical Memorandum "Reef cover and zonation classification system for use with remotely sensed Great Barrier Reef data", and therefore has subsidiary relevance to data classification (interpretation, mapping, and field data collection) from the GBR.

The accompanying memorandum demonstrates a classification system for reef covers and zonation and for use with remotely sensed and ground data (Kuchler, 1986) and utilises the nomenclature developed here. The classification system facilitates rapid and accurate identification, labelling and determination of the significance of reef features by field data collectors and image interpreters. Acceptance of the nomenclature and adoption of the classification system would allow a clearer and more efficient communication between scientists working on the GBR. In addition, the discussion of geomorphological nomenclature and the tabulation of its usage is now available from an historical viewpoint and for indicating present trends in usage.

2. PREVIOUS WORK

Descriptive zonation schemes have been devised for the GBR and for other reef systems of the world. Following work on atolls in the Marshall Islands, Ladd (1950), Wells (1957) and Tracey et al. (1948), developed descriptive zonation schemes for reef study. Similarly, Picard (1967) generated a general scheme of classification based mainly on work at Tuléar. For the GBR, a major advance in knowledge on geomorphological zonation was Maxwell's reef framework of 1968 (Maxwell, 1968). Maxwell attempted to cover all types of reefs. Consequently the categorisation level is too general for the needs of the BRIAN project and other detailed studies by GBR scientists today. Weick (1979) explains, 'if you try to secure any two of the virtues of generality, accuracy and simplicity, you automatically sacrifice the third one'.

A survey of the literature indicates that an ineffective communication exists between scientists since geomorphological zones and coral reef features are labelled inconsistently. For example, a dissensus on terms and a false consensus on meaning is evident in the use of the term 'reef block'. In 1814, Flinders used the terms 'negro head' and 'niggerhead' to label a feature which is currently labelled 'reef block'. By 1930, Spender had observed an inconsistency in its use: 'It is used to describe isolated rounded living coral colonies as well as reef top features' (Spender, 1930). Today, multiple labels for this 'reef top feature' or 'reef block' are still evident (for example, 'coral heads', 'bommies'). Flood and Scoffin in a 1978 publication state 'each boulder is normally one massive coral colony which formerly grew on the leeward flanks of the reef in shallow water as coral heads or 'bommies'' (Flood and Scoffin, 1978).

The survey also showed a difference between actual and perceived agreements on coral reef term usage. An example is given in a statement by Stoddart, McLean and Hopley (1978): 'Some of these old shingle ridges are misleadingly called dunes in the older literature'.

Actual and perceived agreements receive further detailed comment in Kuchler's Phd thesis, "Geomorphological separability, Landsat MSS and aerial photographic data: Heron Island Reef, Great Barrier Reef, Australia", (1984).

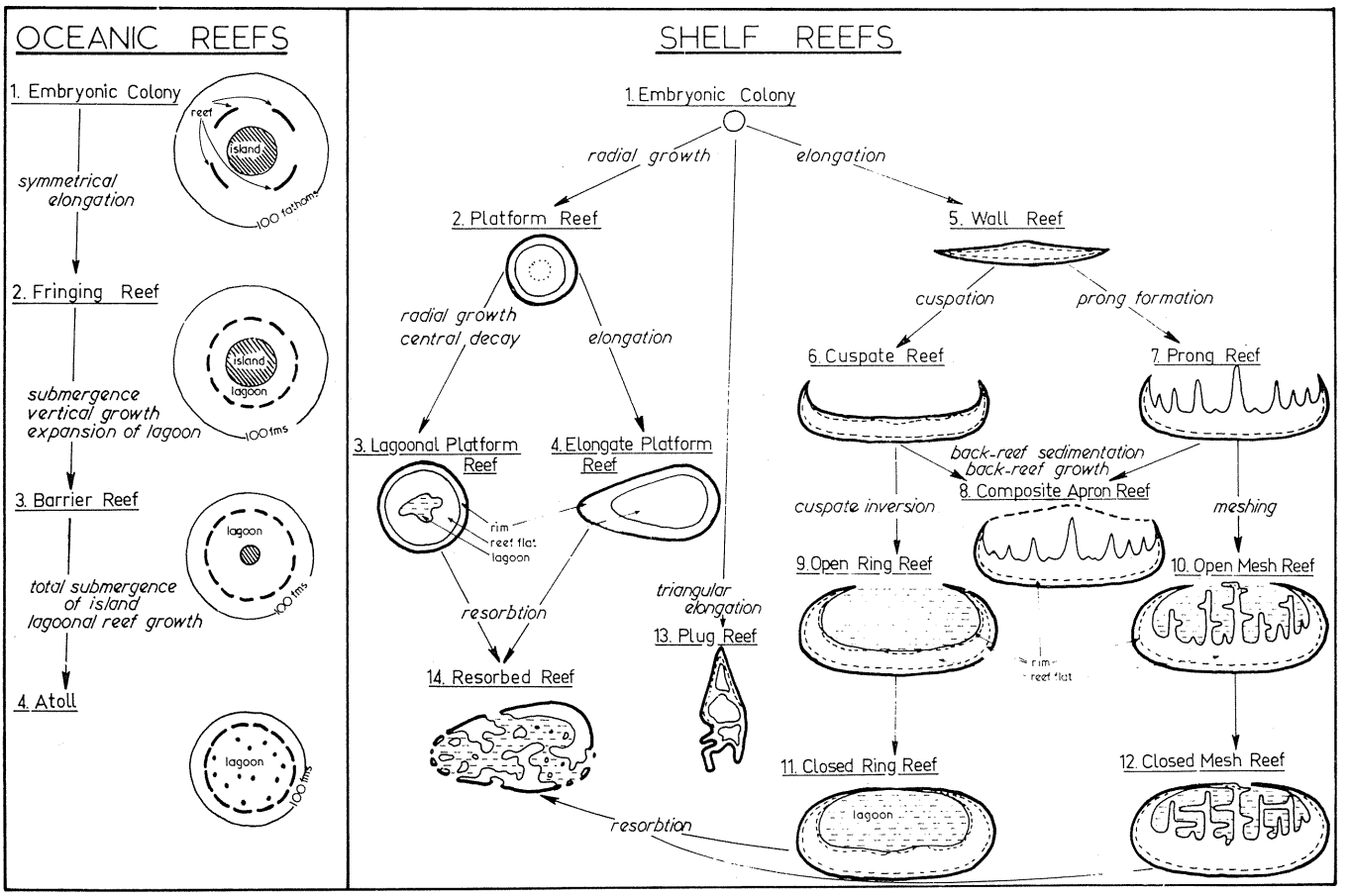
In relation to reef zonation, Taylor argues that 'diversity of life on coral reefs has tended to obscure the relations to a universal zonation scheme and make the analysis of various zonal communities more complex' (Taylor, 1968). This paper argues that it is possible to define zones using geomorphological properties of coral reefs, but that the nomenclature needs to be standardised, accepted and adopted by scientists to allow for the comparison and analysis of reefs.

All literature used in the formulation of the nomenclature proposed here is recorded in the references of this volume.

3. METHOD

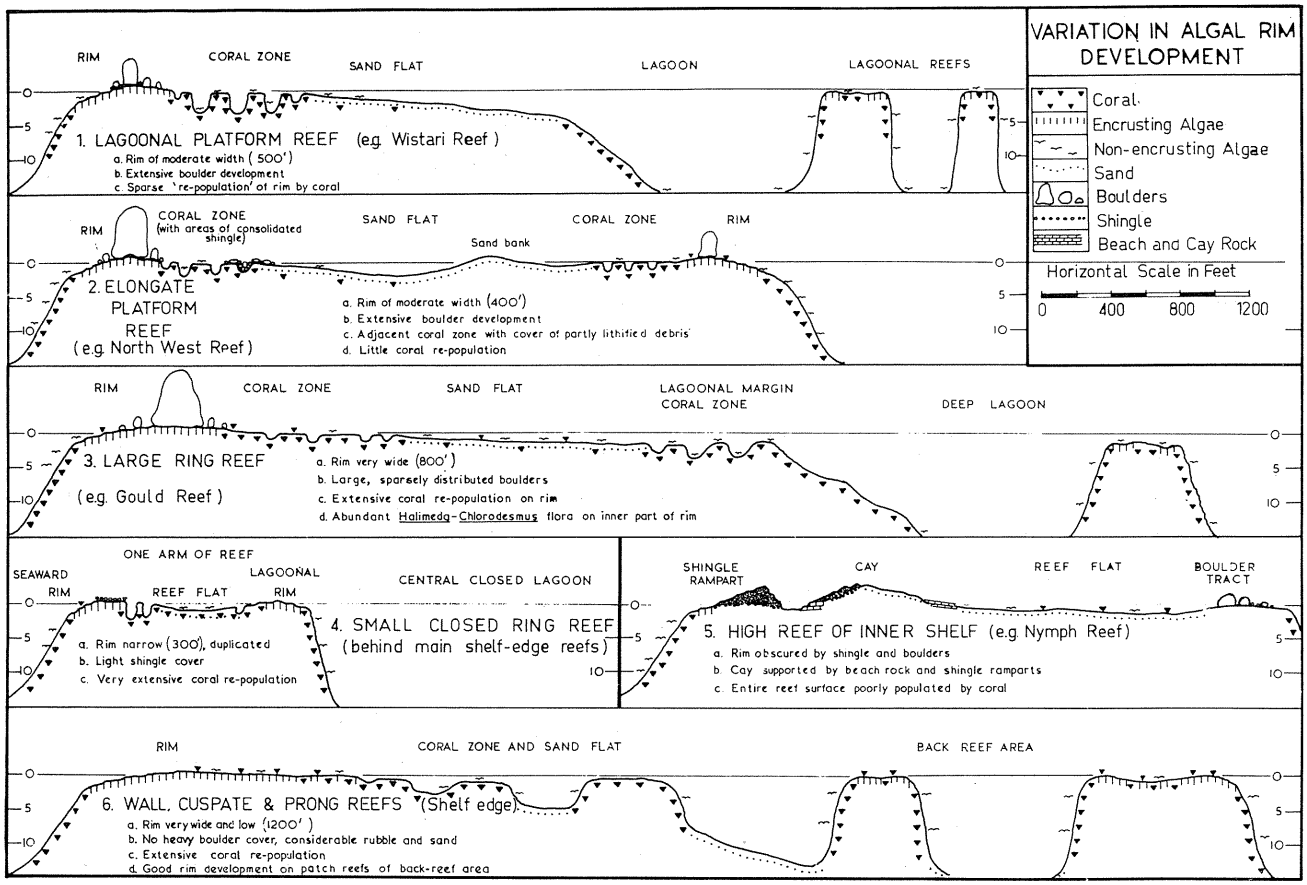
In devising a standard terminology of reef features, whether it be for reefs on the GBR or for all reefs in the world, there are two problems. The first is the range and complexity of reef phenomena. The GBR extends for approximately 1 600 km along the Australian coastline, is located in 215 000 km^2 of ocean and comprises more than 2 000 individual reefs (Done, 1982). Since these reefs are highly variable, a classification based on reef types for example, would have to consider the numerous variations in orientation, type, structure, morphology, zonation, composition and reef development. Such a classification for the GBR was attempted by Maxwell in 1968 and is reproduced here as Figure 1.

Figure 1. A classification of reefs (reproduced with permission from Maxwell, 1968).



The second problem relates to non-documentation of the similarities and differences which are found within and between reef phenomena on the GBR and other reefs of the world (Hopley, 1982; Longman, 1981; Hill, 1974). A rare example of such documentation, for the GBR only, is given in Maxwell (1968) where the variation in development of an 'algal rim' on different reef types is compared in Figure 2 below.

Figure 2. Variation in the development of the algal rim on different reef types (reproduced with permission from Maxwell, 1968).



'A terminology for reef phenomena' is, in effect, a taxonomy of reef forms. Yet there is insufficient published field data available on the GBR to categorise and assess the degree of applicability of such a taxonomy. So, rather than try to derive terms from 'the imperfect and perhaps biased existing field knowledge on reefs' (Stoddart, 1978a, 1978b), the frequency of reef term usage in the GBR literature was analysed and used to develop the nomenclature presented here.

An appropriateness of choice of coral reef identities for the GBR situation is based on a census among publishing scientists. The technique is a variant of 'content analysis' developed by historians and widely used by social scientists. However, the overall lack of definitions, descriptions, sketches or photographs of the reef features which are specifically labelled by publishing scientists does not allow a detailed examination and comparison of definitions of similar reef phenomena or similar nomenclatures. In fact, a survey of the literature indicates that terms are often used interchangeably, are misleadingly employed, or are not defined.

In a Great Barrier Reef Committee publication for example, the labels 'outer reef flat' or 'coral-algal' or 'living coral subzone' were used interchangeably, as were 'reef rock rim' and 'reef rim' (GBR Committee, 1978). Similarly, a publication by the GBR Committee (1978) describes 'Wilson Island as a mixed shingle/sand cay' and 'Lady Musgrave as a sand and shingle cay'. The terms 'island' and 'cay' are used interchangeably and yet other authors (Flood, 1978; Veron, 1978d) have used 'island' to indicate a continental island and 'cay' to indicate the accumulation of reef sediments (sand cay, shingle cay). The term 'breastwork' is used but not defined in the literature (Stoddart, McLean, Scoffin, Gibbs, 1978), and the difference between the use of the terms 'breastwork', 'ridges', and 'ramparts' is unclear.

This attempt to standardise GBR terminology is heavily based on Kuchler's 1984 PhD. thesis, in which may be found the detailed analysis of the usage trends upon which this nomenclature is based. The analysis is not reproduced here because of space restrictions, the two tables combined representing in excess of 100 pages.

The author recognises that a superior nomenclature would be derived from a priori knowledge and from an assessment of the application of each term to the GBR. The literature to date, however, is insufficient to allow the creation of a taxonomy based on field verification.

Furthermore, knowledge of conditions on the whole GBR is still incomplete. Since the immediate labelling and mapping requirements for satellite, aerial photographic and ground data need to be met, this study produces from circulated GBR literature a list of terms used (Table 1) while the trends in their usage for geomorphological reef zones and features are available in Kuchler, 1984 (Volume 2).

The coral reef terms having the highest frequency of use are taken as being the most generally accepted among scientists. However, these were not always strictly used in the proposed nomenclature. In step one, the term in each entry in Kuchler (1984, Volume 2, Figure 4) with the highest frequency of use was identified. Then, in step two, this term was evaluated for its appropriateness to a semi-hierarchically conceived classification system and its application to the different levels of mapping detail possible for the GBR.

The nomenclature was developed to contribute towards achieving the aim of constructing a classification system for use with remotely sensed data. A term which fulfilled both steps one and two, that is, which had both the highest frequency of use and fulfilled the conditions of appropriateness, was included in the nomenclature. For example, the term 'moat' has the highest frequency of use and is appropriate for different levels of mapping detail. However, in cases where a term had the highest frequency of use (passes step one) but was not appropriate for the classification situation (not suitable in step two), the term with the next highest frequency of use was then identified and tested against step two.

This process continued until an appropriate term was included in the nomenclature. For example, the term 'sand cay' is the most frequently used in the literature but the term 'cay' having the second highest frequency of used was selected for the standard nomenclature (Table 1) because 'cay' is a general term which may be used also to describe shingle cays and vegetated cays. The term 'sand cay' is too specific.

Table 1. Terms used in the literature to describe geomorphological reef cover and zonation on the Great Barrier Reef.

1.0 drop off
REEF FRONT
leeward margin
windward margin
REEF SLOPE
reef wall
outer rampart face
leeward/windward face
outer face
reef front slope
fore reef slopes
hard line reef front
seaward platform
windward platform
windward front
lee side detrital slope
leeward reef slope
windward reef slope
outer slope
windward slope
outer reef slope
marginal slope

2.0 reef edge
reef crest
REEF RIM
reef rock rim
reef rock margin
windward edge
leeward edge
reef/the perimeter
hard line margin
outer reef crest
open water reef crest
platform summit
leeward margin
reef margin
rim margin
rubble crest
hard line perimeter
crest
rim
frontal rim

3.0 **OUTER REEF FLAT**
shallow reef flat
dying reef flat
dead coral reef flat
rubble reef flat
windward reef flat
leeward reef flat
reef platform
middle reef flat
algal flat
REEF TOP
planar reef top
INNER REEF FLAT
sand subzone
REEF FLAT
the flat
leeward flat
inshore reef flat
sanded reef flat
reef flat corals
coral reef flat
coral flat
sandy reef flat
live coral reef flat

4.0 LAGOON

5.0 mangrove shingle
rampart-platform island
mangrove-shingle island
continental islands
compound islands
high islands
continental high island
mangrove-shingle cay
mangrove islets
coral cay
SAND CAY
CAY
un/vegetated cay
leeward sand cay
intertidal sand body
ISLAND
coral sand cay
sand-shingle cay
mixed shingle-sand cay
rubble cay
shingle island

6.0 back-reef apron
foul ground
BACK REEF (ZONE)
patch reefs of back reef area
reef back
back-reef banks
back-reef margin
back-reef slope

7.0 back channels
DELTAIC PATTERN
dissected reefs
deltaic system
deltaic reefs

8.0 OFF-REEF FLOOR
leeward off-reef floor

9.0 BLUE HOLES

10.0 sand flat
blanket sands
SAND ZONE
SAND PATCHES
sand blanket
sand sheet

11.0 **BASSETT EDGES**
foreset beds
BREASTWORK

12.0 SWALES

13.0 SAND CHUTE
CHUTE

14.0 ROCK SLOPE
scree slope
REEF ROCK SLOPE

15.0 SPUR AND GROOVE
groove and buttress
saw-tooth area
buttress and channel
buttresses and valley
surge channels
reef front grooves
spurs/ridges
outer reef buttresses
buttress zone
reef buttress zone
prong and buttress formation in back reef zone

16.0 submarine moat
MOAT
submarine trough
trough
marginal surface
CHANNEL
subsurface channel
reef flat moat
trench

17.0 GULCHES

18.0 MICROATOLLS

19.0 SEDIMENT WEDGE
sand wedge

20.0 trickle zone
ALIGNED CORAL ZONE
radial zone

Table 1. Continued.

21.0 living coal subzone
coral-algal subzone
zone of living coral
coral-sand subzone
OUTER LIVING CORAL ZONE
live coral zone
non-aligned coral zone
DEAD CORAL ZONE
CORAL POOLS

22.0 sea-grass reef flat
SEAGRASS BEDS
Thalassia grass
marine grass
seagrasses

23.0 SHALLOW LAGOON
MEDIUM LAGOON

24.0 blue lagoon
DEEP LAGOON
second lagoon
third lagoon

25.0 back-reef apron
in lagoon
lagoonal sediments
sandy lagoon
LAGOON FLOOR
lagoonal apron
reef rim apron
ring-reef apron
open lagoon
leeward LAGOON WALLS
lagoonal margin

26.0 lagoonal coral heads
lagoon corals
PATCH REEFS
coral colonies
lagoonal reefs
isolated/DISPERSED
lagoonal reefs
RETICULATE lagoonal
reefs
isolated/REMNANT
lagoonal reefs
LAGOON CORAL
PATCHES
lagoonal patch reef
reef studded lagoon
deep mesh - reef lagoon

27.0 woodland vegetation
VEGETATION
herbaceous vegetation

28.0 coral beach
BEACH
cay beach
sand beach

29.0 SAND SPIT
littoral spit
SPIT

30.0 BEACH ROCK
cay rock
REEF ROCK
BOULDER-ROCK
RAMPART-ROCK
PHOSPHATE ROCK
boulder-tract-rock
island-rock
conglomerate rock
rampart/rock platform
rock slabs

31.0 CORAL/SHINGLE RIDGE
rubble banks
boulder bank
reef bank
boulder zone
PLATFORM/PROMENADE
CORAL/SHINGLE RAMPART
mangrove rampart
RAMPARTS
rampart conglomerate
rampart system
beach ridge
ridges
rim deposits
coral shingle mounds
submarine ridges

32.0 coral rubble
shingle rubble
boulder rubble
coral gravel
rubble zone
CORAL RUBBLE ZONE

33.0 mangrove scrub
mangrove park
MANGROVES
MANGROVE SWAMP
mangrove vegetation
Rhizophora swamp

34.0 REEF FLANKS
flanks
leeward flanks

35.0 sand slope
algal slope

36.0 TERRACES
algal terraces
submarine terrace

37.0 REEFAL SHOALS
SHOALS

38.0 niggerheads
reef blocks
negro heads
megablock
CORAL HEADS
bommies/bombies
boulders
blocks
coral boulders

39.0 ALGAL ridge
Lithothammon ridge
algal pavement
algal ramp
algal zone
algal platform

40.0 Lithothammon rim
ALGAL RIM
coralgal rim
corraline algal rim
corraline algal zone

41.0 depressed central
strip

Entries in UNDERLINED CAPITALS are those most frequently used.
Entries in BOLDED CAPTIALS are those chosen for the nomenclature.
Entries in UNDERLINED BOLDED CAPITALS are both the most frequently used, and chosen for the nomenclature.

4. RESULTS

The literature reviewed covers a period from 1814 to 1983, totals over 240 entries, and consists of published journal articles (Flinders, 1814; Done, 1982); proceedings from workshops and conferences (Wolanski, 1981); circulated notes (Beach Protection Authority, 1978); scientific reports (GBR Expedition, 1930); monographs (Hopley, 1982); abstracts (Done, Kenchington and Zell, 1981) and monograph series (Veron and Pichon, 1976). A list of the various terms used by scientists to label geomorphological zones and reef cover features is given in Table 1. The trends in the usage of terms and the contexts in which they are used in the literature are available in Kuchler (1984), Volume 2, Figures 4 and 5.

For the remainder of this paper, these two figures drawn from "Geomorphological separability, Landsat MSS and aerial photographic data: Heron Island Reef, Great Barrier Reef, Australia, Volume 2" will be referred to as Figure 4 "Frequency of use: coral reef geomorphological terms, reef cover and zonation, Great Barrier Reef, Australia", and Figure 5 "Context of use for geomorphological nomenclature: reef cover and zonation, Great Barrier Reef, Australia".

In Table 1, the terms used in the literature are summarised for easy reference; the terms chosen for the nomenclature are designated by bolding and upper case lettering; and, the most frequently used terms are designated by underlining and upper case lettering.

Figure 4 shows the frequency of reef term usage. On the left side, the various reef terms used are given; and at the bottom, the author(s) who used the terms are listed. Usage of a term is indicated by the entry of the last two digits in the year of publication (for example; 78) being given at the junction of the term (for example; coral head) and the author(s) who used it (for example; Flood and Scoffin). The number of publication dates entered against a term are totalled on the right side of the table to give the total frequency of use by scientists in over 2340 GBR literature circulations (for example, the frequency of use of the term 'coral head' is 15).

Figure 5 contains the contexts in which reef terms were used in the literature, with a comment on their variability by the author. Figure 5 was designed to allow easy access by the user, and therefore each reef term is presented on a separate page and as a centered heading in bold type. Definitions and descriptions extracted directly from the literature are presented under a 'Context of Use: Literature' title and the authors' comment is easily identified by its indented form.

For each term given in Figure 5, two types of information are supplied. Firstly, the contexts in which a term was used in the literature are directly quoted and presented together with the authors names and dates of publications for bibliographic reference. For example, for REEF SLOPE, the first entry in Figure 5, Maxwell's description is given:

CONTEXT OF USE: LITERATURE

Maxwell 1968 The reef front is the reef's growing edge, best developed along the windward side and resting on a terrace.

The number of authors definitions or descriptions given in Figure 5 may be lower than the frequency of use of a term as shown in Figure 4. This is because many scientists use a reef term without defining, describing or diagrammatically referring to it. Consequently, descriptive support is occasionally given to a term by reef scientists' publications on other reefs of the world, if the zone or feature is common to all reefs. Also, if the meaning of a term could not be inferred from its context of use then it may not be included in Figure 5. For example, the difference between 'the back-reef apron' and the 'foul ground' is not evident in Hill (1974): 'The back-reef apron and foul ground that falls away to the leeward off-reef floor'.

The second type of information given in Figure 5 is a comment by the author on the variability of usage, and a definition for the term. Using the same example, for REEF SLOPE the comment is:

COMMENT

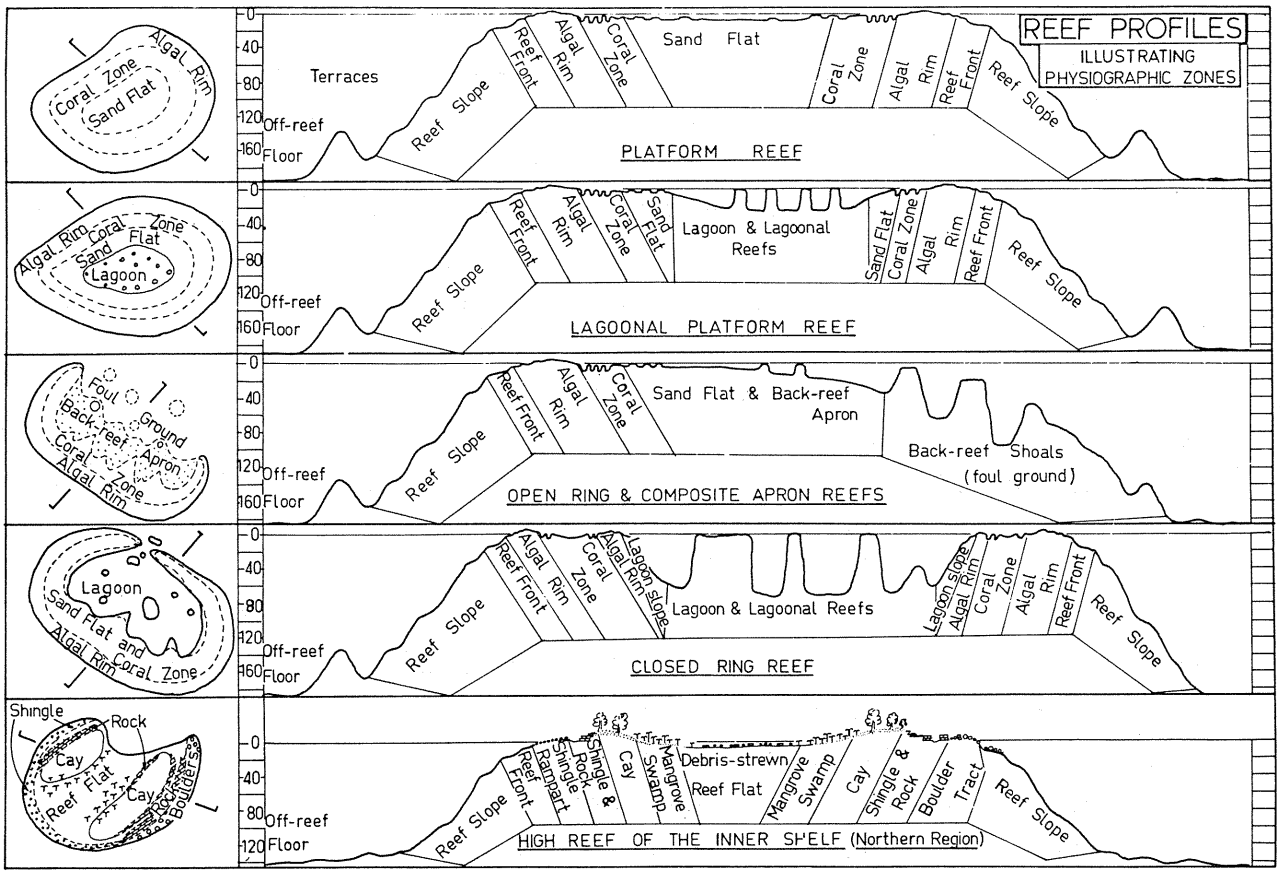
> The literature indicates there is no strong agreement among scientists on the use and meaning of the two terms 'reef front' and 'reef slope'. Different meanings and levels of generality ....
>
> **Reef Slope: Definition** The 'reef slope' is the subtidal portion of the reef mass extending seaward from the perimeter of the horizontal reef surface (on some reefs this will be the edge of the reef rim) and descending towards and terminating at its intersection with the off-reef floor on the continental shelf. 'An average seaward reef slope approaches....

Because of insufficient published data, the comment is not a judgement by the author on the validity of the term, nor can it be an attempt to explain why a reef feature occurs. Rather, it is an attempt to define and describe the feature to which a term relates with the definition or description being based on published information. The comment may include:

1. information on which published scientists agree or disagree;
2. discussion of the cited definitions or descriptions;
3. the clarification of a description;
4. a qualifying statement; and/or,
5. an example from the GBR.

Diagrammatic or pictorial illustrations of the coral reef features or zones listed in Figure 5 are generally not given in this paper. This is because in the accompanying Technical Memorandum, (TM-7), which is intended as the principal reference document, the comment section of Figure 4 is re-presented together with extensive illustrations. However, a diagrammatic illustration (Figure 3) shows the reef profiles of the more common reef types from the GBR and gives labelled physiographic zones. The locations of reefs referred to in Figure 5 are available in Isdale et al. (1982).

Figure 3. Reef profiles of the more common reef types showing the physiographic zonation (reproduced with permission from Maxwell, 1968).



It is proposed that the terms listed in Table 1, defined in Figure 5 and selected for the classification system (Kuchler, 1986) should become, where relevant, standard nomenclature among GBR marine scientists. The nomenclature provides a consistent basis for comparing and analysing the coral reef interpretations made by different interpreters used in the BRIAN project, and it also enables a meaningful comparison between interpretations of the remotely sensed data and field observations.

5. DISCUSSION

Several bases for this nomenclature were considered. They were as follows:

1. field verification by author to determine the appropriateness of each name for a feature;
2. a survey amongst experienced GBR field scientists asking them to nominate the most appropriate name for a feature; and
3. a literature survey of term usage.

The first and second of the above options proved unsuitable for one or more of the following reasons; logistically difficult, outside the time constraints of the BRIAN project, or individual bias.

In any communication there is a transfer of information. Some of the criteria advocated to indicate the effectiveness of the communication are agreement, accuracy and understanding (Shepherdson, 1982). Examination of the variations in reef terms used, the frequency of use data, and the context of use of a reef term given in Figures 4 and 5, indicate there must be some agreement whether actual and/or perceived among GBR scientists on these variations. For example, the terms 'reef front' and 'reef slope' were used in 28 and 19 publications respectively (Figure 4) to label the same reef feature. Shepherdson (1982) states that 'some writers imply that high agreement is an indicator of effective communication; but accuracy, rather than agreement, is a better indicator'.

Accuracy in the emission and/or reception of coral reef information among scientists cannot be ascertained from the literature, but the frequency of use (Figure 4) and the context of use (Figure 5) data give some indication of the level of agreement. An examination of Figures 4 and 5 shows the lack of any general level of agreement, as the level varies for nearly every coral reef term. However, a pattern in the level of agreement for some coral reef terms is evident.

Scientists have a high agreement or consensus, on both the term and its meaning for 'reef flat', 'lagoon', 'beach', 'sand spit', 'vegetation', and 'beachrock'. In comparison, there is a low agreement or dissensus, on the term and high agreement on the meaning for 'reef flat', 'reef rim', and 'reef slope'.

The most frequently used term was 'reef flat', for which a consensus on its meaning but a dissensus on the term exists (for example; 'the flat','leeward flat', 'coral flat', 'coral reef flat', 'planar reef top', 'inshore reef flat', to list but a few of the terms used) (Figure 4). The least frequently used terms were those where only one author used the term within the 240 literature circulations. For example, the term 'prong and buttress formation in back-reef zone' (Figure 4) - Thom and Chappel, 1978; and, the term 'algal platform' - Veron and Hudson, 1978. The communication process is hindered here by the lack of any concise definition and by its uncommon adoption by scientists. For example, a definition for the term 'breastwork' used by the Stoddart, McLean, Scoffin and Gibbs (1978) cannot be derived from its context of use:

> The edge of the mangrove itself is lined by a largely symmetrical breastwork of white shingle, overlapping the landward edges of the old inner rampart.
> (Figure 5, entry no. 11)

From the literature surveyed, it is evident that scientists have concentrated on reefs situated in the GBR region between the outer Ribbon Reefs (Maxwell, 1968) and the Queensland coast, and in the region between the Queensland coastal towns of Cooktown in the north and Maryborough in the south. Therefore, two regions of the GBR have been neglected, the reefs north of Cooktown and the Ribbon Reefs of the outer barrier. Hence this study is only capable of representing reef features to the extent to which terms are used in the literature.

6. REFERENCES (including all material used in the formation of the nomenclature proposed in this volume)

Agassiz, A. 1898. A visit to the Great Barrier Reef of Australia on the steamer 'Croydon'. Bulletin of the Museum of Comparative Zoology, Harvard, 28, 95-148.

Ampol Exploration (Qld) Pty Ltd. 1964. Final report, Queensland offshore area 93P and 94P, Australian marine seismic survey. Australian Bureau of Marine Resources PSSA Report.

Andrews, E.C. 1902. A preliminary note on the geology of the Queensland coast, with reference to the geography of the Qld and NSW plateaux. Proceedings of the Linnaean Society of New South Wales, 27, 146-185.

Andrews, E.C. 1922. A contribution to the hypotheses of coral reef formation (Presidential Address). Journal Proceedings of the Royal Society of New South Wales, 56, 10-38.

Backshall, D.G.; Barnett, J.; Davies, P.J.; Duncan, D.C.; Harvey, N.; Hopley, D.; Isdale, P.; Jennings, J.N. and Moss, R. 1979. Drowned dolines - the blue holes of the Pompey Reef, Great Barrier Reef. BMR Journal of Geology and Geophysics, 4, 99-109.

Battistini, R.; Bourrouilh, F.; Chevalier, J.; Coudray, J.; Denizot, M.; Faure, C.; Fisher, J.; Guilcher, A.; Harmelin-Vivien, M.; Gaubert, J.; Laborel, J.; Montaggioni, L.; Masse, J.; Maugex, L.; Peyrot-Clausade, M.; Pichon, M.; Plante, R.; Plaziat, J.;Plessis, F.; Richard, G.; Salvat, B.; Thomassin, B.A.; Vasseur, P. and Weydert, P. 1975. Elements de terminologie reafale Indopacifique. Tethys, 7, 1, 1-111.

Beach Protection Authority. 1978a. Notes on beach erosion on coral cays of the Great Barrier Reef. Department of Harbours and Marine, Brisbane.

Beach Protection Authority. 1978b. Beach Conservation Pamphlets, Beach Protection Authority, Brisbane.

Beach Protection Authority. 1979. Beach Conservation Pamphlets, Beach Protection Authority, Brisbane.

Beach Protection Authority. 1980. Beach Conservation Pamphlets, Beach Protection Authority, Brisbane.

Beach Protection Authority. 1981. Beach Conservation Pamphlets, Beach Protection Authority, Brisbane.

Bennett, I. 1971. The Great Barrier Reef. Lansdowne Press, Melbourne.

Blake, S.T. 1964. Queensland sea grasses. Queensland Naturalist, 17, 70-73.

Bonem, R.M. and Stanley, G.D. 1977. Zonation of a lagoonal patch reef: analysis, comparison and implications for fossil biothermal assemblages. Third International Coral Reef Symposium, Miami, 2, 175-182.

Braithwaite, C.J.R. 1971. Seychelles reefs: structure and development. Regional Variation in Indian Ocean Coral Reefs. Zoological Society of London Symposium, 28, 39-63.

Clare, P. 1971. The Struggle for the Great Barrier Reef. Walker and Co, New York.

Cribb, A.B. 1973. Algal vegetation of Heron Island and Heron Island reef. Unpublished handout to the Second International Coral Reef Symposium, Brisbane.

Crovitz, H.F. 1967. The form of logical solutions. American Journal of Psychology, 80, 461-462.

Daly, R.A. 1948. Coral reef - a review. American Journal of Science, 46, 193-207.

Dana, J.D. 1851. On coral reefs and islands. American Journal of Science, Series 2, 11, 357-372; 12, 25-51, 165-186, 329-338.

Darwin, C.R. 1842. The Structure and Distribution of Coral Reefs, Smith, Elder and Co, London.

Darwin, C.R. 1962. Coral islands; with introduction, map and remarks by D.R. Stoddart. Atoll Research Bulletin, 88, 1-20.

Davies, P.J. 1977. Modern reef growth - Great Barrier Reef. Third International Coral Reef Symposium, Miami, 2, 325-330.

Davies, P.J. 1978. Reef growth - a review, in D. Barnes (Ed.) Perspectives on Coral Reefs, Australian Institute of Marine Science, Townsville, 69-95.

Davies, P.J. 1981a. Holocene lagoonal sedimentation - One Tree Reef, southern Great Barrier Reef. Fourth International Coral Reef Symposium, Manila, 1, 595.

Davies, P.J. 1981b. The use of geological data in reef management. Fourth International Coral Reef Symposium, Manila, 1, 331.

Davies, P.J. and Kinsey, D.W. 1973. Organic and inorganic factors in Recent beach rock formation, Heron Island, Great Barrier Reef. Journal of Sedimentary Petrology, 43, 1, 59-81.

Davies, P.J. and Kinsey, D.W. 1977. Holocene reef growth - One Tree Island, Great Barrier Reef. Marine Geology, 24, M1-M11.

Davies, P.J.; Marshall, J.F.; Foulstone, D.; Thom, B.G.; Harvey, N.; Short, A.D. and Martin, K. 1977. Reef growth, southern Great Barrier Reef - preliminary results. BMR Journal of Geology and Geophysics, 2, 69-72.

Davies, P.J.; Marshall, J.F.; Thom, B.G.; Harvey, N.; Short, A.D. and Martin, K. 1977. Reef development - Great Barrier Reef, Third International Coral Reef Symposium, Miami, 2, 331-337.

Davies, P.J.; Radke, B.M. and Robinson, C.R. 1976. The evolution of One Tree Reef, southern Great Barrier Reef, Queensland. BMR Journal of Geology and Geophysics, 1, 231-240.

Davies, W.M. 1928. The coral reef problem. American Geographic Society Special Publication 9, 1-20.

Dill, R.F. 1977. The Blue Holes - geologically significant submerged sink holes and caves off British Honduras and Andros, Bahama Islands. Third International Coral Reef Symposium, Miami, 2, 237-242.

Domm, S.B. 1971. The uninhabited cays of the Capricorn-Bunker Group, Great Barrier Reef, Australia. Atoll Research Bulletin, 142, 1-27.

Done, T.J. 1977. A comparison of units of cover in ecological classifications of coral communities. Third International Coral Reef Symposium, Miami, 2,9-14.

Done, T.J. 1982. Patterns in the distribution of coral communities across the Central Great Barrier Reef. Coral Reefs, 1, 95-107.

Done, T.J.; Kenchington, R.A. and Zell, L.D. 1981. Rapid, large area reef resource surveys. Fourth International Coral Reef Symposium, Manila, 1, 299-308.

Edgell, J.A. 1928. Some remarks on coral formations. Report to the Great Barrier Reef Committee, 2, 52-56.

Endean, R. 1977. Acanthaster planci infestations on reefs of the Great Barrier Reef. Third International Coral Reef Symposium, Miami, 2, 185-192.

Endean, R.; Stephenson, W. and Kenny, R. 1956. The ecology and distribution of intertidal organisms on certain islands off the Queensland coast. Australian Journal of Marine and Freshwater Research, 7, 317-342.

Eschmeyer, W.N. 1971. One Tree Island. Pacific Discovery, 24, Jul-Aug, 12-22.

Fairbridge, R.W. 1945. Coral reefs and beaches (strategic and photo interpretation characteristics). Headquarters, Allied Air Forces (South West Pacific Area) Intelligence Memo, No 50, Pt 1.

Fairbridge, R.W. 1950. Recent and Pleistocene coral reefs of Australia. Journal of Geology, 58, 330-401.

Fairbridge, R.W. 1958. Selected bibliography on the geology of organic reefs. International Committee on Reef Terminology, Reef Terminology Index Project, Circular Number 3. Pacific Science Board, National Academy of Sciences, Washington.

Fairbridge, R.W. 1967. Coral reefs of the Australian region, in J.N. Jennings and J.A. Mabbut (Eds.) Landform Studies from Australia and New Guinea. Cambridge University Press, 386-418.

Fairbridge, R.W. 1968. The Encyclopedia of Geomorphology, Encyclopedia of Earth Science Series, III, Reinhold Book Corporation, New York.

Fairbridge, R.W. and Teichert, C. 1948. The Low Isles of the Great Barrier Reef. A new analysis. Geography Journal, 111, 67-88.

Flinders, M. 1814. A Voyage to Terra Australis 1 and 2, C and W Nicol, London.

Flood, P.G. 1973a. Excursion guide to Heron Island Reef (physiographic zonation and sediments). Unpublished handout to the Second International Coral Reef Symposium, Brisbane.

Flood, P.G. 1973b. Heron Island Reef, in W.T. Ward (Ed.), South-Eastern Queensland and Great Barrier Reef, Ninth INQUA Congress, Guidebook for Excursion D3, Queensland, International Quaternary Group, 30-35.

Flood, P.G. 1973c. Preparation of fluorescent carbonate sand tracers for studying sediment movement on coral cays. Queensland Government Mining Journal, 74, 10.

Flood, P.G. 1974. Sand movement on Heron Island - a vegetated sand cay, Great Barrier Reef Province, Australia. Second International Coral Reef Symposium, Brisbane, 2, 387 - 394.

Flood, P.G. 1976. Reefs and reefal shoals of the Capricorn-Bunker Group, southern Great Barrier Reef, Australia. Atoll Research Bulletin, 195, 1-7.

Flood, P.G. 1977a. Coral cays of the Capricorn and Bunker Groups, Great Barrier Reef Province, Australia. Atoll Research Bulletin, 195, 1-8.

Flood, P.G. 1977b. Lady Elliott Island. Geological Society of Australia Incorporated, Queensland Division, Field Conference, 46-47.

Flood, P.G. 1977c. The three southernmost reefs of the Great Barrier Reef Province - an illustration of the sequential evolutionary nature of reef type development. Geological Society of Australia, Queensland Division, Field Conference, 37-45.

Flood, P.G. 1978. Sediments on platform reefs of the inner shelf, northern Great Barrier Reef Region. Workshop on the Northern Sector of the the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 270-291.

Flood, P.G. 1979. Heron Island erosion problems. Reeflections Number 3, Great Barrier Reef Marine Park Authority, Townsville.

Flood, P.G. 1980. Cyclone 'Simon' changes cays. Reeflections Number 6, Great Barrier Reef Marine Park Authority, Townsville.

Flood, P.G. 1981a. A record of the shoreline changes to 1980 on cays of the Capricorn Group, southern Great Barrier Reef, Australia. University of Queensland, Department of Geology Papers, 8,3.

Flood, P.G. 1981b. Cyclone 'Simon' and Heron Island. Beach Conservation, 42, 3.

Flood, P.G. and Jell, J.S. 1977. The effect of cyclone 'David' (January 1976) on the sediment distribution patterns on Heron Reef, Great Barrier Reef, Australia. Third International Coral Reef Symposium, Miami, 2, 119-126.

Flood, P.G. and Scoffin, T.P. 1978. Reefal sediments of the northern Great Barrier Reef. Philosophical Transcripts of the Royal Society of London A, 291, 55-71.

Fosberg, F.R. and Carrol, D. 1965. Terrestrial sediments and soils of the northern Marshall Islands. Atoll Research Bulletin, 113, 1-156.

Fosberg, F.R. and Sachet, M.H. (Eds.). 1953. Handbook for atoll research (second preliminary edition). Atoll Research Bulletin, 17, 1-129.

Fosberg, F.R.; Thorne, R.F. and Moulton, J.M. 1961. Heron Island, Capricorn Group, Australia. Atoll Research Bulletin, 113, 1-156.

Frankel, E. 1977. Previous Acanthaster aggregations in the Great Barrier Reef. Third International Coral Reef Symposium, Miami, 2, 201-208.

Frankel, E. 1978. Bibliography of the Great Barrier Reef Province. Australian Government Printing Service, Canberra.

Frith, C.A. 1981. Circulation in a platform reef lagoon, One Tree Reef, southern Great Barrier Reef. Fourth International Coral Reef Symposium, Manila, 1, 347-354.

Gardiner, J.S. 1928. Structure of the Great Barrier Reef. Nature, 129, 748-749.

Gardiner, J.S. 1932. The Great Barrier Reef and the formation of coral reefs. Nature, 129, 748-749.

Gibbs, P.E. 1978. Macrofauna of the intertidal sand flats on Low Wooded Islands, northern Great Barrier Reef. Philosophical Transactions of the Royal Society of London B, 284, 81-97.

Gillett, K. and McNeill, F. 1962. The Great Barrier Reef and Adjacent Isles, Coral Press, Sydney.

Gillham, M.E. 1963. Coral cay vegetation, Heron Island, Great Barrier Reef. Proceedings of the Royal Society of Queensland, 73, 79-92.

Ginsbury, R.N. and Lowenstam, H.A. 1958. The influence of marine bottom communities on the depositional environment of sediments. Journal of Geology, 66, 310-318.

Glynn, P.W. 1977. Interactions between Acanthaster and Hymenocera in the field and laboratory. Third International Coral Reef Symposium, Miami, 1, 210-215.

Goreau, T.F.; Goreau, N.I. and Goreau, T.J. 1979. Corals and coral reefs, Scientific American, Aug, 110-120.

Goulay, M.R. and Flood, P.G. 1981. Impact of coastal engineering works upon a coral cay: Heron Island. Unpublished paper to the Environmental Engineering Conference, James Cook University of North Queensland, Townsville, 159-163.

Great Barrier Reef. 1966. Angus and Robertson, Sydney.

Great Barrier Reef (editorial). 1928. Nature, 121, 197-200.

Great Barrier Reef Committee. 1923. The Great Barrier Reef of Australia: A popular Account of Its General Nature, Great Barrier Reef Committee, Brisbane, 1-32.

Great Barrier Reef Committee. 1978. A Coral Reef Handbook, Great Barrier Reef Committee, Brisbane.

Great Barrier Reef Expedition. 1930+. Scientific Reports, British Museum of Natural History, London.

Great Barrier Reef Marine Park Authority. 1975. Great Barrier Reef Marine Park, Australian Fishing, January, 9.

Great Barrier Reef Marine Park Authority. 1979-81. Reeflections, Great Barrier Reef Marine Park Authority, Townsville.

Great Coral Reef. 1973. Lookeast, 4, 4-6.

Gutteridge, Haskins and Davey Pty Ltd. 1978. Report on Green Island Erosion and Possible Remedial Measures. Gutteridge, Haskins and Davey, Cairns.

Harvey, N. 1977. The identification of subsurface solution disconformities on the Great Barrier Reef, Australia, between 14°S and 17°S, using shallow seismic refraction techniques. Third International Coral Reef Symposium, Miami, 2, 46-51.

Harvey, N. 1978. Wheeler Reef: morphology and shallow reef structure, in D. Hopley (Ed.), Geographical Studies of the Townsville Area. Geography Department, James Cook University of North Queensland, Monograph Series, Occasional Paper 2, 51-53.

Harvey, N.; Davies, P.J. and Marshall, J.F. 1978. Shallow reef structure: southern Great Barrier Reef. BMR Journal of Geology and Geophysics, 3, 96.

Harvey, N. and Hopley, D. 1981. The relationship between modern reef morphology and a pre-Holocene substrate in the Great Barrier Reef province. Fourth International Coral Reef Symposium, Manila, 1, 549-554.

Harvey, N.; Isdale, P.J. and Backshall, D.G. 1978. Reefs and Islands of the Great Barrier Reef Between 14°S and 17°S. Report prepared for the Great Barrier Reef Marine Park Authority, Townsville.

Hedley, C. 1924. The Great Barrier Reef of Australia. Natural History, 24, 62-69.

Hedley, C. 1925. The natural destruction of a coral reef. Reports of the Great Barrier Reef Committee, 1, 35-40.

Hedley, C. and Taylor, T.G. 1908. Coral reefs of the Great Barrier Reef, Queensland: a study of their structure, life-distribution and relation to mainland physiography! Report of the Australian Association for the Advancement of Science, 11, 397- 13.

Heinsohn, G. 1978. Marine mammals of the northern Great Barrier Reef. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 315-335.

Hill, D. 1960. The Geology of Queensland: The Great Barrier Reef. Journal of the Geological Society of Australia, 7, 412-413.

Hill, D. 1974. An introduction to the Great Barrier Reef. Second International Coral Reef Symposium, Brisbane, 2, 723- 731.

Hopley, D. 1975. Sediment movement on a platform reef, Great Barrier Reef, Australia. Pacific Science Congress, 1, 127.

Hopley, D. 1977. The age of the outer Ribbon reef surface, Great Barrier Reef, Australia: implications for hydro-isostatic models. Third International Coral Reef Symposium, Miami, 2, 24-28.

Hopley, D. 1978a. Aerial photography and other remote sensing techniques, in D.R. Stoddart and R.E. Johannes (Eds.) Coral Reef Research Methods, UNESCO, Paris, 23-44.

Hopley, D. 1978b. Geomorphology of the reefs and reef islands north of Lizard Island. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 218-252.

Hopley, D. 1978c. The Great Barrier Reef in the Townsville Region, in D. Hopley, (Ed.) Geographical Studies of the Townsville Area, Geography Department, James Cook University of North Queensland, Monograph Series, Occasional Paper 2, 45-50.

Hopley, D. 1978d. Wheeler Reef: cay mobility. in D. Hopley (Ed.) Geographical Studies of the Townsville Area. Geography Department, James Cook University of North Queensland, Monograph Series, Occasional Paper 2, 45-50.

Hopley, D. 1981a. Morphological classification of shelf reefs: a critique with special reference to the Great Barrier Reef, in D.J. Barnes (Ed.), Perspectives on Coral Reefs. Australian Institute of Marine Science, Townsville, 180-199.

Hopley, D. 1981b. Sediment movement around a coral cay, Great Barrier Reef, Australia. Pacific Geology, 15, 17-36.

Hopley, D. 1982. Geomorphology of the Great Barrier Reef: Quaternary Development of Coral Reefs, Wiley-Interscience, New York.

Hopley, D.; Davies, P.J.; Harvey, N., and Isdale, P.J. 1981. The Geomorphology of Redbill Reef, Central Great Barrier Reef. Fourth International Coral Reef Symposium, Manila, 1, 541-547.

Hopley, D. and Harvey, N. 1981. Regional variation in structure and morphology on the Great Barrier Reef. Unpublished paper to the Environmental Engineering Conference, James Cook University of North Queensland, Townsville, 107-112.

Hopley, D. and Isdale, P.J. 1977. Coral microatolls, tropical cyclones and reef flat morphology: a north Queensland example. Search, 8, 79-81.

Hopley, D. and Van Steveninck, A. 1977. Infrared aerial photography of coral reefs. Third International Coral Reef Symposium, Miami, 1, 306-310.

Howe, M.A. 1912. The building of 'coral' reefs. Science, 25, 837-842.

Investigation of the Great Barrier Reef. 1928. Science, 68, 245-246.

Isdale, P.J. 1974. The morphology and significance of coral microatolls. Unpublished Honours thesis, Department of Geography, James Cook University of North Queensland. Townsville.

Isdale, P.J. 1977. Variation in growth rate of hermatypic corals in a uniform environment. Third International Coral Reef Symposium, Miami, 2, 403-408.

Isdale, P.J. 1982. Geographical variation in hermatypic coral growth rates in the Great Barrier Reef Province, Australia. Unpublished PhD thesis, James Cook University of North Queensland, Townsville.

Isdale, P.J.; Shearn ,T. and Hopley, D. 1982. Great Barrier Reef Index Series Maps 1:250 000. Five unpublished maps. Great Barrier Reef Marine Park Authority, Townsville.

Jardine, F. 1928a. Bramble Cay, Torres Strait - geological notes. Reports of the Great Barrier Reef Committee, 2, 93-100.

Jardine, F. 1928b. Darnley Island - geological and topographical notes. Reports of the Great Barrier Reef Committee, 2, 101-109.

Jell, J.S. and Flood, P.G. 1978. Guide to the geology of reefs of the Capricorn and Bunker Groups, Great Barrier Reef Province, with special reference to Heron Reef. University of Queensland, Department of Geology Papers, 8, 3, 1-85.

Jones, O.A. 1966. Geological questions posed by the reef. Australian Natural History, Dec, 245-248.

Jones, O.A. 1977. Morphology and development of Southeastern Florida patch reefs. Third International Coral Reef Symposium, Miami, 2, 231-236.

Jones, O.A. and Endean, R. 1969. The Great Barrier Reefs. Science Journal, 3, November, 44-51.

Jones, O.A. and Endean, R. 1973. Biology and Geology of Coral Reefs, 1: Geology, Academic Press, New York.

Jupp, D.L.B.; Mayo, K.K.; Kuchler, D.A.; Heggen, S.J. and Kendall, S.W. 1981a. Remote sensing by LANDSAT as support for management of the Great Barrier Reef. Second Australasian Remote Sensing Conference, Canberra. 9.5.1-9.5.6.

Jupp, D.L.b.; Mayo, K.K.; Kuchler, D.A.; Heggen, S.J. and Kendall, S.W. 1981b. The BRIAN method for large area inventory and monitoring. Second Australasian Remote Sensing Conference, Canberra. 6.5.1-6.5.6.

Kenchington, R.A. 1975. Surveys of large areas of coral reef. Unpublished Abstracts of the Australian Institute of Marine Science, Reef Biogenesis Symposium, Townsville.

Kennedy, V. 1933. Geology of the Barrier Reef. North Queensland Naturalist, 1, 7. 4-6.

Kojis, B.L. and Quinn, N.J. 1981. Factors to consider when transplanting hermatypic coral to accelerate regeneration of damaged coral reefs. Unpublished paper to the Environmental Engineering Conference, James Cook University of North Queensland, Townsville, 183-186.

Kuchler, D.A. 1979. Green Island: the man-environment interface, a geomorphological perspective. Unpublished report to the Great Barrier Reef Committee, Canberra.

Kuchler, D.A. 1980. Shoreline changes on a coral cay: Green Island, Great Barrier Reef, Australia. Unpublished Honours thesis, Department of Geography, James Cook University of North Queensland, Townsville.

Kuchler, D.A. 1982. Mapping the Great Barrier Reef, Coral Reef News, 11,1.

Kuchler, D.A. 1984. Geomorphological Separability, Landsat MSS and aerial photographic data: Heron Island Reef, Australia. Unpublished PhD thesis, James Cook University of North Queensland, Townsville.

Kuchler, D.A. 1986. Reef cover and zonation classification system for use with remotely sensed Great Barrier Reef data. Great Barrier Reef Marine Park Authority Technical Memorandum, GBRMPA TM-7, Townsville.

Kuchler, D.A. (in press). Shoreline adjustments on Green Island cay: Great Barrier Reef, Australia. Australian Geographic Studies.

Ladd, H.S. 1950. Recent reefs. Bulletin of American Society of Petroleum Geologists, 34, 203-214.

Lenox-Conyngham, G. and Potts, F.A. 1925. The Great Barrier Reef. Geography Journal, 65, 314-344.

Limpus, C. 1978. Sea turtles of the northern Great Barrier Reef. Workshop on the Northern Sector of the Great Barrier Reef. Great Barrier Reef Marine Park Authority, Townsville, 336.

Lintz, J. and Simonett, D.S. 1976. Remote Sensing of the Environment, Addison-Wesley, London.

Longman, M.W. 1981. A process approach to recognising facies of reef complexes. The Society of Economic Paleontologists and Mineralolgists, Special Publication Number 30, May, 9-40.

The Macquarie Dictionary. 1981. Maquarie University, St Leonards, New South Wales. Macquarie Library Pty Ltd.

Maiklem, W.R. 1968. The Capricorn Reef complex, Great Barrier Reef, Australia. Journal of Sedimentary Petrology, 38, 3, 785-798.

Manton, S.M. 1935. Ecological surveys of coral reefs. Scientific Reports of the Great Barrier Reef Expedition, 3, 274-312.

Marshall, P. 1931. Coral reefs - rough-water and calm-water types. Reports of the Great Barrier Reef Committee, 3, 64-72.

Marshall, J.F. and Davies, P.J. 1982. Internal structure and holocene evolution of One Tree Reef, southern Great Barrier Reef. Coral Reefs, 1, 21-28.

Maxwell, W.G.H. 1968. Atlas of the Great Barrier Reef. Elsevier, Amsterdam.

Maxwell, W.G.H. 1970. Deltaic patterns in reefs. Deep Sea Research, 17, 1005-1018.

Maxwell, W.G.H. 1973. Sediments of the Great Barrier Reef Province, in O.A. Jones and R. Endean (Eds.) Biology and Geology of Coral Reefs: 1, Academic Press, New York, 299-345.

Maxwell, W.G.H. 1976. Review of reefs in time and space. Marine Geology, 20, 77-82.

Maxwell, W.G.H.; Day, R.W. and Fleming, P.J.G. 1961. Carbonate sedimentation of the Heron Island Reef, Great Barrier Reef. Journal of Sedimentary Petrology, 34, 294-308.

Maxwell, W.G.H.; Jell, J.S. and McKellar, R.G. 1964. Differentiation of carbonate sediments on the Heron Island Reef. Journal of Sedimentary Petrology, 34, 294-308.

Maxwell, W.G.H. and Swinchatti, J.P. 1970. Great Barrier Reef: regional variation in a terrigenous-carbonate province. Geology Society of America, Bulletin, 81, 691-724.

McCall, G.J. 1976. Communication and negotiated identity. Communication, 2, 173-184.

McLean, R.F. and Stoddart, D.R. 1978. Reef island sediments of the northern Great Barrier Reef. Philosophical Transactions of the Royal Society of London A, 291, 101-117.

Meischner, D. and Meischner, V. 1977. Bermuda South above reef morphology. Third International Coral Reef Symposium, Miami, 2, 243-250.

Mergner, H. 1971. Structure, ecology and zonation of Red Sea reefs (in comparison with South Indian and Jamaican reefs). Zoological Society of London Symposium, 28, 141-161.

Milliman, J.D. 1969. Recent Sedimentary Carbonates, Part 1, Springer-Verlag, Berlin.

Moore, W.G. 1974. A Dictionary of Geography - Definitions and Explanations of Terms Used in Physical Geography, Penguin, Ringwood.

Murray, J. 1880. On the structure and origin of coral reefs and islands. Proceedings of the Royal Society of Edinburgh, 10, 505-518.

Murray, S.P.; Roberts, H.H.; Conlon, D.M. and Rudder, G.M. 1977. Nearshore current fields around coral island: control on sediment accumulation and reef growth. Third International Coral Reef Symposium, Miami, 2, 53-60.

Orme, G.R. 1978. Reefs of the Great Barrier Reef north of Lizard Island. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 12-43.

Orme, G.R. and Flood, P.G. 1977. The geological history of the Great Barrier Reef: a reappraisal of some aspects in the light of new evidence. Third International Coral Reef Symposium, Miami, 1, 37-43.

Orme, G.R.; Flood, P.G. and Ewart, A.E. An investigation of sediment and physiography of Lady Musgrave Reef - a preliminary account. Second International Coral Reef Symposium, Brisbane, 2, 371-386.

Orme, G.R.; Flood, P.G. and Sargent, G.E.G. 1978. Sedimentation trends in the lee of outer (ribbon) reefs, northern region of the Great Barrier Reef Province. Philosophical Transactions of the Royal Society of London A, 291, 85-99.

Pearson, R. 1978. Two brief surveys of coral reefs of the northern Great Barrier Reef. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 342-359.

Pentony, P. 1981. The world of communication in P. Pentony (Ed.) Models of Influence In Psychotherapy. The Free Press, New York, 169-197.

Picard, J. 1967. Essai de classement des grands types de peuplements marins benthiques tropicaux, d'apres les observations dans les parages de Tuléar (S-W de Madagascar), Recl Trav Stn Mar Endoume, fasc hors-series, supplement 6, 3-24.

Pichon, M. 1971. Comparative study of the main features of some coral reefs of Madagascar, La Reunion and Mauritius. Zoological Society of London Symposium, 28, 185-215.

Pichon, M. 1974. Dynamics of benthic communities in the coral reefs of Tuléar (Madagascar): succession and transformation of the biotypes through reef tract evolution. Second International Coral Reef Symposium, Brisbane, 2, 261-268.

Pichon, M. 1977. Physiography, morphology and ecology of the Double Barrier Reef of North Bohol (Philippines). Third International Coral Reef Symposium, Miami, 2, 261-268.

Pickard, G.L.; Donguy, J.R.; Henin, C. and Rougerie, F. 1977. A review of the physical oceanography of the Great Barrier Reef and western Coral Sea. Australian Institute of Marine Science Monograph Series, 2, 1-130.

Polach, H.A.; McLean, R.F.; Caldwell, J.R. and Thom, B.G. 1978. Radiocarbon ages from the northern Great Barrier Reef. Philosophical Transactions of the Royal Society of London A, 291, 139-158.

Price, I. 1978. Algae of the Great Barrier Reef from Lizard Island to Cape York. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 304-314.

Purdy, E.G. 1974. Reef configurations: cause and effect, in L.F. Laporte (Ed.) Reefs in Time and Space, Society of Economic Paleontologists and Mineralogists, Special Publication, 18, 9-76.

Pyne, R. 1978. Crustaceans - a natural feature of the area. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 360-367.

Radke, B.M. 1983. Application of Entropy-ratio maps to surficial reef facies, Great Barrier Reef. BMR Journal of Geology and Geophysics, 8, 307-311.

Randall, R.H. and Eldredge, L.F. 1977. Effects of typhoon Pamela on the coral reefs of Guam. Third International Coral Reef Symposium, Miami, 2, 209-214.

Reichelt, R.E. 1982. Space: a non-limiting resource in the niches of some abundant coral reef gastropods. Coral Reefs, 1, 3-11.

Riding, R. 1977. Reef concepts. Third International Coral Reef Symposium, Miami, 2, 209-214.

Roberts, H.H. 1974. Variability of reefs with regard to changes in wave power around an island. Second International Coral Reef Symposium, Brisbane, 2, 497-517.

Roberts, H.H.; Murray, S.P. and Suhayda, J.M. 1975. Physical processes in a fringing reef system. Journal of Marine Research, 33, 2, 233-260.

Rodale, J.I. 1978. The Synonym Finder, Rodale Press Inc. Emmaus, Pennsylvania.

Royal Commission into Exploratory and Production Drilling for Petroleum in the area of the Great Barrier Reef. 1974. Report 1, Australian Government Publishing Service, Canberra.

Saville-Kent, W. 1893. The Great Barrier Reef of Australia, W. H. Allen and Co, London.

Scoffin, T.P. 1977. Sea-level features on reefs in the northern province of the Great Barrier Reef. Third International Coral Reef Symposium, Miami, 2, 319-324.

Scoffin, T.P. and McLean, R.F. 1978. Exposed limestones of the northern province of the Great Barrier Reef. Philosophical Transactions of the Royal Society of London A, 291, 119-138.

Scoffin, T.P. and Stoddart, D.R. 1978. The nature and significance of micro-atolls. Philosophical Transactions of the Royal Society of London B, 284, 99-122.

Scoffin, T.P.; Stoddart, D.R.; McLean, R.F. and Flood, P.G. 1978. The recent development of the reefs in the northern province of the Great Barrier Reef. Philosophical Transactions of the Royal Society of London B, 284, 129-139.

Searle, D.E.; Harvey, N.; Hopley, D. and Johnson, D.P. 1981. Significance of results of shallow seismic research in the Great Barrier Reef province between 16°10'S and 20°05'S. Fourth International Coral Reef Symposium, Manila, 1, 531- 539.

Shepherdson, K.V. 1982. Establishing criteria for communication effectiveness. Seventeenth Annual Conference of the Australian Psychological Society, Melbourne, 1-18.

Shinn, E.A.; Hudson, J.H.; Robbin, D.M. and Lidz, B. 1981. Spurs and grooves revisited: construction versus erosion, Looe Key Reef, Florida. Fourth International Coral Reef Symposium, Manila, 1, 475-483.

Slater, R.A. and Phipps, C.V.G. 1977. A preliminary report on the coral reefs of Lord Howe Island and Elizabeth Reef, Australia. Third International Coral Reef Symposium, Miami, 2, 314-318.

Smith, V.E.; Rogers, R.H. and Reed, L.E. 1975. Automated mapping and inventory of Great Barrier Reef zonation with LANDSAT data. Ocean '75 Conference on Engineering in the Ocean Environment, 775-781.

Spender, M. 1930. Island-reefs of the Queensland coast. Geography Journal, 76, 3, 100-204.

Stark, K.P. and Pomeroy, A.B. 1978. A systems approach to the management of a reef ecosystem. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 403-421.

Stearns, H.T. 1946. An integration of coral reef hypotheses. American Journal of Science, 244, 245-262.

Steers, J.A. 1929. The Queensland coast and the Great Barrier Reefs. Geography Journal, 74, 232-257, 341-370.

Steers, J.A. 1937. The coral islands and associated features of the Great Barrier Reefs. Geography Journal, 89, 119-146.

Steers, J.A. 1938. Detailed notes on the islands surveyed and examined by the geographical expedition to the Great Barrier Reef in 1936. Report of the Great Barrier Reef Committee, 4, 7, 51-102.

Steers, J.A. 1945. Coral reefs and air photography. Geography Journal, 106, 233-235.

Steers, J.A. 1978. Concluding remarks. Philosophical Transactions of the Royal Society of London B, 284, 161-162.

Steers, J.A. and Stoddart, D.R. 1977. The origin of fringing reefs, barrier reefs and atolls, in O.A. Jones and R. Endean (Eds.) Biology and Geology of Coral Reefs, IV, Geology, 2, Academic Press, New York.

Stein, J. and Urdang, L. 1967. Random House Dictionary of the English Language, Random House, New York.

Stephenson, T.A.; Stephenson, A.; Tandy, G. and Spender, M.A. 1931. The structure and ecology of Low Islands and other reefs. Scientific Report of the Great Barrier Reef Expedition 1928-1929, 3, 17-112.

Stoddart, D.R. 1964. Storm conditions and vegetation in equilibrium of reef islands. Ninth Conference on Coastal Engineering, The American Society of Civil Engineers, 893-906.

Stoddart, D.R. 1969. Ecology and morphology of Recent coral reefs. Biological Review, 44, 433-498.

Stoddart, D.R. 1971. Variations on a coral theme. Geographical Magazine, June, 610-615.

Stoddart, D.R. 1978a. Descriptive reef terminology, in D.R. Stoddart and R.E. Johannes (Eds.), Coral Reef Research Methods, UNESCO, Paris, 5-15.

Stoddart, D.R. 1978b. Mapping reefs and island, in D.R. Stoddart and R.E. Johannes (Eds.), Coral Reef Research Methods, UNESCO, Paris, 17-22.

Stoddart, D.R. 1978c. The Great Barrier Reef and the Great Barrier Reef expedition. Philosophical Transactions of the Royal Society of London A, 291, 5-22.

Stoddart, D.R. 1981. Theory and data in small island biogeography. Fourth International Coral Symposium, Manila, 194.

Stoddart, D.R.; McLean, R.F. and Hopley, D. 1978. Geomorphology of reef islands, northern Great Barrier Reef. Philosophical Transactions of the Royal Society of London B, 284, 63-80.

Stoddart, D.R.; McLean, R.F.; Scoffin, T.P. and Gibbs, P.E. 1978. Forty-five years of change on low wooded islands, Great Barrier Reef. Philosophical Transactions of the Royal Society of London B, 284, 63-80.

Stoddart, D.R.; McLean, R.F.; Scoffin, T.P.; Thom, B.G. and Hopley, D. 1978. Evolution of reefs and islands, northern Great Barrier Reef, synthesis and interpretation. Philosophical Transactions of the Royal Society of London B, 284, 149-159.

Talbot, F.H. 1967. Expedition to One Tree Island. Australian Natural History, 15, 343-346.

Talbot, F.H. 1970. Will we damage the Great Barrier Reef? Living Earth, 14, 37-38.

Talbot, F.H. 1971. The Great Barrier Reef, coral reef ecology. Australian Fishing, 30, Jan 24, 34-35.

Talbot, F.H. and Anderson, G.R.V. 1978. Characteristics of marine fish communities of the Great Barrier Reef region, and implications for management. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 292-303.

Talbot, F.H.; Russell, B.G. and Anderson, G. 1975. Chance processes in the maintenance of high diversity on coral reefs. Thirteenth Pacific Science Congress, 1, 133.

Taylor, A. 1963. A visit to Michaelmas Cay. North Queensland Naturalist, 31, Sept 11.

Taylor, F.W. and Jouannic, C. 1981. Coral colonies as monitors of change in relative level of the land and sea: applications to vertical tectonism. Fourth International Coral Reef Symposium, Manila, 1, 485-492.

Taylor, J.D. 1968. Coral reef and associated invertebrate communities (mainly molluscan) around Mahe, Seychelles. Philosophical Transactions of the Royal Society of London B, 254, 129-206.

Taylor, T. 1924. Movement of sand cays: a report on the movement of sand cays on the Great Barrier Reef under the influence of atmospheric conditions. Geographic Journal, 39, 38-39.

Teichert, C. 1947. Contemporary eustatic rise in sea level. Geographic Journal, 109, 288-289.

Teichert, C. 1959. Photointerpretation of coral reefs. Photogrammetric Engineering, 16, 5, 744-755.

Teichert, C. 1952. The coral reefs of Australia. Bulletin of the American Society of Petroleum Geology, 36, 5, 908.

Teichert, C. and Fairbridge, R.W. 1948. Some coral reefs of the Sahul shelf. Geography Review, 38, 222-249.

Tenison-Woods, J. E. 1879. A trip to a coral reef. Australasian, October 18, 486-487.

Tenison-Woods, J.E. 1880. Australian coral reefs. Australasian, July 31, 134-135; September 18, 359; November 6, 582.

Thom, B.G. and Chappell, J. 1978. Holocene se level change: an interpretation. Philosophical Transactions of the Royal Society of London A, 291, 187-194.

Thom, B.G.; Orme, G.R. and Polach, H.A. 1978. Drilling investigation of Bewick and Stapleton Islands. Philosophical Transactions of the Royal Society of London A, 291, 37-54.

Tracey, J.I.; Ladd, H.S. and Hoffmeister, J.E. 1948. Reefs of Bikini, Marshall Islands. Bulletin of the Geological Society of America, 59, 861-878.

Traves, D.M. 1960. Wreck Island, subsurface. Journal of the Geological Society of Australia, 7, 369-371.

Van Steveninck, A.L. 1976. A comparative study of the use of infrared and other emulsions in photographic reconnaissance of coral reef morphology. Unpublished Honours thesis, Department of Geography, James Cook University of North Queensland, Townsville.

Veron, J.E.N. 1978a. Barrier Reefs of the northern region. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 44-71.

Veron, J.E.N. 1978b. Deltaic and dissected reefs of the far northern reefs. Philosophical Transactions of the Royal Society of London B, 284, 23-37.

Veron, J.E.N. 1978c. Evolution of far northern Barrier Reefs. Philosophical Transactions of the Royal Society of London B, 284, 123-127.

Veron, J.E.N. 1978d. Reef corals of the northern region of the Great Barrier Reef. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 210-217.

Veron, J.E.N. and Hudson, R.C.L. 1978. Ribbon reefs of the northern region. Philosophical Transactions of the Royal Society of London B, 284, 3-21.

Veron, J.E.N. and Pichon, M. 1976. Scleractinia of Eastern Australia, Part I: Families Thamnasteriidae, Astrocoeniidae, Polilloporidae. Australian Institute of Marine Science Monograph Series, 1, 1-86.

Wallace, C.C. and Dale, M.B. 1977. An information analysis approach to zonation patterns of the coral genus Acropora on outer reef buttresses. Atoll Research Bulletin, 220, 95-110.

Warne, D. 1978. Application of LANDSAT to management of the Great Barrier Reef. Workshop on the Northern Sector of the Great Barrier Reef, Great Barrier Reef Marine Park Authority, Townsville, 388-402.