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ASSESSMENT OF THE BIOMASS OF CORALS OF THE FAVIIDAE FAMILY ON A COMMERCIALLY EXPLOITED REEF IN NEW CALEDONIA

INTRODUCTION

Coral harvesting in New Caledonia is authorised on a single reef, Tetembia reef located between Uitoe pass to the South and St Vincent pass to the North (Figure 1). The fishing effort of the company exploiting the reef focuses largely on corals of the Faviidae family which are fashioned into various decorative objects. In order to prevent possible overfishing, a first attempt to assess the stock of Faviidae existing on the reef was made. The results of this study should enable a management plan to be set up on objective bases.

METHODS

On site sampling

The Faviidae balls are counted on site using a transect sampling method:

500 m transects : The procedure consists of unrolling a 500 m long rope at random on a portion of the reef and counting the Faviidae corals in contact with it. This method, although very reliable, is extremely lengthy as the rope must be handled with the utmost care, otherwise it tends to get caught up in the colonies of branching corals, breaking them if pulled too hard. Consequently, we preferred the method described hereunder.

1000 to 2000 m transects : The transects are covered by a diver pulled along by a small boat travelling in a straight line at low speed. The main ship follows the progress of the small boat on its radar and plots the transects on a map. The diver whose range of vision under water is about 5 m, records the number of colonies seen on a slate by size class. Five size classes of Faviidae balls have been defined on the basis of their longer diameter (Table 1).

Table 1. Size classes of Faviidae balls

CLASSES	C1	C2	C3	C4	C5
Diam (long cm)	0 - 30	30 - 50	50 - 70	70 - 90	90 & +

Estimating the mean weight of the colonies harvested

After counting the Faviidae along a transect, the diver knows the number of the corals on the site. He now needs to estimate their weight. The second stage of the assessment took place in the company's warehouse where the balls are stored. A sample of balls was measured, weighed and photographed. The long and short diameters of each ball were recorded to obtain the mean diameter, after which the balls were sorted by mean diameter into the different size classes (Table 2).

Lastly, the mean weight of each size class was calculated to enable a first assessment of the Faviidae stock present in the area covered by the diver (Table 3).

Table 2. Weight, diameters and size classes of Faviidae balls

Sample N	Weight (kg)	D (cm) *	d (cm) **	Dm (cm) ***	size class
1	140	80	55	67.5	
2	120	62	57	59.5	
3	110	68	41	54.5	
4	100	56	52	54	C3
5	83	57	46	51.5	
6	77	62	54	58	
7	73	63	46	54.5	
8	70	63	52	57.5	
9	104	50	48	49	
10	59	44	42	43	
11	52	55	30	42.5	
12	46	40	35	37.5	
13	41	50	34	42	
14	27.5	46	35	40.5	C2
15	15.2	35.5	33	34.25	
16	13.7	34	26.5	30.25	
17	13.7	35	29	32	
18	13.5	37	27	32	
19	27	30	27	28.5	
20	14.3	31	28	29.5	
21	10.8	12.3	12	12.5	
22	8.8	31	22	26.5	C1
23	7.8	12	9	10.5	
24	5.2	25	22	23.5	
25	1.1	10	10	10	

* D = long diameter
** d = short diameter
*** Dm = Mean diameter

Table 3. Mean weight of Faviidae colonies by size class

	C1	C2	C3	C4	C5
Mean weight kg	20	38.5	96.6	120 * estim.	180 * estim.

* Estimated from fragments harvested.

Estimating the exploitable area by remote sensing

- **Biotope suitable for development of Faviidae on Tetembia reef**

  During the transect counts, some areas were seen to be richer in Faviidae than others. The scale developed by Dahl (1981) allowed coverage by Faviidae to be estimated for the different reef zones. Bottoms deeper than 5 m and soft bottoms are considered poor in Faviidae with a coverage less than 1. The reef flat and reticulate reefs bottoms less than 5 m deep are richer with a coverage of about 3.

- **SPOT thematic map of the southern tip of Tetembia reef**

  Simulation of the numerical images obtained by the SPOT satellite was carried out in New Caledonia at the end of 1983, before the satellite was launched. Computer processing of the images obtained on Tetembia reef enabled Bour et al. (1986) to map the hard bottoms of the southern portion of the reef (Figure 1).

  The thematic map obtained shows the localisation and the surface area (in hectares) of each biotope identified (Figure 2). The themes "Reef flat", "Reticulate reef", "Inner reef" are the bottoms on which living corals are found, including those of the Faviidae family. The sum of their respective surface areas gives a good estimate of the area of the suitable biotope.

- **Extrapolation to the whole of the reef**

  Once the surface area of the suitable bottoms has been obtained from the thematic map, it is easy to calculate what fraction it forms of the total hard bottom surface area. A series of aerial photos covering the whole of Tetembia reef enabled the total surface area of hard bottoms on Tetembia reef to be measured with a planimeter (*).

  The reef is fairly homogeneous over its whole length. The total suitable area was therefore estimated using the proportion calculated earlier for the southern tip. This is a rough estimate which can be regarded as acceptable until thematic mapping of the whole of Tetembia reef can be carried out with a real SPOT image. It must be noted that the suitable biotope cannot be easily identified on aerial photographs which by virtue of their very quality represent every detail of a complex and diversified environment. Satellite image processing will provide the necessary smoothing of the information for an objective partitioning of the major environmental themes.

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* An instrument used in mapping to measure the area of any plane figure by passing a tracer around the boundary line.

RESULTS

Total biomass

The total area of reef flat and reticulate reef was found by planimetry to be 1300 ha. The biotope suitable for Faviidae could thus be calculated for the whole reef. The proportion of suitable biotopes on the thematic map being 40%, the total suitable area is 520 ha. From the transect counts made on the reef the mean weight of Faviidae was estimated at 70 tonnes for an area of 15 ha (Tables 4 and 5).

Table 4. On site transect counts. Number of balls counted by size class

N transect	C1	C2	C3	C4	C5	dist m	Area m2
1	0	5	0	0	1	945	4725
2	24	17	12	7	7	1131	5655
3	15	6	7	2	6	1291	6455
4	65	34	25	23	0	1660	8300
5	40	16	6	5	1	1264	6320
6	26	17	10	4	7	1286	6430
7	24	25	3	5	0	1416	7080
8	7	6	2	1	2	496	2480
9	33	11	4	5	2	1600	8000
10	7	2	1	0	0	1200	6000
11	25	6	4	1	1	1341	6705
12	46	18	6	9	5	2577	12885
13	84	16	6	10	3	3330	16650
14	25	20	23	12	18	2100	10500
15	3	1	1	1	1	872	4360
16	39	39	17	17	12	2640	13200
17	24	23	11	6	9	2760	13800
18	93	94	37	9	8	2058	10290
TOTAL	580	356	175	117	76	29967	149835

Table 5. Biomass sampled by size class

CLASS	C1	C2	C3	C4	C5	TOTAL
Mean weight kg	11600	13706	16905	14040	13680	69930 # 70 T

Total biomass (Bt) of Faviidae extrapolated to the whole reef is:

$$Bt = \frac{520 \text{ ha} \times 70 \text{ T}}{15 \text{ ha}} = 2427 \text{ T}$$

Exploitable biomass

Harvesting of balls in size class 1 is prohibited, to enable them to reach their size at first maturity (25 cm). Balls in size class 5 must not be taken into account for setting of quotas because they can only be extracted with heavy machinery, use of which is strictly prohibited. Exploitation of Faviidae therefore only concerns size classes C2, C3 and C4.

The total biomass of balls in these three size classes on 15 ha is 44,650 tonnes. Extrapolating this figure to the total area of Tetembia reef we get the following approximate value for total exploitable biomass (Be):

$$Be = \frac{44{,}650 \text{ T} \times 520 \text{ ha}}{15 \text{ ha}} = 1548 \text{ T}$$

Mortality

Faviidae corals grow very slowly. Their diameter increases by 0.5 to 1.5 cm a year, which is an average of 1 cm/year. By establishing the size-age relationship (Table 6), we can see that there is a very considerable age difference (a difference of 60 years) between class 1 and class 5 balls.

Table 6. Size-age relationship

Class	C1	C2	C3	C4	C5
age years	30 max	50 max	70 max	90 max	90 min

To estimate the maximum sustainable yield, it is necessary to work out total mortality. To do so, we used the number of balls - size classes relationship (Figure 3).

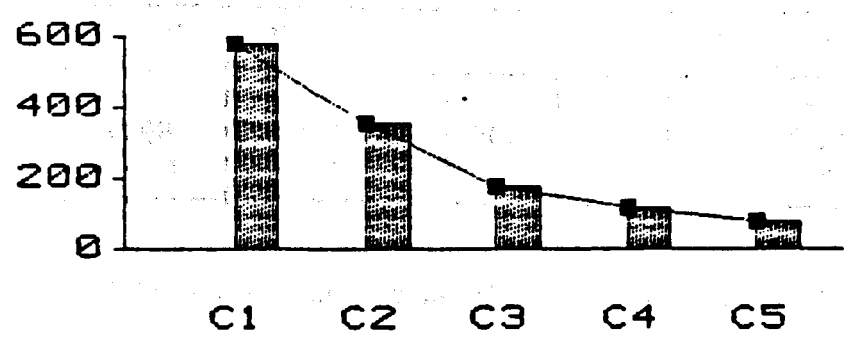

Figure 3. Number-size class relationship

The regular curve of the graph indicates that all classes are represented and none is particularly overfished. Total mortality is given by the classical formula (Gulland 1969):

$$\text{LogNt} = \text{LogNo} - Z \times t \text{ where}$$

Nt = Number of Faviidae at time t. Nt = 76
No = Number of Faviidae at time 0. No = 580
t = time elapsed between No and Nt, i.e. between C1 and C5 t = 60 years
Z = Total mortality per year.

$$Z = \frac{\text{Log } 580}{\text{Log } 76} \times \frac{1}{60} = 0.02$$

Stock management plan

Knowing the exploitable biomass we can estimate the maximum sustainable yield (MSY) by the equation * :

$$\text{MSY} = 0.5 \times Z \times \text{Be where}$$

MSY = Annual maximum sustainable yield
Z = Total mortality = 0.02
Be = Estimate exploitable biomass = 1548 T

* (Brouard and Grandperrin, 1984)

$$\text{MSY} = 0.5 \times 0.02 \times 1548 \text{ T} = 15.5 \text{ T}$$

The maximum sustainable catch is thus about 15.5 T, which is only a twelfth of the tonnage of Faviidae at present being harvested per year.

CONCLUSION

A preliminary assessment of Faviidae stocks in New Caledonia showed these stocks to be very limited on Tetembia reef. With the present rate of exploitation, which is ten times higher than the maximum sustainable yield, there is a real danger of Faviidae becoming extinct on this reef which is the only one where harvesting of corals is authorised.

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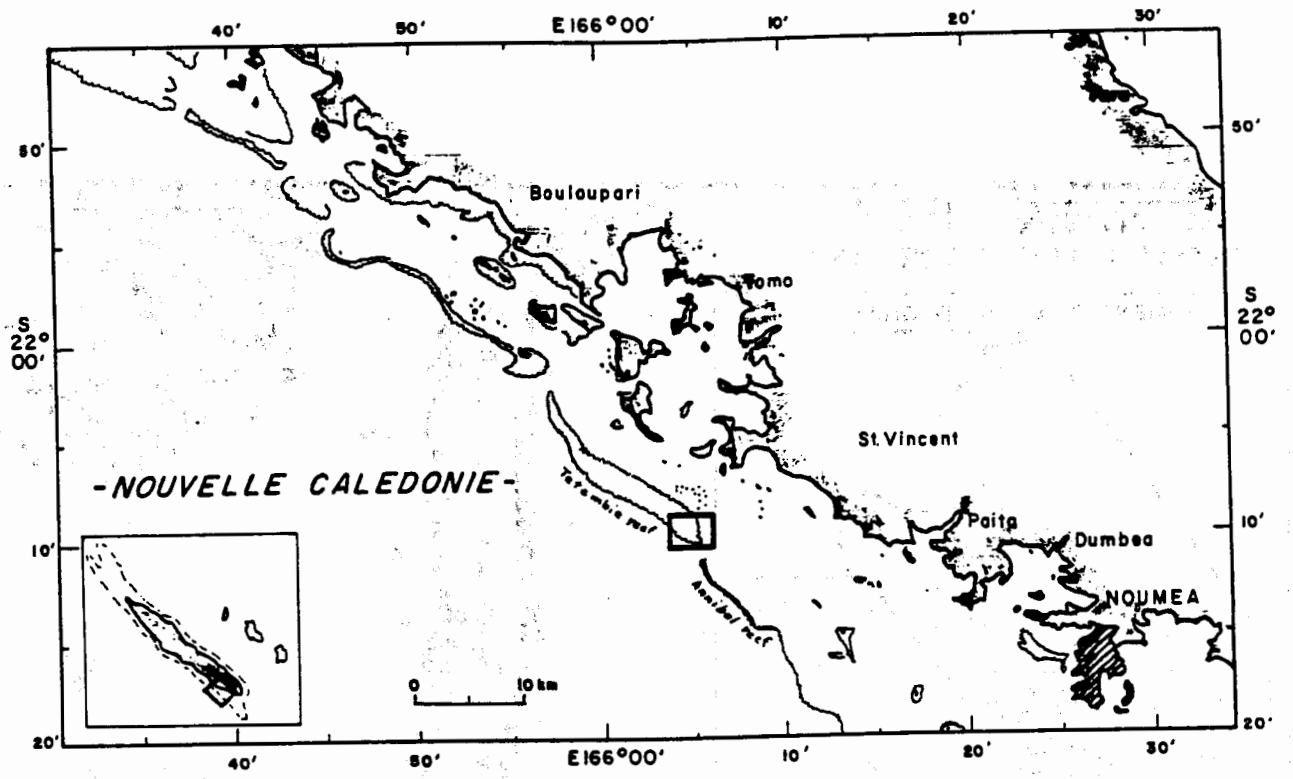
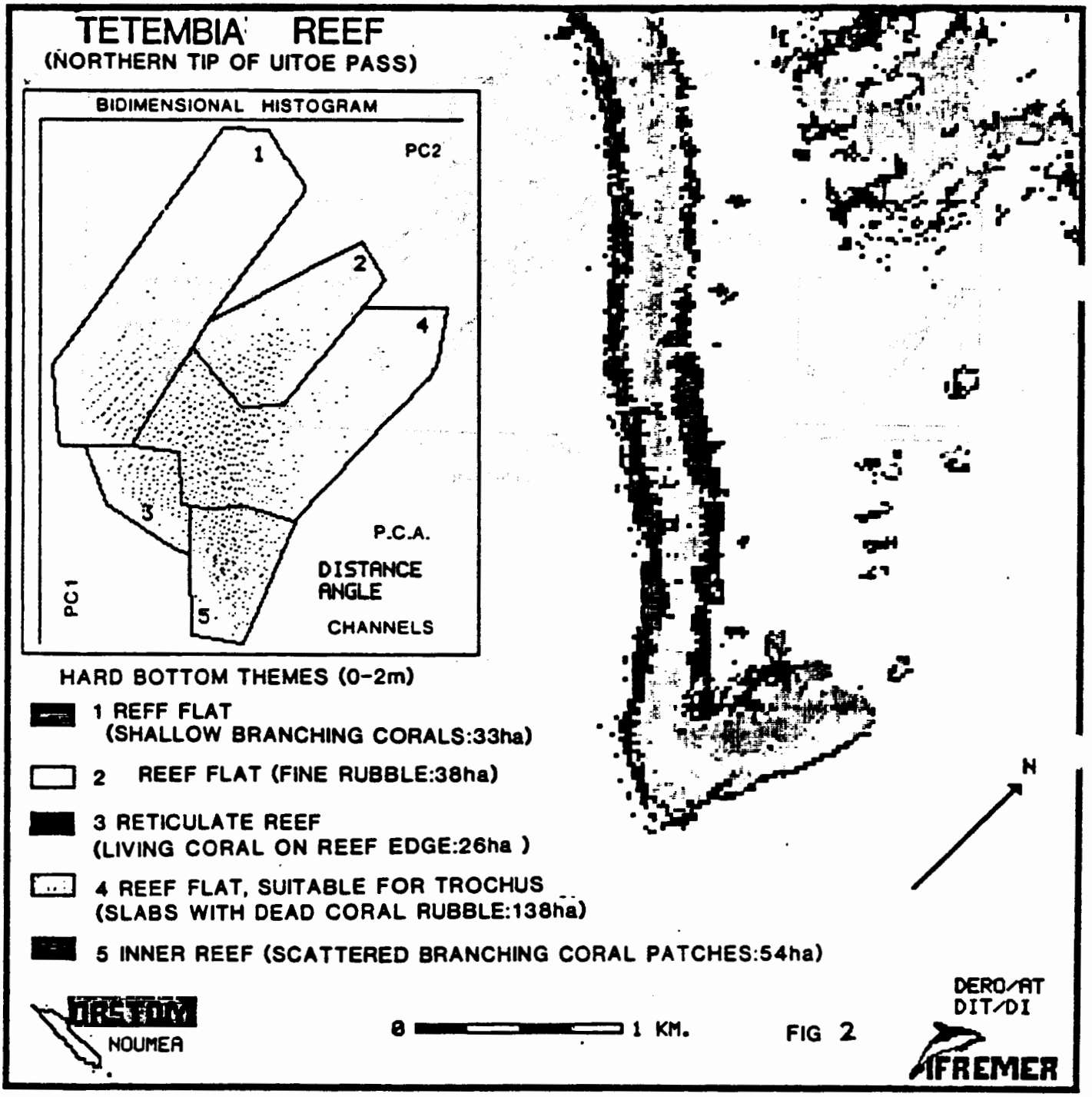


Fig. 1. Location map


TETEMBIA REEF
(NORTHERN TIP OF UITOE PASS)
BIDIMENSIONAL HISTOGRAM
PC2
PC1
1
2
3
4
5
P.C.A.
DISTANCE
ANGLE
CHANNELS
HARD BOTTOM THEMES (0-2m)
1 REFF FLAT
(SHALLOW BRANCHING CORALS:33ha)
2 REEF FLAT (FINE RUBBLE:38ha)
3 RETICULATE REEF
(LIVING CORAL ON REEF EDGE:26ha)
4 REEF FLAT, SUITABLE FOR TROCHUS
(SLABS WITH DEAD CORAL RUBBLE:138ha)
5 INNER REEF (SCATTERED BRANCHING CORAL PATCHES:54ha)
N
ORSTOM
NOUMEA
0
1 KM.
FIG 2
DERO/AT
DIT/DI
IFREMER