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

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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.

Technical memoranda are of a preliminary nature, and represent the views of the author, not necessarily those of the Great Barrier Reef Marine Park Authority.

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TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Previous work</td>
<td>4</td>
</tr>
<tr>
<td>3. Method</td>
<td>6</td>
</tr>
<tr>
<td>4. Results</td>
<td>12</td>
</tr>
<tr>
<td>15. Discussion</td>
<td>16</td>
</tr>
<tr>
<td>6. References</td>
<td>18</td>
</tr>
</tbody>
</table>

FIGURES

Figure 1. A classification of reefs (reproduced with permission from Maxwell, 1968). 6
Figure 2. Variation in the development of the algal rim on different reef types (reproduced with permission from Maxwell, 1968). 7
Figure 3. Reef profiles of the more common reef types showing the physiographic zonation (reproduced with permission from Maxwell, 1968). 15

TABLES

Table 1. Terms used in the literature to describe geomorphological reef cover and zonation on the Great Barrier Reef. 10
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.


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 Tulear. 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'.

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 km² 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
g 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
foreest 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  | 28.0 | coral beach  |
|      | coral-algal subzone  |      | BEACH        |
|      | zone of living coral |      | cay beach    |
|      | coral-sand subzone   |      | sand beach   |
|      | OUTER LIVING CORAL ZONE | |  |
|      | live coral zone      | 29.0 | SAND SPIT    |
|      | non-aligned coral zone | | littoral spit |
|      | DEAD CORAL ZONE      |      | SPIT         |
|      | CORAL POOLS          |      |  |
| 22.0 | sea-grass reef flat  | 30.0 | BEACH ROCK   |
|      | SEAGRASS BEDS        |      | cay rock     |
|      | Thalassia grass      |      | REEF ROCK    |
|      | marine grass         |      | BOULDER-ROCK |
|      | seagrasses           |      | RAMPART-ROCK |
|      | 23.0 | SHALLOW LAGOON       |      | PHOSPHATE ROCK|
|      | MEDIUM LAGOON        |      | boulder-tract-rock |
|      | 24.0 | blue lagoon          |      | island-rock  |
|      | DEEP LAGOON          |      | conglomerate rock |
|      | second lagoon        |      | rampart/rock platform |
|      | third lagoon         |      | rock slabs   |
| 25.0 | back-reef apron in lagoon | | 31.0 | CORAL/SHINGLE RIDGE |
|      | lagoonal sediments   |      | rubble banks |
|      | sandy lagoon         |      | boulder bank |
|      | LAGOON FLOOR         |      | reef bank    |
|      | lagoonal apron       |      | boulder zone |
|      | reef rim apron       |      | PLATFORM/PROMENADE |
|      | open lagoon          |      | CORAL/SHINGLE RAMPART |
|      | leeward LAGOON WALLS |      | rampart      |
|      | lagoonal margin      |      | rampart system |
|      | 26.0 | lagoonal coral heads |      | beach ridge  |
|      | lagoon corals        |      | ridges       |
|      | PATCH REEF          |      | coral deposits |
|      | coral colonies      |      | coral shingle mounds |
|      | lagoonal reefs       |      | submarine ridges |
|      | isolated/DISPERSED  |      | CORAL RUBBLE ZONE |
|      | lagoonal reefs       | 32.0 | coral rubble |
|      | RETICULATE lagoonal reefs | | shingle rubble |
|      | isolated/REMNANT    |      | boulder rubble |
|      | lagoonal reefs       | 33.0 | coral gravel |
|      | LAGOON CORAL        |      | rubble zone  |
|      | PATCHES             |      | CORAL RUBBLE ZONE |
|      | lagoonal patch reef  |      | mangrove scrub |
|      | reef studded lagoon |      | mangrove park |
|      | deep mesh - reef lagoon | | MANGROVES |
|      | 27.0 | woodland vegetation  | 34.0 | REEF FLANKS |
|      | VEGETATION          |      | flanks       |
|      | herbaceous vegetation | | leeward flanks |
|      | 35.0 | sand slope          |      | sand slope   |
|      | 36.0 | TERRACES            |      | algal slope  |
|      | 37.0 | REEFAL SHOALS       |      | algal terraces |
|      | SHOALS              |      | submarine terrace |
|      | 38.0 | niggerheads         |      | 40.0 | Lithothammon rim |
|      | reef blocks          |      | ALGAL RIM     |
|      | negro heads          |      | coralgal rim  |
|      | megablock            |      | corraline algal rim |
|      | CORAL HEADS          |      | corraline algal zone |
|      | boulders/bombies     |      | 41.0 | depressed central strip |
|      | blocks               |      | coral boulders |
|      | 39.0 | ALGAL ridge         |      | Lithothammon ridge |
|      | Lithothammon ridge   |      | algal pavement |
|      | algal ramp           |      | algal zone    |
|      | algal platform       |      | 41.0 | depressed central strip |
|      | 40.0 | Lithothammon rim    |      | coralgal rim  |
|      | ALGAL RIM            |      | corraline algal rim |
|      | coralgal reef        |      | corraline algal zone |
|      | 41.0 | depressed central strip |

Entries in UNDERLINED CAPITALS are those most frequently used.  
Entries in BOLDED CAPITALS 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:
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)


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