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AUSTRALIAN ENVIRONMENTAL
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Griffith University

AES WORKING PAPER 8/83

June 1983

HYDROCARBONS IN GREAT BARRIER REEF
ORGANISMS AND ENVIRONMENT

BY M. COATES, D.W. CONNELL AND G.J. MILLER

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ORGANISMS AND ENVIRONMENT

by

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AES WORKING PAPER 8/83

JUNE, 1983

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PROGRESS IN GREAT BRITAIN

ORGANISMS AND ENVIRONMENT

M. COATES, D.W. CONNELL AND G.J. MILLER

ALL WORKING PAPER

JUNE 1983

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School of Australian Environmental Studies
Griffith University, Nathan, Brisbane, Australia, 4111

ISBN 0 86857 180 6

ISSN 0725 6272

ABSTRACT

Hydrocarbons have been analyzed in specimens from six coral reefs in the Capricorn Group in the southern Great Barrier Reef area, from Arlington Reef near Cairns, from reefs near Lizard Island in the northern Great Barrier Reef area, and from Northwest Reef near Thursday Island in Torres Strait. Sediments and the same suite of seven species were analyzed from each site. Water samples were analyzed in the region of Heron Island.

Silica gel chromatography was used to partition the hydrocarbons into two fractions (f_1 and f_2). The f_1 fraction, eluted from the silica gel column with one column volume of double distilled hexane, contained alkanes, monoolefins and unknowns, which are perhaps cyclo-alkenes or alkanes. The f_2 fraction contained alkenes and in some cases PAHs (polycyclic aromatic hydrocarbons). A total of 288 individual samples from the above areas have been analyzed by gas chromatography. The data are reported as concentration per tissue weight and concentration per lipid weight. After analysis of the individual samples by quantitative gas chromatography, f_1 and f_2 fractions of each sample type were pooled for examination, by gas chromatography/mass spectrometry (GC/MS) in order to identify the components of each sample type.

This report consists of two parts. Part one comprises the results of analysis of the f_1 fractions from the Capricorn Group. Part two comprises the results of analysis of f_1 fractions from the northern Great Barrier Reef (NGBR) including Torres Strait.

In the vast majority of samples, the level of hydrocarbons is very low and probably of biogenic origin. Indeed, in comparison with baseline studies of hydrocarbons in Arctic, Antarctic and northern hemisphere temperate and tropical regions, it appears that the Great Barrier Reef area may be one of the most pristine areas yet studied on the planet, in terms of hydrocarbon pollution. Evidence of localized petroleum pollution was obtained from Heron Island boat harbour and from Freshwater Beach on Lizard Island. The possibility of airborne pollution from the coal burning power station at Gladstone, Queensland as the source

of possible nonbiogenic hydrocarbons (the unresolved complex mixture or UCM) in some organisms and sediments of the Capricorn Group is discussed. The evidence for bacterial production of UCM is also considered.

The different organisms, and the sediments, have characteristic patterns of biogenic hydrocarbons which were, for the most part, constant throughout the area at the time of sampling. Since the levels of biogenic hydrocarbons are very low, these characteristic patterns would be expected to be swamped by even a very small input of petroleum hydrocarbons. Thus the presence of petroleum pollution could be easily detected.

The concentrations of each n-alkane, $C_{15}-C_{32}$, as well as total hydrocarbons, at each site in the Capricorn Group are compared, by regression and correlation analysis, for each pairwise combination of species vs. species and species vs. sediments. Few correlations were found. These results and the specific hydrocarbons in each sample type are the basis of discussion of the causes of the distributions of hydrocarbons in the reef ecosystem.

The relationship of lipid concentration to hydrocarbon concentration in tissue is examined. In general, the concentration of hydrocarbons in these unpolluted reef organisms is not significantly correlated with lipid content of the tissues.

No relationship between length (or weight) and hydrocarbon content was found for the fishes sampled in this study. This suggests that hydrocarbons are not "bioaccumulating" in these fishes.

These negative results: no spacial correlation in concentrations of hydrocarbons, no correlation between lipid content and hydrocarbon concentration and no bioaccumulation of hydrocarbons, are consistent with an unpolluted environment in which factors other than passive accumulation of excess amounts of pollutant hydrocarbons are responsible for the concentrations of hydrocarbons in the tissues.

Part 1: the Capricorn Group

INTRODUCTION

Petroleum is a major pollutant in the oceans. Petroleum wastes arise from land based sources, such as urban run-off, sewage and industrial wastes as well as water based sources such as tankers and oil fields. Estimates place the total quantity involved per year as between 1.9 and 11.08×10^6 tonnes (see Connell and Miller, 1981). Much of this exists in the marine environment in sublethal concentrations which can be absorbed by living organisms and have detrimental effects (see Connell and Miller, 1981).

The Capricorn Group of coral reefs and cays lies within the newly established Capricornia Section of the Great Barrier Reef Marine Park. In the interests of conservation, and management, of the park it is important to have knowledge of the present, baseline levels of hydrocarbons in the reef ecosystems. This study of the Capricorn Group is part of a larger baseline study of hydrocarbons in the Great Barrier Reef region, the first to be undertaken.

Located at some distance from major shipping lanes and population centres, the Capricorn Group makes a good starting point for the larger study. It was expected that this region would be fairly pristine in terms of petroleum pollution and the hydrocarbons present would be primarily of biogenic origin. However it is noteworthy that there have been plans to develop large oil shale deposits at Rundle, near Gladstone. Should this occur substantial quantities of hydrocarbons and related compounds will be handled in this vicinity.

We here concentrated on the so called "saturated" or "alkane" fraction (f_1) resulting from silica gel chromatography of the total hydrocarbon extract. This fraction contains alkanes, mono-olefins and unknowns whose mass spectra are consistent with cyclo-alkanes or alkenes. These are quantified primarily by gas chromatography. This fraction is convenient to work with and has the advantage that there exist many other studies of it from both petroleum polluted and unpolluted environments in other parts of the world.

We report fully on the quantitative analysis of the f_1 fraction of hydrocarbons from seven different organisms as well as sediments from seven sites in the Capricorn Group, and from water sampled near Heron Island. These data have been explored for evidence of petroleum pollution and the individual components in each sample type are discussed. The relationships between lipid content of tissues or sediments and hydrocarbon content, has been analysed for all sample types. In this analysis the data from the NGBR is combined with that of the Capricorn Group.

Finally, we speculate on the possible mechanisms responsible for the distributions of hydrocarbons observed.

MATERIAL AND METHODS

Sample collection

Samples were collected in December, 1980 from seven sites in the Capricorn Group of coral reefs and cays located near the southern extreme of the Great Barrier Reef of Australia (see Fig. 1). Only two of the sites were on the same reef. On Heron Reef it was decided to make an additional collection in the area of the small boat harbour because, of all the sites, this area is the most likely to be polluted with petroleum products.

The sediments and organisms were collected by divers. To avoid contamination of samples the following precautions were taken: divers wore freshly laundered cotton gloves; collecting was done well away from boats with collection stations upcurrent from the boat location; all collecting equipment (spearguns, pry bars, etc.) were carefully washed in n-hexane which was analysed later to check against analysis of collected samples; and the samples were wrapped in aluminium foil and placed in plastic bags as they were collected. Further, the aluminium foil used to wrap the samples was prewashed in n-hexane (although this was an unnecessary precaution as it was later shown that no contaminants could be extracted from the aluminium foil which were not removed by our clean-up procedure).

The organisms sampled were: Plectropoma maculatum (Coral Trout); Scarus sp. (Parrot Fish); Tridacna maxima and crocea (clam); Holothuria atra (sea-cucumber); Acropora sp. (staghorn coral); Fungia sp. (mushroom coral); and Chlorodesmis fastigiata (Turtle Weed). Surface sediments, to a depth of about 15cm, were collected by hand from several locations on the reef flat at each site. In addition a special collection, in which the top 2cm of surface sediments were scooped up, was made at Heron Reef. Water samples were taken in the vicinity of Heron Island over the reef flat at high tide and outside the reef crest at high tide.

General description of organisms and sediment

Scarus sp. (Parrot Fish) are herbivorous feeders which use their beak-like teeth to scrape off algae growing on dead coral and consolidated material on the reef (Choat, 1966).

Plectropoma maculatum (Coral Trout) are carnivorous predatory fish feeding mainly on small fish (Choat, 1968).

Tridacna sp. (clam) are conspicuous bivalves on the reef flat. They are attached to coralline rock, and are usually partially imbedded in the substrate. They are filter feeders; however, some of their nourishment, if not most, are the photosynthetic products of symbiotic, single celled algae (zooanthellae) living in the mantle (Barnes, 1974).

Holothuria atra (sea cucumbers) are deposit feeders which are very abundant in the "sandy" areas of most reefs in the Great Barrier Reef Province. We were unable to locate them in Torres Strait, however, although we searched on a number of reefs in the vicinity of Thursday Island. H. atra appear to obtain their nourishment from bacteria, detritus and algae in the very surface layers of the sediments (Bakus, 1973; Moriarty, 1982).

Acropora sp. (staghorn coral) are large, abundant, branching, colonial stony corals. They occur on the reef flat, crest and slope. They feed by capturing plankton and organic detritus. They also obtain organic carbon from symbiotic zooanthellae (Barnes, 1974).

Fungia sp. (mushroom coral) are solitary, stony coral. They represent a much smaller fraction of the living corals on the reef than Acropora. They occur on the reef flat and slope. They obtain food in the same way as Acropora.

Chlorodesmis fastigiata (Turtle Weed) is a filamentous green alga which grows as bright green tufts firmly attached to coralline rock. This species occurs on the outer reef flat and on the reef slope.

The surface sediments are primarily composed of coral and coralline algae rubble (Maxwell, 1973). Living algae, both red and green, are often conspicuous to the naked eye within the sediment. The top 4cm of sediment collected at Heron Reef, where a large concentration of Holothuria atra were feeding, was covered with a thin mat of algae and detritus.

Sample Preparation

Tissue sampling from each type of organism was as follows: Fish, muscle tissue was removed from the inside of fillets, fish were analysed individually, or in some cases, tissue from 2-3 fish was pooled, three to four samples were analyzed from each site; Iridacna, abductor muscle and kidney tissue were analyzed separately, 3-4 individuals were pooled, 2-4 poolings were analyzed for each site; Holothuria, muscle tissue was scraped from the inside of the outer test, 3-4 individuals were pooled, 2-4 poolings were analyzed for each site; Acropora, parts of branches about 3-4cm from the tips of 7-10 colonies from each site were crushed together, two replicate samples were drawn from each mixture; Fungia, pie-shaped wedges were broken from 7-10 individuals from each site and crushed together, two replicates were drawn from each mixture; Chlorodesmis, portions from 7-10 growths from each site were pooled, two replicates were drawn from each mixture.

Samples of sediments, top 15cm, from 8-12 locations at each site were pooled and replicates drawn for analysis from each mixture.

On Heron Reef a small metal dredge was used to scoop up the top 2cm of sediments in an area where many Holothuria atra were feeding. H. atra were also collected from this area. The purpose was to determine to what extent hydrocarbons in the sediments upon which H. atra feed are transferred directly to the holothurian. The sediment samples were pooled and 5 replicates drawn. Five poolings of 3 H. atra each from this area were analyzed. Since no consistent differences were observed between these H. atra and the others, their analyses are included with the Heron Island collection.

Three filtered and three unfiltered water samples of about 10 litres each were taken at Heron Reef at the top of the tide over the reef flat and on the outer edge of the reef.

Analysis

In the case of all organisms, except the corals, 10-15 grams of tissue, plus 30-45 grams of anhydrous sodium sulphate (heat treated at 400°C for 3 hours) were homogenized with 80ml of n-hexane using an IKA Ultra-Turex T.P. 18/10. This was repeated twice and the decanted hexane solutions bulked, filtered and poured through 3x20 cm heat treated anhydrous sodium sulphate columns. At the start of homogenation the sample was spiked with an internal standard consisting of 2 µg each of flourene, 2,3-benzo-fluorene, C₁₆n-alkane and C₂₆n-alkane.

In the case of the corals 10-15 grams of crushed coral was treated for four hours with 5NHCl to dissolve the calcium carbonate skeleton and the internal standard introduced at the beginning of acid treatment. The solution was then neutralized with 3NNaOH and homogenized with the Ultra-Turex. The 80-100 ml of solution was then twice extracted with 150 ml of n-hexane by shaking in a separatory funnel. The two organic phases were pooled, filtered and poured through an anhydrous sodium sulphate column as above.

With sediments two replicates of about 100g were combined with 200g of anhydrous sodium sulphate and 200 ml of n-hexane. Internal standard was added and the mixture was shaken for four hours at room temperature. The n-hexane extract was then collected and the sediments washed with an additional 200 ml of n-hexane. The two lots of n-hexane were then combined, filtered and poured through an anhydrous sodium sulphate column as above.

The water samples were extracted at the site of collection by consecutively shaking aliquots of about one litre with the same 400 ml of n-hexane, which had been spiked with internal standard, in a separatory funnel. The n-hexane extracts were later poured through anhydrous sodium sulphate columns as above.

The n-hexane extracts from all samples except water were concentrated on a steam bath then air dried at room temperature and the weight of the n-hexane soluble residue ("lipid weight") determined. In the case of water samples it was found that drying resulted in an unacceptable loss of hydrocarbon and therefore lipid weight was not determined.

The hexane soluble residue was dissolved in 2-3 ml of n-hexane (or concentrated to that volume in the case of water samples) and applied to a 3x10 cm column of silica gel (70-230 mesh Keisel Gel; heat treated at 600°C for 3 hours and then deactivated with 5% water). The "n-alkane" fraction (f_1) was eluted with one column volume of n-hexane. An additional fraction (f_2) was eluted with 1.5 column volumes of 5% redistilled diethyl ether in n-hexane. This procedure gave a clean separation of the n-alkane internal standards (f_1) from the aromatic internal standards (f_2). However, (f_1) was shown to contain some unsaturated hydrocarbons. Squalene was distributed about 5% in f_1 and 95% in f_2 .

The f_1 and f_2 fractions were concentrated with a stream of pure nitrogen and analysed by a combination of gas chromatography and gravimetry. Further analysis by gas chromatography/mass spectrometry was carried out for each sample type on pooled fractions.

The gas chromatographic technique was as described by Miller and Connell (1980). A Shimadzu Gas Chromatograph GC-6A instrument was utilized with two metre packed columns (2% SP-2100 liquid phase on Gas-Chrom Q 80/100 mesh solid phase), temperature programmed from 80-280°C. For quantification, a Hewlett Packard Reporting Integrator 3390A was fitted to the instrument. The n-alkanes and squalene were identified by their recovery times. The integrator was calibrated with an external standard mixture of n-alkanes, C₁₂-C₃₂ and with the internal standard mixture described above.

Initial recovery experiments with the standard mixture of C₁₂-C₃₂ n-alkanes showed that in the analytical procedures used recoveries of C₂₀ and above were equal for particular runs but varied between runs. Below C₂₀, however, recovery, in particular runs, dropped away more or less linearly. Therefore the results for hydrocarbons in the f₁ fraction with retention times greater than C₂₀ were corrected for the recovery of the C₂₆ n-alkane internal standard. Results for squalene in the f₂ portion were corrected for recovery of 2,3-benzofluorene (retention time slightly less than C₂₆ n-alkane). Results for hydrocarbons of the f₁ fraction with retention times between C₁₆ and C₂₀ were corrected according to the formula (Chesler, et al., 1976):

$$C_c = (1-k)C_{16}(A_c/A_{16}) + kC_{26}(A_c/A_{26})$$

where: C_c = the concentration in the original sample of the compound of interest.

C₁₆ and C₂₆ = the concentrations in the original samples of the internal standards C₁₆ and C₂₆ n-alkanes.

A_c = peak area of compound of interest.

A₁₆ and A₂₆ = peak areas of internal standards C₁₆ and C₂₆ n-alkanes.

$$k = \frac{t_{Rc} - t_{R16}}{t_{R20} - t_{R16}}$$

where: t_{Rc} = the retention time of the compound of interest.

t_{R16} and t_{R20} = the retention times of the n-C₁₆ and n-C₂₀.

Results for C_{15} n-alkane were corrected for the recovery of n- C_{16} . Use of C_{16} and C_{26} n-alkanes as internal standards of course prevented quantification of these two compounds in the samples. Analysis of samples free of internal standards showed that the concentrations of these n-alkanes were always less than 2% of the internal standard concentrations. The over-estimate of recovery of the internal standards was thus minor.

When the gas chromatographs revealed an unresolved complex mixtures (UCM) of hydrocarbons the combined weight of the UCM was determined by subtracting the combined weight of the resolved hydrocarbons, measured by GC analysis, from the total weight of hydrocarbons in the fraction, determined gravimetrically by air drying aliquots of the fraction and weighing the residues on a Kann microbalance. The total weight of hydrocarbons was corrected for the recovery of C_{26} n-alkane.

Detection limits for individual hydrocarbons were about 0.001 $\mu\text{g/l}$ for water, 0.01 $\mu\text{g/g}$ (lipid weight) and 0.1 $\mu\text{g/kg}$ (wet weight) for tissue and 0.1 $\mu\text{g/g}$ (lipid weight) and 0.01 $\mu\text{g/kg}$ (dry weight) for sediments. Detection limit for UCM was about 20 $\mu\text{g/kg}$ (wet or dry weight), but a measurable amount of UCM was at least >200 $\mu\text{g/kg}$ (wet or dry weight).

Purification of Reagents and Contamination Checks

In order to avoid laboratory contamination of the samples all glassware and instruments were heat treated at 100°C for at least 48 hours and/or rinsed twice with n-hexane before use. Other precautions appropriate to analysis of trace levels of hydrocarbons were employed in a laboratory reserved for this purpose. Blanks were run with every group of ten samples. On the rare occasions when evidence of contamination was obtained the group of samples were discarded. The n-hexane referred to throughout the paper has been twice redistilled through an all glass fractional distillation column having about 10 theoretical plates efficiency.

Gas Chromatography/Mass Spectrometry Examination

Gas chromatography/mass spectrometry examinations were carried out on pooled fractions in order to confirm the identification of

n-alkanes and to partially characterize important unknowns. Because the unknowns seen in this study occur at trace levels their characterization necessarily stops with their mass spectra from the GC/MS runs. These spectra are weak and contaminated with background which further interferes with characterization. However, these spectra serve as "fingerprints" of the compounds so that their presence in different samples can be confirmed. The total hydrocarbons from 10 to 15 samples were pooled for each GC/MS run. A Kratos MS25 instrument was used with a OV-1 capillary column.

GC/MS was also used to determine the mean percentage of different compounds combined in one peak in the packed column gas chromatography (see below). To do this a standard curve was constructed by analyzing a series of mixtures of the compounds by GC/MS, performing single ion plots of the molecular ions of the compounds, and comparing the relative height of the peaks of the molecular ions with the relative amount of each compound present.

RESULTS AND DISCUSSION

The results for each sample type from the different collecting sites in the Capricorn Group are summarized in Tables 1-11. The means and standard deviations are given for each n-alkane, important unknowns, and for the totals listed. N values are as indicated in the materials and methods section. The C_{16} and C_{26} n-alkanes are not quantified because these were used as internal standards. The concentrations of n- C_{17} and pristane are given as combined values in the tables as these compounds were not separated by the packed columns used in most quantitative GC analyses. Furthermore, GC/MS revealed a C_{17} monoolefin (n- C_{17} :1) combined with n- C_{17} and pristane in some sample types. An n- C_{15} :1 compound cochromatographed, in packed column gas chromatography, with n- C_{15} in isolates from the top 4cm sediments from Heron Reef and an n- C_{19} :1 was unseparated as a shoulder on the n- C_{19} peak in Acropora and Iridacna kidney. A $C_{25}H_{48}$ unknown (possibly a cycloalkane) was combined with n- C_{21} in isolates from sediments (see below). Similarly n- C_{28} was not separated from squalene, so these are combined. The squalene + n- C_{28} values are not accurate

for Holothuria, Chlorodesmis and Acropora due to interference by lipid in the GC analysis of the f_2 fraction. The unknowns and identified monoolefins were quantified separately if they were present in most samples of one type (organism, sediment or water) and represented at least two percent of resolved hydrocarbons in more than half of the samples. Total "alkanes" are the sums of the n-alkanes $n-C_{15}$ through $n-C_{32}$, the $n-C_{15}/n-C_{15}:1$, $n-C_{17}/\text{pristane}/n-C_{17}:1$, $n-C_{19}/n-C_{19}:1$ and $n-C_{21}/C_{25}H_{48}$ combined peaks and certain other unknowns. Total resolved hydrocarbons are the sums of all peaks resolved in the GC analyses of the f_1 fractions plus squalene from the f_2 fraction. Total resolved hydrocarbons-squalene is all resolved hydrocarbons in the f_1 fraction less the squalene/ $n-C_{28}$ pair. UCM is the unresolved complex mixture of the f_1 fraction determined gravimetrically as described in materials and methods. Total hydrocarbons are the sums of resolved hydrocarbons plus UCM (Total hydrocarbons = resolved hydrocarbons where no UCM was detected).

Tables 12 and 13 give means and standard deviations, over all samples of a type from all sites, of the most relevant totals from Tables 1-11 in $\mu\text{g}/\text{kg}$ for wet and dry weights (Table 12) and $\mu\text{g}/\text{gm}$ for lipid weight (Table 13). Squalene was subtracted from these totals because it is not included in the values given by other workers to which we wish to compare our data, and, as stated above, it was not accurately measured by us in Holothuria, Chlorodesmis and Acropora.

Graphs in Figures 2-4 are histograms of the mean percentage of total resolved hydrocarbons minus squalene, in the f_1 fraction, of n-alkanes C_{15} through C_{32} ($n-C_{16}$, $n-C_{26}$ and $n-C_{28}$ not included), plus pristane and significant unknowns. Phytane was not detected in any of the sample types in Tables 1-11. Carbon numbers along the X axis refer to n-alkanes, bars representing unknowns are positioned according to their retention times relative to the n-alkanes. In the graphs in Figures 2-4 mean values are for all sites in Tables 1-11. Standard deviations are represented by lines extending from the bars. Where compounds are combined in one peak in packed column gas chromatography the mean percentage of each compound in the peak, as revealed by GC/MS analysis of pooled samples, is given.

Hydrocarbon components of the sample types : biogenic or pollutant ?

It is of major importance to decide if there is any evidence of petroleum, or other types of hydrocarbon, pollution among these baseline data. Therefore, the possibility of hydrocarbon pollution will be considered as the hydrocarbons of each sample type are discussed.

There are four generally recognized criteria for the presence of petroleum hydrocarbons in the "alkane" fraction:

1. a wide range of molecular weights and structures;
2. a homologous series of n-alkanes with no odd/even predominance, usually in the C₁₂-C₂₅ range;
3. the presence of a large UCM component;
4. a relatively high total of hydrocarbon in the fraction; and
5. a significant amount of phytane (some pollution sources).

(Thompson and Eglinton, 1976; Farrington, et al., 1976; Mironov and Shchekaturina, 1976; Hardy, et al., 1977; Miller and Connell, 1980; Connell and Miller, 1981).

Using the same clean up and chromatographic techniques as used for the biological samples, we have analyzed certain possible sources of petroleum pollution in the Great Barrier Reef area. From the Ampol refinery at Litton, on the Brisbane River, we obtained the three major components of fuel oil, which is shipped north, inside the reef, as far as Torres Strait. The refinery names for these components are straight run diesel (SRD), light cycle oil (LCO) and decarbonized bottoms (DCB). LCO and DCB make up 20 and 80 percent, respectively, of furnace oil. SRD and LCO make up 2/3 and 1/3, respectively, of automotive diesel. The f₁ fractions of SRD has a large UCM and a homologous series of n-alkanes from n-C₁₅ to n-C₂₂. Both the homologous series and the UCM are maximum at n-C₁₇. LCO has a UCM and homologous series from n-C₁₂ to n-C₂₄, with a maximum at n-C₁₇. DCB has a UCM and homologous series from n-C₁₂ to n-C₂₄, with a maximum at n-C₁₆-n-C₁₇ (graphs 1-3, fig. 2). With weathering, involving the loss of the lighter components of these petroleum products, it is

expected that their peaks will shift towards high carbon numbers.

Outboard motor fuel had very few resolved peaks but chromatographed as a large UCM extending from about $n-C_{21}$ to $n-C_{34}$ with a maximum at $n-C_{31}$. The marine grease used on boats at Heron Island is essentially all UCM extending from $n-C_{17}$ to $n-C_{34}$ with a maximum at $n-C_{29}$. The outside of motor boats at Heron Island were swabbed with hexane soaked cotton to collect residual hydrocarbons. These chromatographed as large UCMs extending from $n-C_{22}$ to $n-C_{34}$ with a maximum at about $n-C_{31}$.

The presence in continental margin sediments from the north-western Atlantic of a significant UCM, with a maximum at about $n-C_{28}$ to $n-C_{29}$, but without an accompanying homologous series of n-alkanes, has been proposed to be of pyrolytic origin by Farrington, et al. (1977). There is a UCM of this nature in urban air, resulting from the burning of fossil fuel (Farrington, et al., 1977).

Comparisons of the total quantities of hydrocarbons in samples reported by different workers in different parts of the world are difficult for at least four important reasons:

1. the efficiency of extraction techniques used by different workers may vary tremendously (Hilpert et al., 1978). This is more important in a comparison of concentrations of hydrocarbons than in comparison of relative amounts of components within a sample.
2. the same components are not included in the totals by different workers;
3. different species are analysed in different parts of the world, thus we are uncertain as to how much of any difference is due to pollution effects and how much to species differences; and
4. differences in climate may result in differences in environmental modification and/or metabolism of hydrocarbons.

This last point is particularly relevant in the case of the present study because little other work has been done in the tropics. However, some comparisons may be made between our data and those from polluted and unpolluted samples analysed by others.

Water

Brown and Huffman (1976) give 4 $\mu\text{g}/\text{kg}$ as the mean concentration of hydrocarbons in water from the Atlantic, Arctic and Indian Oceans, the Mediterranean Sea and the Persian Gulf. They concluded that the hydrocarbons found were petroleum derived. Shaw and Baker (1978) report values of <0.01 to $1.9 \mu\text{g}/\text{kg}$ saturates in water from unpolluted Port Valdez, Alaska. Middleditch, et al. (1979) determined total alkanes ($n\text{-C}_{13}$ through $n\text{-C}_{36}$ + pristane and phytane) in water samples in the vicinity of the Buccaneer oilfield in the Gulf of Mexico which chronically discharges low levels of hydrocarbons (about 200 g/day/platform). They report total alkanes in unpolluted water samples to be in the range of 0 to perhaps 5 $\mu\text{g}/\text{kg}$. Petroleum polluted samples were as high as 42 $\mu\text{g}/\text{kg}$. However, based on the presence of homologous series of n-alkanes in the $\text{C}_{14}\text{-C}_{21}$ range, there was evidence of pollution in samples of about 1-5 $\mu\text{g}/\text{kg}$. Table 12 gives 0.19 $\mu\text{g}/\text{kg}$ total "alkanes" (similar to the alkanes of Middleditch, et al., 1979) and 0.29 $\mu\text{g}/\text{kg}$ total resolved hydrocarbons minus squalene (similar to the "saturates" of Shaw and Baker) for Heron Reef. Thus, water in the vicinity of Heron Reef, presumably representative of the Capricorn Group waters, contains very low levels of total hydrocarbons compared to other areas of ocean.

In some of Middleditch, et al.'s samples, $n\text{-C}_{17}$ was the predominant biogenic alkane. Others contained n-alkanes in the C_{26} to C_{36} range, with maximum about $\text{C}_{30}\text{-C}_{32}$. It was concluded that these were of bacterial origin (see Davis, 1968).

The four sets of mean values in Table 1 are not significantly different. This probably reflects the relatively small load of phytoplankton and fine organic particles in the southern Great Barrier Reef waters at the time of sampling. It should be noted that during water sampling large pieces of algae and salps were avoided. Graph 4 in figure 2 shows that water from Heron Reef is relatively low in $n\text{-C}_{17}$ compared to the sediments and organisms of the Capricorn Group. There is, however, a significant amount of this compound, as well as a relatively large percentage of n-

C₁₅. n-C₁₇ is characteristic of phytoplankton (Brassell, et al., 1977) and both n-C₁₇ and n-C₁₅ are found in some benthic algae (Blumer, et al., 1971; Youngblood, et al., 1971; Youngblood and Blumer, 1973).

No UCM was detected in the analysis of f₁ hydrocarbons from 10 litres of water. However, when the f₁ hydrocarbons of 401 were analyzed by GC/MS a barely detectable UCM, with a peak at about n-C₂₆ was seen. We were unable to measure this small amount of UCM but it is estimated to be <0.5 µg/kg.

Judging from our samples of water in the vicinity of Heron Island, the background levels of hydrocarbons in southern Great Barrier Reef waters are very low. For this reason we conclude that they are unpolluted. However, the sources of the hydrocarbons in the water are probably varied and may include petroleum and airborne fallout as well as biogenic origins.

Sediments

The hydrocarbon contents of the top 15cm sediments, taken from all stations in the Capricorn Group, and the top 2cm sediments, taken at Heron Reef only, differ considerably and are therefore considered separately.

The U.S. National Academy of Sciences (1975) gives a value of <70 µg/g (dry weight) of alkanes for surface sediments of unpolluted coastal areas and deep marginal seas and basins. Botello and Mandelli (1978) found values for total "n-paraffins" (C₁₄ to C₃₂ + pristane and phytane) in the range of 12 to 56 µg/g dry weight in surface sediments from an unpolluted sea water lagoon on the Gulf of Mexico. The range of values of total alkanes (n-C₁₃ through n-C₃₆ + pristane and phytane) given by Middleditch and Basile (1978) for mainly unpolluted surface sediments, 0.7 to 11.0 km distance from the Buccaneer oil field, is 30 µg/kg to 3.0 µg/g (dry weight). Shaw and Baker (1978) report 0.42 to 25 µg/g (dry weight) for total saturates in sediments from unpolluted Port Valdez, Alaska. The mean values, for Capricorn Group top 15cm sediments, of 248.4 (±232.2) µg/kg (dry weight) for total "alkanes" and 904.1 (±701.4) µg/kg for UCM + total resolved hydrocarbons minus squalene (Table 12) are probably within the

range of unpolluted sediments, as are the mean values of 290 ± 37.2 $\mu\text{g}/\text{kg}$ (dry weight) for total "alkanes" and 658.6 ± 90.6 $\mu\text{g}/\text{kg}$ (dry weight) for total resolved hydrocarbons minus squalene in Heron Reef top 2cm sediments.

Graph 5, figure 2 gives the mean resolved hydrocarbon composition of the top 15cm sediments. In these sediments, as well as in the organisms in this study, the pattern of hydrocarbon composition in all samples from all sites is remarkably constant. In common with the unpolluted sediments reported on in the three studies cited above, the pattern is dominated by a few components and there is a strong odd/even predominance.

Among the resolved hydrocarbons the $n\text{-C}_{17}$ /pristane/ $n\text{-C}_{17}$:1 group predominates, as it does in all samples, other than water, in this study. There are also large amounts of squalene present in all samples (Table 2-9). Middleditch and Basile (1978) and Shaw and Baker (1978) also found relatively large amounts of $n\text{-C}_{17}$, pristane and squalene in their unpolluted sediments. We thus conclude that the resolved hydrocarbons in top to 15cm sediments of the Capricorn Group are primarily biogenic in origin.

The unknown between $n\text{-C}_{20}$ and $n\text{-C}_{21}$ in the top 15cm sediments is primarily polymerized sulfur, indicating that, at least for part of their depth, these sediments are anaerobic.

Two C_{25} unknowns were detected in these sediments by GC/MS. One, which cochromatographs with $n\text{-C}_{21}$ (graph 5, fig. 2 and Table 2), has a molecular weight of 348 and is probably $\text{C}_{25}\text{H}_{48}$ (designated $\text{C}_{25}\text{H}_{48}\text{A}$). The other, detectable in some samples between $n\text{-C}_{21}$ and $n\text{-C}_{22}$ (graph 5, fig. 2) has a molecular weight of 350 and thus is probably $\text{C}_{25}\text{H}_{50}$ (designated $\text{C}_{25}\text{H}_{50}\text{A}$). The mass spectra of these compounds are given in Figures 5 and 6. The prominent even numbered ions in these spectra are consistent with cyclic structures. If this is true the 350 molecular weight compound would be a saturated compound with one ring. The 348 compound may have one ring and one double bond or two rings. Some branching in these compounds is suspected.

The pattern of hydrocarbons for the top 2cm sediments from Heron Island (graph 6, fig. 2) also appears to be biogenic. The $C_{15}:1$, $C_{17}:1$ and $C_{19}:1$ compounds, present in relatively large proportions, are characteristic of some benthic algae (Blumer, et al., 1971; Youngblood, et al., 1971; Youngblood and Blumer, 1973). It is noteworthy that the top 15cm sediments contain pristane, whereas the top 2cm sediments do not.

The C_{25} unknowns seen in the top to 15cm sediments are present in greater proportion in the top 2cm sediments. Also there is a significant amount of another unknown, perhaps $C_{21}H_{36}$, branched and/or cyclic (see fig. 7 for mass spectra).

Interestingly, both Farrington, et al. (1977) and Boehm and Quinn (1978) report the presence of C_{25} cyclic alkenes in sediments from localities off the northeast coast of the U.S.A. Similar, if not identical, alkenes in coastal sediments have been reported from other locations in the Atlantic Ocean and Gulf of Mexico (Erhardt and Blumer, 1972; Farrington and Quinn, 1973; Farrington and Tripp, 1975; and Gearing, et al., 1976). One of these has a molecular weight of 348 in common with the $C_{25}H_{48}^A$ unknown found in the Capricorn Group sediments. However, comparison of the mass spectra indicate that the compounds are not identical. Farrington, et al. (1977) and Boehm and Quinn (1978) conclude that these compounds are biogenic, however, they were not able to identify their source.

Of the organisms analyzed in this study we found the $C_{25}H_{48}^A$ unknown in the deposit feeding Holothuria only. This fact, and the observation that the relative concentration of the C_{25} unknowns decreases with depth in the sediments, suggests to us that they are produced in situ by organisms, perhaps benthic algae or bacteria living in the upper aerobic sediment layers and that the compounds are broken down, perhaps by other bacteria, in the lower anaerobic sediment layers.

All the top to 15cm sediment samples had a UCM (Tables 2, 12) with a very broad peak between $n-C_{21}$ and $n-C_{28}$. The mean percentages of UCM of the total of UCM + resolved hydrocarbons minus squalene are given for all sites in Table 14. Although the

UCM is a substantial percentage of the total in all cases, it is still a very small amount of material, \bar{X} of $630.0 \pm 664.5 \mu\text{g}/\text{kg}$ (dry weight)(Table 12). Teal and Farrington (1977) report UCM values of 3800 to 28000 $\mu\text{g}/\text{kg}$ (dry weight) for unpolluted, and 5000 to 60000 $\mu\text{g}/\text{kg}$ (dry weight) for slightly polluted sediments. Shaw and Baker (1978) also found an UCM in three of their presumably unpolluted samples.

It is the concensus that the UCM, which consists of isoalkanes, cycloalkanes and polyaromatic hydrocarbons, is not of biogenic origin although production of a UCM by bacteria is not ruled out (see Farrington, et al., 1977 for discussion). Four likely sources of the UCM in the sediment studied by Farrington, et al. (1977), given here in descending order of importance, according to these authors, are: anthropogenic pyrolytic sources (UCM in air due to burning of fossil fuels), natural pyrolytic sources (forest fires), chronic oil pollution, and recent diagenesis of organic matter.

Farrington, et al. (1977) measured the UCM at a series of depths in core samples of sediments. They found the highest concentration in sediments from 1-2cm deep, 105 $\mu\text{g}/\text{g}$ (dry weight), and the lowest, 5.2 $\mu\text{g}/\text{g}$ (dry weight), in the deepest sediments, 54-58cm. These deeper samples correspond to the late eighteenth century, before the industrial revolution. Even given that our extraction technique may be less efficient (they used the Soxhlet technique), our values, which ranged from about 0.1 $\mu\text{g}/\text{g}$ (dry weight) (One Tree Island) to 2.0 $\mu\text{g}/\text{g}$ (dry weight) (Heron Island boat harbour)(Table 2), are more comparable to the preindustrial values of the north east coast of North America.

The source of the UCM in Capricorn Group sediments may, in fact, be a combination of those listed above, which is consistent with the broad peak of the UCM. Bacterial activity may also contribute to the UCM. In the case of the Heron Island boat harbour, where the percentage of UCM is greater than one standard deviation from the mean (Table 14), chronic petroleum pollution probably contributes significantly to the UCM.

A large coal burning power station exists about 70km west of the Capricorn Group at Gladstone, Queensland. Although the prevailing winds are from the south east in this region, it is conceivable that airborne UCM could be deposited in Capricorn Group sediments. This suggestion is supported by the fact that the collecting site closest to Gladstone, Polmaise Reef, contained the highest UCM concentration, after the Heron Island boat harbour (Tables 2 and 14).

The UCM in the top 2cm of sediments at Heron Island was present in trace amounts ($<10 \mu\text{g}/\text{kg}$), unmeasurable by our gravimetric method, but seen when all samples were pooled for GC/MS analysis. Farrington, et al. (1977) also observed in some samples a lower concentration of UCM in surface to 1cm than in the sediment layer just below. Farrington, et al. list two possibilities to account for this:

1. surface sediments are further from the source(s), and
2. dilution of surface sediments by deep sediments, with low UCM, by bioturbation.

The sediments on Heron Reef where our sampling was done originated from coralline algae and coral growing on the reef (Maxwell, 1973). Thus any explanation for the lower UCM concentrations in surface sediments can not involve movement of sediments over great distances. At this point we can only give the possibilities which might account for lower UCM in surface sediments:

1. a slower rate of deposition of UCM in recent times - this argues against the Gladstone power station as the source;
2. dilution of UCM in the upper sediments;
3. removal of UCM from the upper sediments;
4. concentration of UCM in lower sediments;
5. production of UCM in lower sediments - this last possibility needs investigation in coral reef environments.

Investigation of the PAH's in the f_2 fractions and in possible sources of pollution may shed light on the source(s) of UCM in Capricorn Group sediments and organisms.

We can not rule out the possibility of a chronic very low level of hydrocarbon pollution in sediments throughout the Capricorn Group. It appears certain to occur in the Heron Island boat harbour. However, the patterns of resolved hydrocarbons are strongly suggestive of biogenic origin, and the total concentration of hydrocarbons in the sediments is low, suggesting that hydrocarbon pollution is minimal. We also suggest that airborne hydrocarbon pollutants, possibly originating from the power station at Gladstone, may be finding their way into Capricorn Group sediments. Although bacterial production of the UCM is not ruled out.

Chlorodesmis

Although relatively rich in hydrocarbons (Tables 12 and 13), there is almost no evidence of nonbiogenic hydrocarbons in any of the Chlorodesmis samples. There is no detectable UCM.

Graph 1, figure 3 shows a pattern of hydrocarbons for Chlorodesmis which is eminently biogenic in nature. Note the series of odd carbon number pairs of n-alkanes and monoolefins from C₁₇ to C₂₅, as determined by GC/MS. Also there is a virtual absence of compounds above C₂₅.

Corals

Meyers (1977) gives values for total saturated hydrocarbons in corals of 1-4968 µg/g (dry weight), $\bar{X} = 325.4 (\pm 975.7)$ µg/g. Table 12 shows that both Fungia and Acropora are well within this range, even allowing for a ten fold increase to convert to dry weight values. Fungia with a mean concentration of total resolved hydrocarbons minus squalene of about 294.4 (± 120.4) µg/kg (wet weight), is about an order of magnitude lower in concentration than Acropora, with $\bar{X} = 4140.4 (\pm 1496.8)$ µg/kg (wet weight) (Table 12). Further, a UCM was not detected in any of the Fungia samples, while all of the Acropora samples had UCM's with a peak at about n-C₂₂ to n-C₂₃. The percentages of UCM of the total of UCM + resolved hydrocarbons minus squalene for Acropora in Table 14 do not show great variation between sites.

Graphs 3 and 4, figure 3, show strong odd/even predominance in the alkanes of Fungia and Acropora. This is at variance with the conclusions of Koons, et al. (1965) and Meyers (1977). Meyers (1977) reports that n-C₁₇, pristane and squalene are important constituents in many corals. C₁₇ n-alkane is the most important constituent of both Fungia and Acropora f₁ fractions (graphs 3 and 4, fig. 3). Acropora also contains n-C₁₇:1 and pristane, while Fungia has neither of these compounds. Note the presence in Acropora of n-C₁₉:1 and an unknown between n-C₂₁ and n-C₂₂. The unknown between n-C₃₁ and n-C₃₂ in Fungia is possibly an C₃₃ alkene with one double bond (molecular ion 462, formula C₃₃H₆₆).

While the patterns of resolved hydrocarbons in graphs 3 and 4, figure 3 appear biogenic, the presence of a UCM in Acropora samples indicates some pollution; if we accept the consensus that the UCM is nonbiogenic (see above). The position of the UCM peak is n-C₂₂ to n-C₂₃.

It is interesting that a UCM is present in Acropora while it is absent in the organisms other than Holothuria. Holothuria may get its UCM from the sediments upon which it feeds, but what is the source of the UCM in Acropora?

The UCM hydrocarbons may be accumulating in lipid, known to be present within the nonliving skeleton of Acropora (Young, et al., 1971). In our analysis both the polyps and the much greater mass of the coral skeleton are extracted. Minute amounts of UCM hydrocarbons may be extracted from the water by the living outer polyp layer of the coral and these may find their way to the underlying skeletal material, either actively or passively, and become entrapped in the lipid material there. The lack of a detectable UCM in the coral Fungia may be related to lower activity and growth rate of a solitary coral as opposed to a colonial one.

Iridacna

Of the invertebrates analyzed for hydrocarbons, mussels, oysters and scallops are at least in the same taxonomic class as Iridacna. These organisms are all filter feeders, however Iridacna's nourishment is subsidized by symbiotic unicellular algae (Zooanthellae) living in the mantle of the clam.

Anderson, et al. (1974) give concentrations of paraffins (C_{15} to C_{33} + pristane and phytane) in oysters of 1-2 $\mu\text{g/g}$ and 10 to 160 $\mu\text{g/g}$ (wet weight) for unpolluted and polluted areas respectively. Botello and Mandelli (1978) report values of total paraffins (C_{14} to C_{32} + pristane and phytane) of 3.3-8.4 $\mu\text{g/g}$ (wet weight) for the same species in an unpolluted area.

Whittle, et al. (1977) report values for the sum of n-alkanes C_{15} - C_{33} of 1.7 $\mu\text{g/g}$ and 0.3 $\mu\text{g/g}$ (wet weight) for mussels and scallops respectively. Values reported by Middleditch and Basile (1980) for total alkanes (n- C_{13} -n- C_{36} + pristane and phytane) for an oyster species in the vicinity of the Buccaneer oil field were in the range <0.01 to 2.9 (\bar{X} = 0.89) $\mu\text{g/g}$ (wet weight). Australian mussels from clean sites in Westernport Bay had 0-16.0 (\bar{X} = 7.4) $\mu\text{g/g}$ (wet weight) of n-alkanes (C_{14} - C_{34}) (Burns and Smith, 1977). These values compare with \bar{X} = 105.1 (± 150.4) $\mu\text{g/kg}$ (wet weight) and \bar{X} = 427.9 (± 163.7) $\mu\text{g/kg}$ (wet weight) for total "alkanes" in Iridacna muscle and kidney tissues respectively (Table 12).

Unpolluted mussels analyzed by Shaw and Baker (1978) had 0.1-2.5 $\mu\text{g/g}$ (wet weight) of saturates. Wise, et al. (1980) report values of resolved aliphatics, UCM and UCM + resolved aliphatics from different laboratories for unpolluted Alaskan, and polluted Santa Barbara mussels. For unpolluted mussels resolved aliphatics were in the range 1.5-7.1 (\bar{X} = 4.1) $\mu\text{g/g}$ (wet weight), whereas for polluted the range was 1.8-10.9 (\bar{X} = 3.5) $\mu\text{g/g}$ (wet weight). UCM's for unpolluted and polluted, respectively, were 14.8-22.0 (\bar{X} = 17.6) $\mu\text{g/g}$ and 66-99 (\bar{X} = 82.8) $\mu\text{g/g}$ (wet weight). Totals of resolved + UCM for unpolluted and polluted, respectively, were 12-23.5 (\bar{X} = 23.5) $\mu\text{g/g}$ and 42.7-105.5 (\bar{X} = 99.4) $\mu\text{g/g}$ (wet weight). Burns and Smith (1977) report values of 0.3 to 1.0 (\bar{X} = 0.8) $\mu\text{g/g}$ (wet weight) for UCM in Australian mussels. Anderlini, et al. (1981) give values for resolved and unresolved hydrocarbons in saturate fractions from oysters on the Kuwait Coast. These animals can be expected to suffer from some chronic oil pollution. Values for resolved and unresolved, respectively, are 9.6-18.8 (\bar{X} = 13.4) $\mu\text{g/g}$ and 6.9-212 (\bar{X} = 47.1) $\mu\text{g/g}$ (dry weight).

These values are compared with $\bar{X} = 277.1 (\pm 576.4) \mu\text{g}/\text{kg}$ and $\bar{X} = 516.6 (\pm 203.2) \mu\text{g}/\text{kg}$ (wet weight) for total resolved hydrocarbons minus squalene in Iridacna muscle and kidney tissues respectively (Table 12). Allowing a tenfold increase in concentration in Iridacna, to account for the dry weight/wet weight difference, the Iridacna values are closer to the values for unpolluted oysters from Kuwait. One of the three Iridacna muscle tissue samples, consisting of three pooled individuals, from Wreck Island had unusually large amounts of alkanes and a sizeable UCM (6000 $\mu\text{g}/\text{kg}$ wet weight) (Table 6). All other Iridacna samples, including those from Wreck Island, the UCM was below the level of detection in the analysis of individual samples. When samples were pooled for GC/MS analysis small UCMs (<10.0 $\mu\text{g}/\text{kg}$), with peaks between n-C₂₂ and n-C₂₃ were detected in both muscle and kidney tissue of Iridacna. The muscle UCM was slightly larger.

The dominant constituent of both muscle and kidney tissue of Iridacna is n-C₁₇. Both contain some n-C₁₇:1 but lack pristane. Both have relatively large percentages of n-C₁₅. Kidney tissue contains a significant percentage of n-C₁₉:1, while muscle lacks this component. On the other hand, there are larger percentages of n-C₂₅, n-C₂₇, n-C₂₉ and n-C₃₁ in muscle than in kidney tissue (graphs 1 and 2, fig. 4).

The relatively low levels of hydrocarbons in Iridacna muscle and kidney tissue, along with the barely detectable UCM and strongly biogenic patterns in graphs 1 and 2, fig. 4 lead us to conclude that if there is any hydrocarbon pollution, petroleum or otherwise, in Iridacna of the Capricorn Group it exists at the limits of our ability to detect it.

Holothuria

Teal (1976) has analyzed two individual deposit feeding holothurians, of two different species, from abyssal depths; thus presumably unpolluted. The patterns of hydrocarbons in the fraction analyzed (nearly equivalent to our f₁ fraction) showed no relation to the pattern of the sediments upon which the organisms feed. Total hydrocarbons were 7.7 $\mu\text{g}/\text{g}$ wet weight and 29.0 $\mu\text{g}/\text{g}$ lipid weight for Holothurian #1 and 22.2 $\mu\text{g}/\text{g}$ wet weight and

115.00 $\mu\text{g/g}$ lipid weight for Holothurian #2, which also had a UCM of 7.9 $\mu\text{g/g}$ wet weight. The mean values for Holothuria for total resolved hydrocarbons minus squalene are 1033.5 (\pm 418.2) $\mu\text{g/kg}$ (wet weight)(Table 12) and 125.1 (\pm 45.0) $\mu\text{g/g}$ lipid weight (Table 13). Mean UCM for this species is 4288.7 $\mu\text{g/kg}$ wet weight (Table 12). Thus the values for Holothuria are similar to those of holothurians from abyssal depths.

The alkane concentrations of three echinoderms (not deposit feeders) in relatively unpolluted areas have been reported. One starfish species had a mean of 43.1 $\mu\text{g/kg}$ (wet weight) (sum of $n\text{-C}_{15}\text{-}n\text{-C}_{33}$ + pristane and phytane) (Clarke and Law, 1981). Another starfish species had 100 to 4200 (\bar{X} = 1700) $\mu\text{g/kg}$ (wet weight) (sum of $\text{C}_{15}\text{-C}_{33}$ n-alkanes) (Whittle, et al., 1977). A sea urchin had <10 to 2400 (\bar{X} = 1195) $\mu\text{g/kg}$ (wet weight) of n-alkanes ($\text{C}_{13}\text{-C}_{36}$ + pristane and phytane) (Middleditch and Basile, 1980). The \bar{X} values of 627.3 $\mu\text{g/kg}$ (\pm 214.3) (wet weight) for Holothuria total "alkanes" given in Table 12 is within this range of values. A deposit feeding clam from Alaska had 500-6200 $\mu\text{g/kg}$ (wet weight) of saturates (Shaw and Baker, 1978). The value for the total of UCM + resolved hydrocarbons minus squalene given for Holothuria in Table 12 (5322.2 \pm 4164.8 $\mu\text{g/kg}$, wet weight) is somewhat in excess of this range.

The UCM of Holothuria, present in all but the Wreck Island samples (Table 8), may be derived from the UCM of the sediments upon which the animal feeds. Like the UCM of sediments, that of Holothuria also has a broad peak from $n\text{-C}_{21}$ to $n\text{-C}_{24}$. Water may also be a source of UCM in Holothuria. Holothuria does not burrow into the sediments but feeds by picking up material from the surface with its tentacles and placing the particles into its mouth. As pointed out earlier, the top 2cm has only trace amounts of UCM, <10 $\mu\text{g/kg}$. Water has even less UCM, <0.5 $\mu\text{g/kg}$. Thus the UCM is greatly concentrated in the Holothuria. This would suggest that the UCM hydrocarbons are very resistant to breakdown and/or discharge by these animals. Thus we can not rule out the possibility of chronic, but very slight, hydrocarbon pollution of Capricorn Group Holothuria. This pollution, if present, does not seem to effect the resolved hydrocarbon pattern which appears biogenic.

$n\text{-C}_{17}$ is again the dominant component of the f_1 fraction in Holothuria. $n\text{-C}_{25}$ is the next most important alkane. $n\text{-C}_{15}$ and $n\text{-C}_{17}:1$ are also present in significant percentages, while pristane is missing (graph 2, fig. 3). The unknown between $n\text{-C}_{20}$ and $n\text{-C}_{21}$ is predominantly the $\text{C}_{25}\text{H}_{48}$ unknown found in sediments (fig. 5). The peaks between $n\text{-C}_{21}$ and $n\text{-C}_{22}$ and $n\text{-C}_{22}$ and $n\text{-C}_{23}$ are a mixture of $\text{C}_{25}\text{H}_{48}$ and $\text{C}_{25}\text{H}_{50}$ unknowns which are not identical to those found in sediments.

Coral Trout and Parrot Fish

The means of total n-alkanes ($\text{C}_{15}\text{-C}_{33}$) of fish from the open sea, thus presumably unpolluted, measured by Whittle, et al. (1977) ranged from 200 to 1500 $\mu\text{g}/\text{kg}$ (wet weight) in muscle tissue. Means of total n-alkanes ($\text{C}_{15}\text{-C}_{33}$ + pristane + phytane) ranged from about 64.9 to 135.5 $\mu\text{g}/\text{kg}$ (wet weight) for six fish muscle tissues from an unpolluted area in Antarctica (Clarke and Law, 1981). For Parrot Fish and Coral Trout the mean values for total "alkanes" are 236.7 (± 74.3) $\mu\text{g}/\text{kg}$ and 291.4 (± 69.1) $\mu\text{g}/\text{kg}$ (wet weight) (Table 12). These values are consistent with the "unpolluted" values given above. The resolved hydrocarbon patterns in graphs 3 and 4 in figure 4 are consistent with biogenic origin.

The fishes have similar patterns with very few n-alkanes present in significant amount other than $n\text{-C}_{15}$, $n\text{-C}_{17}$ and $n\text{-C}_{25}$. Pristane is the dominant component in the f_1 fraction of Coral Trout, while $n\text{-C}_{17}$ is dominant in Parrot Fish. Both have $n\text{-C}_{17}:1$.

Barely detectable UCMs ($<10.0 \mu\text{g}/\text{kg}$) were seen in the pooled f_1 fractions of both fishes analyzed by GC/MS. These were bimodal with peaks at $n\text{-C}_{22}$ to $n\text{-C}_{24}$ and $n\text{-C}_{28}$ to $n\text{-C}_{30}$.

We conclude that any hydrocarbon pollution in Coral Trout and Parrot Fish is at the limit of our ability to detect it.

Possible causes of observed distribution of hydrocarbons in the Capricorn Group

The results of our analysis of hydrocarbons in organisms and sediments of the Capricorn Group are now considered in terms of what they may reveal about the causes of the observed distribution of hydrocarbons in this area.

There are basically two ways in which the hydrocarbon results may be inspected in an attempt to reveal relationships which may suggest causes of the distribution. One way is to see if there is a correlation between the concentration of the hydrocarbons and some other characteristic of the sample types, eg. location, phylogenetic position, trophic level, lipid content, feeding behaviour, etc. Another way is to compare the relative proportions of hydrocarbons in different sample types (figs. 2, 3 and 4).

A search for causes is complicated by the different ways by which hydrocarbon patterns may be produced in marine organisms, for instance: passive uptake from water or food; selective accumulation, and/or loss of specific hydrocarbons; diagenesis of hydrocarbons and/or other classes of chemicals and synthesis of hydrocarbons.

The possible contribution of various known causes of hydrocarbon distribution in marine organisms will be considered for the Capricorn Group data under separate headings.

Synthesis

We distinguish synthesis as it occurs in plants from diagenesis, or production of hydrocarbons from precursors taken in as food, as occurs in animals. Some of the hydrocarbons synthesized by Chlorodesmis are shown in graph 1, figure 3. This pattern is quite simple and consists of pairs of odd numbered n-alkanes and monoolefins from C₁₇ to C₂₅. Significant amounts of n-C₁₅ and n-C₁₈ are also present.

Unfortunately the extent to which animals synthesize hydrocarbons is unknown. Here we will follow convention and assume insignificant synthesis of hydrocarbons by animals.

Passive uptake of pollutant hydrocarbons

It has been abundantly demonstrated that marine organisms will passively take up hydrocarbons from petroleum, and presumably other types of hydrocarbon, pollution (Lee, 1977; Connell and Miller, 1981).

In the previous section we were unable to rule out a very low level of chronic hydrocarbon pollution in the Capricorn Group area because of the presence of UCM's. However, the low overall level of hydrocarbons, the eminently biogenic patterns in all sample types, the lack of any detectable phytane, whose presence is considered evidence of petroleum pollution, and the low UCM component in the samples suggests strongly that possible uptake of hydrocarbon pollutants is at a very low chronic level.

Further evidence bearing on the possibility of hydrocarbon pollution in the Capricorn Group comes from the attempt to correlate the concentration of hydrocarbons in one sample type with that in another collected at the same site. If there were a significant amount of passive uptake of hydrocarbon pollutants, it is likely that varying amounts of pollution at different sites would be reflected in the hydrocarbon concentrations of sediments and organisms at different sites and there would thus be a significant spatial correlation between hydrocarbon concentrations in different sample types. Some workers have found hydrocarbon concentrations in organisms to be spatially correlated with pollution intensity (Burns and Smith, 1977; Jensen, 1981).

Regression/correlation analyses were performed for the individual alkanes and the totals (both wet or dry weight and lipid weight) in Tables 2-10, over the sites listed in Tables 2-10 (each site represents a point), in all pairwise combinations of organisms versus organisms and organisms versus sediments (top 15cm). In all 1512 analyses were performed. The positive regression/-correlations obtained, where the analyses of variance showed significance at the 5% level at least, are listed in Tables 15 and 16. Thirty-one occurred for wet or dry weight and 46 for lipid weight. Fifteen and 9 significant negative correlations occurred for wet or dry weight and lipid weight respectively.

These data show little evidence of significant uptake of hydrocarbon pollutants. The number of positive correlations is low compared to the total number of analyses, about what would be expected by chance. The only suggestive results are the correlations between Parrot Fish and Coral Trout for individual alkanes and the correlation between Acropora and Holothuria for UCM.

The correlations between the fish may reflect a similar mode and rate of uptake, through the gills, from water and perhaps similar physiologies and the fact that large Coral Trout feed on Scarus (Choat, 1966). Beyond $n-C_{17}$ the percentages of hydrocarbons of the fish are similar to water (compare graphs 3 and 4, fig. 4 with graph 4, fig. 2).

The correlation between Acropora and Holothuria for UCM supports the possibility that UCM hydrocarbons from a chronic low level source may be accumulating in these organisms.

It might have been expected that there would be significant correlations between sediments and the deposit feeding Holothuria. However, the top 15cm sediments sampled do not adequately represent the surface sediments upon which Holothuria feed.

Passive uptake and accumulation of biogenic and background hydrocarbons

The lack of spatial correlations between different sample types does not rule out the possibility of passive uptake, and accumulation, of certain hydrocarbons present at low levels. For instance, the immediate source of hydrocarbon may differ for each organism or a common source of hydrocarbon might exist but its level of variation may be less than the variation between organisms of the same sample type, caused by active processes such as selective uptake, concentration, metabolism, etc.

$n-C_{17}$, $n-C_{15}$, $n-C_{17}:1$ and $n-C_{25}$ are all commonly prominent hydrocarbons in the samples from the Capricorn Group (figs. 2-4). It seems, therefore, that the most likely ultimate cause of their presence in the animals is passive uptake from similar,

probably food, source(s). All of these components are prominent in some benthic algae (Blumer, et al., 1971; Youngblood, et al., 1971; Youngblood and Blumer, 1973), certainly Chlorodesmis is a rich source of them (graph 1, fig. 3). $n-C_{17}$ is the dominant alkane in phytoplankton (Brassell, et al., 1977). Phytoplankton may also contain $n-C_{15}$, $n-C_{17}$ and $n-C_{17}:1$ (Clark and Blumer, 1967). All of the animals in this study could have some benthic algae, or its detritus, or phytoplankton in their diets. Alternatively, some animals may obtain these compounds secondarily by feeding on animals which feed on benthic algae or phytoplankton. For instance, Coral Trout are known to feed on Parrot Fish (Choat, 1968). The contribution of the symbiotic zooanthellae of Iridacna and coral to the animals' hydrocarbon patterns is unknown but deserves investigation.

The lack of pristane in the top 2cm sediments and in Holothuria, and the presence of the $C_{25}H_{48}A$ unknown in both, supports the idea that the hydrocarbon patterns of animals reflect uptake from food.

Interestingly, the patterns of relative proportions of alkanes above $n-C_{17}$ in animals, and sediment, but not in Chlorodesmis are suggestive of those in water where there is a dip between $n-C_{18}$ and $n-C_{24}$ and a broad peak between $n-C_{25}$ and $n-C_{29}$ which then falls away to $n-C_{32}$ (figs. 2-4). This may indicate a passive uptake, and accumulation, by animals, of these hydrocarbons from water.

Selective uptake, concentration, and/or loss of hydrocarbon

For the patterns of hydrocarbons seen in figures 3 and 4, which are quite similar among the animals, to have been caused by selective uptake, concentration, and/or loss of hydrocarbons, the mechanisms for these processes would have to be remarkably similar in the different animals. We feel this is unlikely given the great phylogenetic distances between organisms in this study and given the fact that the resolved hydrocarbon patterns of the different animals in the Capricorn Group are more similar to one another than they are to patterns from more closely related animals from other parts of the world (see Koons, et al., 1965; Whittle, et al., 1974; Meyers, 1977; Teal and Farrington, 1977;

Mackie, et al., 1978; Shaw and Baker, 1978; Shaw and Wiggs, 1980; Clarke and Law, 1981).

Thus we do not believe the similarities between the major features of the patterns of the different animals are primarily due to similar mechanisms of selective uptake, concentration, and/or loss, but to passive uptake, and accumulation, from common source(s), probably food and water.

Nevertheless, some selective uptake, concentration and/or loss may occur. There is evidence for this in the differences between Tridacna muscle and kidney tissue (graphs 1 and 2, fig. 4). However, since we do not know the relative contributions of hydrocarbons by water and food, and indeed do not know the hydrocarbon patterns of the food in all cases, except Holothuria, we can not say to what extent these processes may occur.

Biochemical diagenesis of hydrocarbons or other classes of compounds

By the same argument just given for selective uptake, concentration and/or loss, we do not believe the similarities in figures 3 and 4 are caused by similarities in the metabolisms of the different animals in this study. However, biochemical diagenesis does apparently occur. For instance, the relative concentrations of $n-C_{15}:1$, $n-C_{17}:1$ and $n-C_{19}:1$ in the top 2cm sediments are much reduced in Holothuria (graph 6, fig. 1 and graph 2, fig. 3). This may be due to oxidation of the alkenes at the double bond in Holothuria. Further, significant amounts of C_{25} unknowns appear in Holothuria which are not found in the top 2cm sediments. These may result from biochemical modification of the $C_{25}H_{48}^A$ and $C_{25}H_{50}^A$ unknowns found in sediment or some other compound.

Phylogenetic position

If hydrocarbon content is related to phylogenetic position we should expect the members of the Coral Trout/Parrot Fish and Acropora/Fungia pairs to be more similar to each other than to other species. Coral Trout and Parrot Fish are quite similar to one another in terms of mean concentrations of components, while the corals are not (Tables 12 and 13). The patterns for the fish

in graphs 3 and 4, figure 4 are also very similar, except for the greater ratio of pristane to n-C₁₇ in Coral Trout. This similarity may be due to the fact that Coral Trout feed on small herbivorous fish. Although Acropora has components which are not detected in Fungia, and visa versa, the percentages of alkanes are quite similar (graphs 3 and 4, fig. 3).

It is doubtful the phylogenetic similarities in hydrocarbons have any meaning other than similar metabolisms and uptake/excretion mechanisms in closely related organisms. However, the food of closely related species is often quite different. Indeed, the different food of Parrot Fish and Coral Trout is probably reflected in the different pristane/n-C₁₇ ratios of the two fishes.

Trophic level

The trophic levels of the coral reef organisms in this study are not clear cut. However, we can say that Chlorodesmis is on the lowest trophic level, Parrot Fish, being a herbivore, is on the next, Iridacna, the coral and Holothuria are on the next level, and Coral Trout is on the highest level.

There is no obvious relationships between the concentrations of the various hydrocarbon components and trophic level (Tables 12 and 13). Furthermore, the graphs in figures 3 and 4 do not suggest any relationship between trophic level, as such, and the relative proportions of hydrocarbon components.

Lipid content and hydrocarbon concentration

Few workers have reported hydrocarbon concentrations as a fraction of both lipid weight and wet or dry tissue weight. Tables 12 and 13 give quite different impressions of comparative hydrocarbon concentration among species.

In an attempt to detect any relationships between hydrocarbon concentration and lipid content three hydrocarbon components were examined, total hydrocarbons, UCM and resolved hydrocarbons minus squalene in the different sample types. Spearman's rank correlation analyses were performed for concentration of hydrocarbon component (wet or dry and lipid weight) versus percentage lipid, for individual samples of each of the 9 sample types in this

study. The results of the correlation analyses are summarized in Table 17.

In our method the lipid material and hydrocarbons are extracted together. Therefore, all of the hydrocarbon is in the lipid. We thus have this relationship for an individual sample:

$$\text{hydrocarbon/tissue weight} = \text{hydrocarbon/lipid weight} \times \text{lipid weight/tissue weight}$$

The lack of significant correlations between hydrocarbon concentration (wet or dry weight) versus percentage lipid, for all animals, suggests that, for most species in this study, the concentration of hydrocarbon in the tissue as a whole is not influenced significantly by lipid content. This is probably true also for the separate sediment samples. This conclusion is perhaps unexpected. It would seem likely a priori that the more lipid an organism contained, the greater its tendency to take up and store hydrocarbons. Indeed, the work of Stegeman and Teal (1973) on the uptake of petroleum hydrocarbons by oysters supports this idea.

Perhaps because the hydrocarbon concentrations of animals in the Capricorn Group are small, and their lipid material is thus far from being saturated, the lipid content is not a limiting factor and is therefore unimportant among the many factors affecting the uptake and accumulation of hydrocarbons. In polluted systems, where a huge load of hydrocarbon may be forced upon organisms, more nearly saturating the available lipid compartment, lipid content would assume greater importance.

In those animals where there are negative correlations between hydrocarbon concentration in lipid and percentage lipid, it appears that the hydrocarbon content of the tissue is relatively constant and greater lipid content results in dilution of hydrocarbon in lipid.

Hydrocarbon content and size in fish

Spearman's rank correlation analyses were performed for total weight and for length versus resolved hydrocarbons minus squalene (wet weight and lipid weight) and for weight and length versus percentage lipid for both Coral Trout and Parrot Fish from both

the Capricorn Group and from the northern areas sampled. No significant correlations were found. Apparently, weight and length are not important factors in hydrocarbon uptake and accumulation in these species in the Great Barrier Reef Province. Thus older fish do not appear to have accumulated more hydrocarbon and the process of "bioaccumulation" is not in operation. Although some bioaccumulation of pollutant hydrocarbons might be expected, we feel it is less likely to occur with naturally occurring biogenic hydrocarbons because the metabolisms of organisms will have evolved in the presence of these hydrocarbons and an equilibrium between uptake and metabolism/excretion will exist.

CONCLUSIONS

The conclusions which can be drawn from our study of the hydrocarbons of the f_1 fraction in water, sediments and marine organisms of the Capricorn Group, Great Barrier Reef are:

1. The patterns of resolved f_1 fraction hydrocarbons are biogenic in nature for all sample types in this study and characteristic of the sample type.
2. Although the biogenic nature of the resolved hydrocarbons, the lack of phytane in any of the samples, and the low overall levels of hydrocarbons, suggest that there is no significant hydrocarbon pollution in the Capricorn Group, there is evidence of low level chronic pollution, perhaps in part airborne of pyrogenic origin, which is seen as barely detectable UCMs in most sample types and more obvious UCMs in Acropora, Holothuria and sediments. Long term accumulation of UCM hydrocarbons may occur in lipid compartments in nonliving parts of Acropora (skeleton) and sediments. There is also evidence of petroleum product pollution in Heron Island boat harbour sediments.
3. In general the components $n-C_{15}$, $n-C_{17}$ and $n-C_{17}:1$ are prominent in the animals in this study. The cause is probably passive uptake and accumulation from similar food source(s). Either benthic algae or plankton are likely sources.
4. The pattern of alkanes above $n-C_{17}$ in the animals reflects that of water and is probably due to passive uptake and accumulation from this source.
5. Further evidence that uptake of hydrocarbons from food

- occurs is the presence of an unusual $C_{25}H_{48}$ unknown hydrocarbon in both Holothuria and the surface sediments upon which it feeds.
6. Biochemical diagenesis probably accounts for the presence of significant amounts of other C_{25} unknowns in Holothuria, which are not present in surface sediments, and the loss of $n-C_{15}:1$ and $n-C_{19}:1$ and reduction of the relative percentage of $n-C_{17}:1$ in Holothuria, compared to surface sediments.
 7. f_1 fraction hydrocarbons synthesized in the green algae Chlorodesmis are predominantly odd numbered pairs of n-alkanes and monoolefins from C_{17} to C_{25} .
 8. Lack of significant spacial correlation in individual hydrocarbon concentrations between sample types suggests that the concentration of hydrocarbons in the samples are not the result of passive uptake of an extraneous pollution source. A possible exception is the UCM found in Acropora and Holothuria which may have a pyrogenic source, namely the coal burning power station at Gladstone.
 9. Lack of positive correlation between lipid content and hydrocarbon concentration in the tissues in any of the animals indicates that uptake of hydrocarbons is independent of lipid content, as might be expected in unpolluted systems where the available lipid compartments are far below saturation and thus lipid content is not a limiting factor in uptake of hydrocarbons.
 10. There is no relationship between size and hydrocarbon or lipid content in fish. Thus hydrocarbons do not appear to be concentrating in older fish. This is seen as further evidence that the hydrocarbons of this system are primarily biogenic, not pollutant.
 11. The patterns of resolved hydrocarbons in Capricorn Group marine organisms and sediments are very distinct and are based on very small amounts of material. The patterns would be swamped by any significant hydrocarbon pollution. Thus with this study we have provided a sensitive background pattern for pollution detection.

The applicability of this last conclusion to all of the Great Barrier Reef Province is examined in Part 2 of this report which is concerned with the northern Great Barrier Reef including Torres Strait.

Part II: Northern Great Barrier Reef and Torres Strait

INTRODUCTION

Our survey of sites in the northern Great Barrier Reef (NGBR) area serves two general purposes: to provide base line data of hydrocarbon levels for these sites and to test the generality of conclusions drawn on the basis of our study of the Capricorn Group.

Baseline data from Arlington Reef, near Green Island, about 12km east of Cairns, and from the Lizard Island area are of interest because both are within the Cairns-Cormorant Pass Section of the Great Barrier Reef Marine Park and both are areas of comparatively heavy recreational use. Furthermore, a relatively heavily used shipping lane passes between Lizard Island and Eyrie Reef, about 4.5km to the west of Lizard Island. Indeed, a small mass of "tar", presumably originating from a passing ship, was found on one of the Lizard Island beaches (Freshwater Beach) and the hydrocarbons of sediments and Holothuria in the vicinity were investigated.

Baseline data from Northwest Reef, near Thursday Island, in Torres Strait, is of particular interest because of the differences between this site and the others in this study. Ecologically, this area would appear to be different because of the influences of nearby mangroves and sea grass communities, the detritus of which were observed in the areas sampled and which were absent from the collection sites to the south. The pattern of use of the study area near Thursday Island was also different. In the Capricorn Group, Arlington Reef and Lizard Island, use is almost entirely recreational, whereas in Torres Strait there is both heavy commercial fishing and subsistence harvesting of marine organisms by Torres Strait Islanders.

In the Capricorn Group we found low levels of hydrocarbons generally, with evidence of very low level chronic pollution and some local pollution in the Heron Island boat harbour. The patterns of resolved hydrocarbons appear to be biogenic and unique for each sample type throughout the Capricorn Group. The similarities between the animals suggest related sources of hydrocarbons, perhaps, primarily food and secondarily water. We also concluded that the biogenic patterns of the different sample types, since they are based on such small amounts of hydrocarbons, would be easily swamped by any significant level of pollutant hydrocarbons.

The results of analysis of the same sample types, from the NGBR provides a test of the predictive value of these findings in the Capricorn Group study. Since, to our knowledge, there have been no episodes of large scale hydrocarbon pollution in recent times in the NGBR areas sampled, we would expect that the levels of hydrocarbons would, in general, be low and the patterns of resolved hydrocarbons would be biogenic in nature. However, since there are reasons to believe there is some low level chronic pollution in the areas, and indeed, one incident of localized acute pollution (the "tar" mass) was found, we would expect to find evidence of this in our samples. Because of the spacial and temporal separations of the collections, and because of the particular characteristics of the different collection sites, we would expect there to be more variation in the hydrocarbons than was found in the Capricorn Group study. Also, if our conclusion that the important features of the patterns of resolved hydrocarbons in animals are due to passive uptake of biogenic hydrocarbons from food and water is correct, the patterns would appear different for at least some of the animals from the northern sites, due to differences in food and/or water hydrocarbons. If they did not, it would suggest that the patterns were not primarily influenced by passive uptake but were due to the nature of the physiology and/or biochemistry of the animals, in other words, selective uptake, concentration, loss and/or metabolism of hydrocarbons.

MATERIALS AND METHODS

Sample types

The same suite of sample types was analysed: top 15cm of sediments, Chlorodesmis (Turtle weed), Tridacna sp. (clam) kidney and abductor muscle tissue, Acropora sp. (staghorn coral), Fungia sp. (mushroom coral), Holothuria atra (sea cucumber), Plectropomus maculatus (Coral Trout) and Scarus sp. (parrot fish).

Methods of analysis

All methods of collection, sampling, extraction and analysis were as in Part I, the Capricorn Group study. The numbers sampled and pooled were also as in Part I.

Collection sites and times

The collection sites and their positions relative to the Queensland coast, Torres Strait and the Great Barrier Reef are shown in figures 8-10.

Arlington Reef is a short distance from Cairns (about 28.5km) and from a popular tourist resort on Green Island (about 5km) (fig. 8). There is a large amount of recreational boat traffic in this area and a regular daily ferry service from Cairns to Green Island. Thus some chronic petroleum product pollution is likely.

Lizard Island is more isolated from population centres than Arlington Reef. There is, however, a resort on Lizard Island and a safe anchorage. Thus there is considerable boat traffic, both recreational and commercial fishing, around the island. In addition, a heavily used shipping lane passes between Lizard Island and nearby Eyrie Reef (see fig. 9). The shortest distance from Lizard Island to Eyrie Reef is about 5.3km.

All of the sample types were obtained from First Beach, Lizard Island near the resort. The reef here is fringing reef, Lizard Island being a continental island. In addition, Holothuria atra were collected from Eyrie Reef and sediments were collected from Eyrie Reef and Carter Reef, on the outer barrier (fig. 9).

It was expected, a priori, that Carter Reef, would be the most pristine of any of the collection sites, but that chronic petroleum product pollution might occur at Lizard Island and Eyrie Reef. A "tar" mass about 120cm in diameter and located at the high tide mark was found at Freshwater Beach on Lizard Island some distance from the collection site at First Beach (fig. 9). Samples of sediments and Holothuria were taken directly in front of the tar mass.

Northwest Reef is about 7.3km from Thursday Island, one of the Torres Strait islands (fig. 10). As stated in the introduction the general ecology of this reef appeared different from the others we collected. Sea grass and mangrove detritus was often seen in the area. In addition, there are very strong tidal flows in this area which cause very high water turbidity during part of each day. We found no Holothuria atra in this area.

There is a relatively large harbour at Thursday Island for commercial fishing boats, interisland transport ships and numerous small recreational and fishing boats. There are permanent communities on Thursday Island and the other Torres Strait islands. There is thus the possibility of chronic petroleum product pollution in this area.

The Lizard Island area collections were made between the 14th and 18th May, 1981. The Torres Strait collections were made between the 18th and 21st November, 1981. The Arlington Reef collections were made between the 24th and 25th November, 1981.

RESULTS AND DISCUSSION

The results of analysis of the different types from each collection site are summarized in Tables 18-26. These include means of all samples from each site, n-values are as given for each sample type in Materials and Methods, Part I. As in Part I each n-alkane from C₁₅ to C₃₂ is quantified, except for n-C₁₆, n-C₂₆ and n-C₂₈. Important unknowns are also quantified. In some cases, e.g. n-C₁₇, n-C₁₉ and n-C₂₁ certain unknowns are included in the values given for some sample types. The presence of the unknowns, as determined by GC/MS is indicated in the tables. As in Part I the

mean percentages, over all sites of the various compounds in these combined peaks was determined by GC/MS. The totals given in Tables 18-26 are as in Results, Part I.

Tables 27 and 28 give the mean and standard deviation values, over all the NGBR collection sites, for the totals of alkanes, resolved hydrocarbons minus squalene, UCM and UCM plus resolved hydrocarbons minus squalene for each sample type. Table 27 gives values in $\mu\text{g}/\text{kg}$ wet weight (organisms) or $\mu\text{g}/\text{kg}$ dry weight (sediments). Table 28 gives values in $\mu\text{g}/\text{g}$ lipid weight.

Given in figures 11-13 are bar diagrams showing the means and standard deviations of percentage of total resolved hydrocarbons minus squalene of n-alkanes C_{15} to C_{32} (excluding n- C_{16} , n- C_{26} and n- C_{28}) and of important unknowns for each sample type. In addition separate graphs are given for Lizard Island Freshwater Beach sediments and Holothuria. As in figures 2-4, Part I, standard deviations are indicated by lines extending from the bars.

Bars for unknowns are positioned according to their approximate chromatographic position relative to the n-alkanes. Some bars are composite, indicating components not separated by quantitative gas chromatography. The mean percentages of each component within these bars, as determined by GC/MS analysis of pooled samples, are shown in the graphs.

Sediments

Because of the spacial and temporal separation of the NGBR collections we might expect the standard deviations in the graphs in figures 11-13 to be greater than those in figures 2-4 (Capricorn Group) for all sample types. For the sediments the standard deviations are markedly greater for the n- C_{17} , pristane, n- $\text{C}_{17}:1$ composite peak, the unknowns around n- C_{21} and n- C_{25} (compare graph 1, fig. 11 with graph 5, fig. 2).

The unknowns $\text{C}_{25}\text{H}_{48}\text{A}$ and $\text{C}_{25}\text{H}_{50}\text{A}$ found in the Capricorn Group sediments were also found in the pooled NGBR sediments by GC/MS. The mean percentage of the n- C_{17} , pristane, n- $\text{C}_{17}:1$ composite peak is less for the NGBR sediments while both pristane and n-

C₁₇:1 represent greater proportions of the peak. There are a number of other differences but in general the NGBR and the Capricorn Group top 15cm sediments are similar and in particular the composite n-C₁₇, pristane, n-C₁₇:1 peak is predominant in both.

The mean values for the hydrocarbon totals per dry weight in Table 27 are comparable to those for the Capricorn Group (see Table 12). However, the mean lipid content is about seven times greater on average in NGBR sediments than in Capricorn Group sediments (Table 13 and 28). The mean concentrations of hydrocarbons per lipid weight are lower by a factor of 3 or 4, perhaps partly as a consequence of the higher lipid contents.

No UCM was detected in the top 15cm sediments from either Arlington Reef or Northwest Reef (Table 18). These sites were also notably low in total resolved hydrocarbons. All of the Lizard Island area (Lizard Island, Eyrie Reef and Carter Reef) sediments had measurable UCMs, with a peak in the area of n-C₂₁ to n-C₂₂.

The Freshwater Beach sample was the only one with a UCM greater than one standard deviation from the mean (Tables 18, 27, 28). This sample was taken not far from a "tar" mass (see above). The pattern of hydrocarbons from this site (graph 2, fig. 11) is significantly different from the other sites. Note the bimodal distribution of n-alkanes and lack of unknowns.

However, the values of total resolved hydrocarbons minus squalene for this site (310.3 µg/kg dry weight; 4257.8 µg/g lipid weight) are within one standard deviation of the means values for NGBR sites (Tables 27 and 28). This supports our conclusion that the biogenic patterns of the sample types will be swamped by the addition of a small amount of pollutant hydrocarbons.

Chlorodesmis

Although there are some minor differences in the pairs of n-alkanes and monoolefins, the resolved hydrocarbon patterns of NGBR and Capricorn Group Chlorodesmis are remarkably alike (graph 3, fig. 11; graph 1, fig. 3). The standard deviations of the NGBR

and Capricorn Group samples are not significantly different. All of this attests to the consistency of the synthesis of resolved hydrocarbons in this green algae despite the many differences associated with the large spacial and temporal separation of the collections.

Both the lipid and hydrocarbon content of the NGBR Chlorodesmis is less, on average than in the Capricorn Group (Tables 12, 27, 13, and 29). As in the Capricorn Group no UCM was detected in NGBR Chlorodesmis (Table 19).

Fungia

The predominant resolved hydrocarbon in NGBR Fungia f₁ fraction is n-C₁₇ as in Capricorn Group Fungia (graph 3, fig. 3; graph 1, fig. 12). Once again, pristane and n-C₁₇:1 were not detected. All of the NGBR Fungia lacked any detectable n-C₂₇, n-C₃₀, n-C₃₁, n-C₃₂ or the unknown between n-C₃₁ and n-C₃₂ found in Capricorn Group Fungia. The Torres Strait Fungia also lacked n-C₂₀, n-C₂₁, n-C₂₅ and n-C₂₉ and indeed resolved hydrocarbons in Torres Strait Fungia were mainly n-C₁₅, n-C₁₇ and squalene (Table 20). On average NGBR Fungia contain more n-C₁₅ than Capricorn Group Fungia. The standard deviations in graphs 3, figure 3 and graph 1, figure 12 are not significantly different, suggesting variability among the northern sites is about the same as that in the Capricorn Group Fungia.

Although NGBR Fungia are slightly richer in lipid, on average, (Tables 13 and 28) they are poorer in hydrocarbon than Capricorn Group Fungia (Table 12 and 27). A barely detectable UCM (<10 µg/kg), peaking around n-C₂₀ to n-C₂₂, was revealed by GC/MS analysis of pooled samples of NGBR Fungia but, as in the Capricorn Group, none was detectable in any of the individual samples by quantitative gas chromatography. In general the Lizard Island Fungia appear to contain more resolved hydrocarbons than those from the other two NGBR sites.

Acropora

There are a number of differences between the patterns of resolved hydrocarbons of Acropora both between the NGBR and Capricorn Group samples (graph 4, fig. 3 and graph 2, fig. 12)

and among the NGBR samples (Table 21).

The composite, n-C₁₇:1, peak remains a predominant peak, with small increases in the percentage of n-C₁₇:1 in NGBR Acropora over Capricorn Group Acropora. The n-C₁₉/n-C₁₉:1 pair is a lower percentage of total resolved hydrocarbons minus squalene in NGBR Acropora, but the ratio of n-C₁₉ to n-C₁₉:1 is about the same as in the Capricorn Group (graph 4, fig. 3 and graph 2, fig. 12). The unknown between n-C₂₁ and n-C₂₂ in Capricorn Group Acropora is missing in NGBR Acropora, while the former lacks the unknowns between n-C₁₉/n-C₁₉:1 and n-C₂₀ and between n-C₂₅ and n-C₂₆ found in the latter.

A small amount of UCM, unmeasurable by our gravimetric techniques, (<100 µg/kg) was detected by gas chromatographic analysis of most individual Acropora samples from the NGBR. The peaks of these UCMs were between n-C₂₀ and n-C₂₂. These levels of UCM are labelled "trace" in Tables 21, 27 and 28. The UCM of NGBR Acropora is thus at least 1000 times less, on average, than that of Capricorn Group Acropora (Table 12). On average, NGBR Acropora have about twice as much lipid, as Capricorn Group Acropora (Table 13 and 28). Torres Strait Acropora are an exception (Table 21). Capricorn Group Acropora contain slightly more resolved hydrocarbons on average (Tables 12 and 27).

As in the case of Fungia, Arlington Reef and Northwest Reef Acropora appear to have lower concentrations of resolved hydrocarbons than Lizard Island area Acropora. Furthermore, both Arlington Reef and Northwest Reef Acropora lack n-C₃₀, n-C₃₁ and n-C₃₂ which are present in significant amounts in Lizard Island Acropora, particularly n-C₃₂. Northwest Reef Acropora lack the unknown between n-C₂₅ and n-C₂₆.

The low UCM in NGBR Acropora, and the differences in the unknowns between Capricorn Group and NGBR Acropora, are indicative of differences between the collection sites.

Tridacna

A major difference between the resolved hydrocarbons of Tridacna muscle tissue from NGBR and the Capricorn Group is that in

Iridacna muscle from the former area the $n-C_{17}/n-C_{17}:1$ peak is not predominant. Indeed, no $n-C_{17}:1$ was detected in NGBR Iridacna muscle (graph 1, fig. 4 and graph 3, fig. 12). Furthermore, the n-alkanes show a smooth distribution peaking at $n-C_{23}$, reminiscent of certain types of hydrocarbon pollution.

The concentration of n-alkanes from C_{21} to C_{25} are about 2 to 10 times greater in the NGBR than in the Capricorn Group samples (Tables 6 and 22). Although there is a striking difference between the resolved hydrocarbon patterns of NGBR and Capricorn Group Iridacna muscle, the pattern is relatively constant among the NGBR samples (Table 22) as evidenced by the relatively low standard deviations in graph 3, figure 12.

NGBR Iridacna muscle samples also have trace amounts (<100 ug/kg) of UCM peaking at about $n-C_{26}$. The total amounts of hydrocarbons are still small in the northern samples, comparable to those found in the Capricorn Group (Tables 12 and 27 and 13 and 28).

The relative amounts of $n-C_{17}/n-C_{17}:1$ and $n-C_{19}/n-C_{19}:1$ in Iridacna kidney from NGBR are less than in the Capricorn Group while the relative amount of $n-C_{15}$ is greater. A significant amount of an unknown between $n-C_{20}$ and $n-C_{21}$ was found in all NGBR Iridacna kidney samples (Table 23; graph 4, fig. 12). This unknown is uncharacterized. There are other differences in the patterns of n-alkanes, between the two areas (graph 2, fig. 4 and graph 4, fig. 12). As with Iridacna muscle, Iridacna kidney samples from the NGBR were relatively constant in their patterns of resolved hydrocarbons. No UCM was detected in any of the NGBR Iridacna kidney samples.

The mean totals in Tables 12 and 27 and 13 and 28 for Iridacna kidney are similar for the Capricorn Group and NGBR.

Holothuria

The Lizard Island Freshwater Beach Holothuria samples were treated separately from the other NGBR samples and were not pooled with these for GC/MS analysis. In the NGBR Holothuria, as in those from the Capricorn Group, the $n-C_{17}$ and $n-C_{17}:1$ are important hydrocarbons (graph 2, fig. 3 and graph 1, fig. 13). The

mean ratios of $n\text{-C}_{17}$ to $n\text{-C}_{17}:1$ are the same in both groups of samples.

The greatest differences between the two groups of samples, and indeed among the NGBR samples, are in the unknowns. The $\text{C}_{25}\text{H}_{48}\text{A}$ unknown (fig. 5) found in Capricorn and NGBR top 15cm sediments, in Heron Island top 2cm sediments and in Capricorn Group Holothuria was identified by GC/MS in pooled NGBR Holothuria. This chromatographed between $n\text{-C}_{20}$ and $n\text{-C}_{21}$ (graph 1, fig. 13 and Table 24). A $\text{C}_{25}\text{H}_{50}$ unknown (designated $\text{C}_{25}\text{H}_{50}\text{B}$) which is similar to the $\text{C}_{25}\text{H}_{50}\text{A}$ unknown in sediments, but not identical (fig. 14), chromatographs between $n\text{-C}_{21}$ and $n\text{-C}_{22}$ (graph 1, fig. 13).

The most important unknown in the pooled NGBR Holothuria samples was another $\text{C}_{25}\text{H}_{48}$ unknown (designated $\text{C}_{25}\text{H}_{48}\text{B}$) chromatographing just before $n\text{-C}_{22}$ (graph 1, fig. 13) The mass spectra of this unknown is shown in figure 15. Yet another $\text{C}_{25}\text{H}_{48}$ unknown ($\text{C}_{25}\text{H}_{48}\text{C}$) chromatographs between $n\text{-C}_{21}$ and $n\text{-C}_{22}$. This compound is included with the $\text{C}_{25}\text{H}_{48}\text{B}$ unknown in graph 1, figure 14. A further unknown, not seen in Capricorn Group Holothuria, chromatographing between $n\text{-C}_{17}$ and $n\text{-C}_{18}$ was seen in Eyrie Reef and Freshwater Beach Holothuria (graphs 1 and 2, fig. 13 and Table 24). A clear mass spectra was not obtained for this compound and it is uncharacterized. Similarly the unknown chromatographing between $n\text{-C}_{22}$ and $n\text{-C}_{23}$ (graph 1, fig. 13) was uncharacterized.

It can be seen from Table 24 and the size of the standard deviations shown in graph 1, figure 13, that there was considerable variation among NGBR sites in the concentrations of the unknowns. This indicates that these unknowns reflect the food sources in the sediments upon which Holothuria feed. If the sources of these various unique compounds could be identified they would serve as excellent markers in identifying the foods of deposit feeding organisms.

On average, NGBR Holothuria had higher contents of both lipid and resolved hydrocarbons than did Capricorn Group Holothuria (Tables 12 and 27, 13 and 28). However, since NGBR Holothuria contained

only trace amounts ($<100 \mu\text{g}/\text{kg}$) of UCM, broadly peaking in the region of $n\text{-C}_{20}$ to $n\text{-C}_{25}$, the UCM plus resolved hydrocarbons minus squalene values were greater for Capricorn Group Holothuria (Tables 12 and 27, 13 and 28).

The resolved hydrocarbon pattern of the Lizard Island Freshwater Beach Holothuria collected in the region of the "tar" mass (see above) appear quantitatively different from the pattern representing the mean percentages of resolved hydrocarbons in the other NGBR Holothuria (graphs 1 and 2, fig. 13). However, there is no evidence of pollution, in the pattern, as there was in the case of the sediments taken in this area. Furthermore, there is no increase in UCM over the trace amounts seen in the other NGBR Holothuria (Table 24). Either the Holothuria avoided the pollutant hydrocarbons from the "tar" mass or the pollutant hydrocarbons (UCM and homologous series of n-alkanes) found in the Freshwater Beach top 15cm sediments were, by some unknown mechanism, not as concentrated in the extreme surface sediments upon which the Holothuria feed, as was found to be the case with the UCM in Heron Island sediments (Part I, results).

Parrot Fish

The patterns of resolved hydrocarbons for NGBR and Capricorn Group Scarus are very similar (graph 2, fig. 4, graph 3, fig. 13). The major difference is an increase in the importance of $n\text{-C}_{15}$ and decrease in $n\text{-C}_{17}/\text{pristane}/n\text{-C}_{17}:1$ in the former compared to the latter, on average. However, Torres Strait Parrot Fish had a low ratio of $n\text{-C}_{15}$ to $n\text{-C}_{17}/\text{pristane}/n\text{-C}_{17}:1$ compared to the other NGBR sites (Table 25).

The largish $n\text{-C}_{27}$ peak in graph 3, fig. 13 is due to an unusually large amount of this compound in the samples from Torres Strait, it was not detected in other NGBR Scarus (Table 25).

No UCM was detected in any NGBR Scarus samples or in pooled samples for GC/MS analysis.

On average Capricorn Group Scarus were richer in both lipid and hydrocarbons than NGBR Scarus (Table 12 and 27, 13 and 28).

Coral Trout

The major differences between NGBR and Capricorn Group Coral Trout in the average patterns of resolved hydrocarbons is again the ratio of $n-C_{15}$ to $n-C_{17}$ /pristane/ $n-C_{17}$:1 (graph 4, fig. 4; graph 4, fig. 13). In all NGBR sites, except Northwest Reef, this ratio is relatively high. In Coral Trout from Northwest Reef, however, $n-C_{15}$ was not detected (Table 26). Thus in both Scarus and Coral Trout from Torres Strait $n-C_{15}$ is low compared to other NGBR sites. NGBR Coral Trout also differed significantly from those from the Capricorn Group in the average relative amounts of $n-C_{17}$, pristane and $n-C_{17}$:1.

No UCM was detected in NGBR Coral Trout. As in the case of Scarus, Capricorn Group Coral Trout contained more lipid and hydrocarbon than NGBR Coral Trout (Tables 12 and 27, 13 and 28).

CONCLUSIONS

In the introduction we claimed that the results of our survey of the NGBR areas would provide a test of certain conclusions reached in the Capricorn Group study. We now list those conclusions and show the relevance of the NGBR data to each.

1. The patterns of f_1 fraction hydrocarbons are biogenic in origin for all sample types and characteristic of each sample.

With the possible exception of Tridacna muscle tissue, the patterns of resolved hydrocarbons in the f_1 fraction of all sample types from the NGBR are also biogenic in origin. The patterns are also characteristic of each sample type, both within the NGBR collections and, despite certain qualitative and quantitative differences between Capricorn Group and NGBR samples, over the entire range sampled, with the exception of Tridacna muscle tissue (fig. 2-4 and 11-13). Despite the large spacial and temporal separations of the NGBR collections, the standard deviations of percentage of resolved hydrocarbons are consistently greater only for NGBR sediments and Holothuria (fig. 2-4 and 11-13).

2. There is evidence of very low level, chronic hydrocarbon pollution in the Capricorn Group with detectable UCM in all sample types and measurable UCMs in top 15cm sediments, Holothuria and Acropora. Local hydrocarbon pollution was detected in Heron Island boat harbour sediments in the form of increased UCM.

In the majority of NGBR samples there was even less evidence of pollution. UCMs were lower, being barely detectable or non-detectable in most sample types. The UCMs of NGBR Holothuria and Acropora were about 1000 times less than in the Capricorn Group. Measureable UCMs were found only in Lizard Island area top 15cm sediments. The UCM of sediments near a "tar" mass on Freshwater Beach, Lizard Island were significantly greater than in other Lizard Island area sediments.

The proximity of the shipping lane to the Lizard Island area may be responsible for the larger UCMs in sediments in this area. Otherwise, it appears that the NGBR area is even more pristine with regard to hydrocarbon pollution than is the Capricorn Group. There may, however, be some accumulation of petroleum hydrocarbons, perhaps from water, in NGBR Tridacna muscle tissue.

3. The prominence of the compounds $n-C_{15}$, $n-C_{17}$ and $n-C_{17}:1$ in Capricorn Group organisms led us to suggest related food sources, perhaps algae, for these compounds. As we stated in the introduction to Part II, if we found the patterns of resolved hydrocarbons to be invariant over the entire range of our collections we would have to doubt the validity of the above conclusion because it would seem unlikely that any food source(s) would not vary somewhat.

$n-C_{15}$, $n-C_{17}$ and $n-C_{17}:1$ are still predominant in the sample types from the NGBR. However, on average, the ratio of $n-C_{15}$ to the other two compounds is greater (figs. 2-4 and 11-13). In some NGBR sample types, however, the ratio of $n-C_{15}$ to $n-C_{17}$ /pristane/ $n-C_{17}:1$ varies between sites. For instance, this ratio is low in fish and sediments from Northwest Reef (Tables

24 and 25) and in Fungia and Acropora from Arlington Reef (Tables 20 and 21). Whereas in Holothuria the n-C₁₅ to n-C₁₇/pristane/n-C₁₇:1 ratio is higher at Arlington Reef than at the other two NGBR sites (Table 24). Thus, our suggestion of similar food sources of hydrocarbons in the Capricorn Group is supported by the NGBR results.

A further possible cause of the similarities in hydrocarbon patterns, at least among Iridacna and the corals, is the contribution which the algal zooanthellae make to the patterns of these organisms. The hydrocarbon patterns of the zooanthallae and animal tissues of these organisms need to be determined separately.

4. In the Capricorn Group further evidence of uptake from food was the presence of the C₂₅H₄₈A unknown (fig. 5) in both Holothuria and sediments. This was true also of NGBR Holothuria and sediments. Interesting, a number of other C₂₅ unknowns, possibly cycloalkanes or cycloalkenes, were observed in NGBR Holothuria (figs. 14 and 15). The amounts of these varied greatly between sites (Table 24), suggesting variable amounts in the food source(s) in the very surface sediments.
5. In all Chlorodesmis, in which the hydrocarbons present are probably due entirely to endogenous synthesis, the resolved hydrocarbons over the entire range of collections, Capricorn Group and NGBR, were extremely constant (graph 1, fig. 3 and graph 3, fig. 12). This consistency in Chlorodesmis, given the lack of consistency in the animals, lends support to the conclusion that the common predominant hydrocarbons in animals are derived from related, yet variable food source(s).
6. Because the characteristic resolved hydrocarbon patterns of both Capricorn Group and NGBR sample types are based on very small amounts of material, it is concluded that a very low level of pollution will swamp the patterns and thus be detected. The characteristic pattern of sediments was indeed swamped out in Lizard Island Freshwater Beach sediments by a level of hydrocarbon pollution which did not significantly raise the level of resolved hydrocarbons in the sediments.

Thus, our baseline data provide a sensitive indicator of hydrocarbon pollution throughout the Great Barrier Reef Province.

LITERATURE CITED

Anderlini, V.C., L. Al-Harmi, B. W. De Lappe, R.W., Risebrough, W.II. Walker, B.R.T. Simoneit, and A.S. Newton: Distribution of hydrocarbons in the oyster, *Pinctada margaritifera*, along the coast of Kuwait. Mar. Pollut. 12, 57-62 (1981).

Bakus, G.J.: The biology and ecology of tropical holothurians. In: Vol. 2. Biology 1. Biology and geology of coral reefs, pp 325-368. Ed. by O.A. Jones and R. Endean. New York : Academic Press 1973.

Barnes, R.D.: Invertebrate zoology, 3rd edition. 870 pp. Philadelphia : W.B. Saunders 1974.

Blumer, M., R.R.L. Guillard, and T. Chase: Hydrocarbons of marine phytoplankton. Mar. Biol. 8, 183-9 (1971).

Boehm, P.D. and J.G. Quinn: Benthic hydrocarbons of Rhode Island sound. Estuar. coast. mar. Sci. 6, 471-494 (1978).

Botello, A.V. and E.F. Mandelli: Distribution of n-paraffins in sea grasses, benthic algae, oysters and recent sediments from Terminos Lagoon, Campeche, Mexico. Bull. Environ. Contam. Toxicol. 19, 162-70 (1978).

Brassell, S.C., G. Eglington, J.R. Maxwell and R.P. Philp: Natural background of alkanes in the aquatic environment. In: Aquatic pollutants : transformation and biological effects, pp 69-86. Ed. by O. Hutzinger, I.H. Van Lelyveld and B.C.J. Zoeteman. Oxford : Pergamon Press 1977.

Brown, R.A. and H.L.Jr. Huffman: Hydrocarbons in open waters. Science 191, 847-9 (1976).

Burns, K.A. and J.L. Smith: Distribution of petroleum hydrocarbons in Westernport Bay (Australia) : Results of chronic low level inputs. In: Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms, pp 442-453. Ed. by D.A. Wolfe. Oxford : Pergamon Press 1977.

Chesler, S.N., B.H. Gump, H.S. Hertz, W.E. May, S.M. Dyszel, and D.P. Enagonio: Trace hydrocarbons analysis: The National Bureau of Standards Prince William Sound/ Northeastern Gulf of Alaska Baseline Study. 66 pp. Washington, D.C. : The National Bureau of Standards 1976.

Clark, R.C. Jr. and M. Blumer: Distribution of n-paraffins in marine organisms and sediment. Limnol. Oceanogr. 12, 79-87 (1967).

Clarke, A. and R. Law: Aliphatic and aromatic hydro-carbons in benthic invertebrates from two sites in Antarctica. *Mar. Pollut. Bull.* 12, 10-14 (1981).

Connell, D.W. and G.J. Miller: Petroleum hydrocarbons in aquatic ecosystems - Behaviour and effects of sublethal concentrations: Part 1. *In*: Vol. 2. Issue 1. Critical reviews in environmental control, pp 37-104. Ed. by C.P. Straub. West Palm Beach : CRC Press 1981.

Connell, D.W. and G.J. Miller: Petroleum hydrocarbons in aquatic ecosystems - Behaviour and effects of sublethal concentrations: Part 2. *In*: Vol. 2. Issue 2. Critical reviews in environmental control, pp 105-162. Ed. by C.P. Straub. West Palm Beach : CRC Press 1981.

Davis, J.B.: Paraffinic hydrocarbons in the sulfate-reducing bacterium Desulfovibrio desulfuricans. *Chem. Geol.* 3, 155-60 (1968).

Erhardt, M. and M. Blumer: The source identification of marine hydrocarbons by gas chromatography. *Environ. Pollut.* 3, 179-194 (1972).

Farrington, J.W., N.M. Frew, P.M. Gschwend and B.W. Tripp: Hydrocarbons in cores of Northwestern Atlantic coastal and continental margin sediments. *Estuar. coast. mar. Sci.* 5, 793-808 (1977).

Farrington, J.W. and J.G. Quinn: Petroleum hydrocarbons in Narragansett Bay. I. Survey of hydrocarbons in sediments and clams, Mercenaria mercenaria. *Estuar. coast. mar. Sci.* 1, 71-79 (1973).

Farrington, J.W., J.M. Teal, and P.L. Parker: Petroleum hydrocarbons. *In*: Strategies for marine pollution monitoring, pp 3-34. Ed. by E.D. Goldberg. New York : Interscience 1976.

Farrington, J.W. and B.W. Tripp: A comparison of analysis methods for hydrocarbons in surface sediments. *In*: ACS Symposium Series No. 18. Marine chemistry in the coastal environment, pp. 267-284. Ed. by T.M. Church. Washington, D.C. : American Chemical Society 1975.

Hardy, R., P.R. Mackie and K.J. Whittle: Hydrocarbons and petroleum in the marine ecosystem - A review. *Rapp. P.-v. Re'un. Cons. int. Explor. Mer.* 171, 17-26 (1977).

Hilpert, L.R., W.E. May, S.A. Wise, S.N. Chesler and H.S. Hertz: Interlaboratory comparison of determinations of trace level petroleum hydrocarbons in marine sediments. *Analyt. Chem.* 50, 458-463 (1978).

Jensen, K.: Levels of hydrocarbons in mussels, Mytilus edulis, and surface sediments from Danish coastal areas. *Bull. Environm. Contam. Toxicol.* 26, 202-206 (1981).

Koons, C.B., G.W. Jamieson and L.S. Cieresko: Normal alkane distributions in marine organisms; possible significance to petroleum origin. Bull. Amer. Assoc. Petro. Geol. 49, 301-304 (1965).

Lee, R.F.: Accumulation and turnover of petroleum hydrocarbons in marine organisms. In: Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms, pp 60-70. Ed. by D.A. Wolf. Oxford : Pergamon Press 1977.

Mackie, P.R., H.M. Platt and R. Hardy: Hydrocarbons in the marine environment II. Distribution of n-alkanes in the fauna and environment of the Sub-antarctic island of South Georgia. Est. Coast. Mar. Sci., 6, 301-313 (1978).

Maxwell, W.G.H.: Sediments of the Great Barrier Reef Province. In: Vol. 1. Geology 1. Biology and geology of coral reefs, pp 299-345. Ed. by O.A. Jones and R. Endean. New York : Academic Press 1973.

Meyers, P.A.: Fatty acids and hydrocarbons of Caribbean corals. Proc. 3rd Int. Coral Reef Symp. 1, 530-536 (1977).

Middleditch, B.S. and B. Basile: Alkanes in surficial sediments from the region of the Buccaneer Oilfield. J. Chromatog. 158, 449-463 (1978).

Middleditch, B.S., B. Basile and E.S. Chang: Alkanes in seawater in the vicinity of the Buccaneer Oilfield. Bull. Environ. Contam. Toxicol. 21, 413-420 (1979).

Middleditch, B.S., E.S. Chang and B. Basile: Alkanes in plankton from the Buccaneer oil field. Bull. Environ. Contam. Toxicol. 21, 421-427 (1979).

Middleditch, B.S. and B. Basile: Alkanes in benthic organisms from the Buccaneer oil field. Bull. Environ. Contam. Toxicol. 24, 945-952 (1980).

Miller, G.J. and D.W. Connell: Occurrence of petroleum hydrocarbons in some Australian seabirds. Aust. Wildl. Res. 7, 281-293 (1980).

Mironov, O.G. and T.L. Shchekaturina: Hydrocarbons in marine organisms. Hydrobiol. J. 12, 5-15 (1976).

Moriarty, D.J.W.: Feeding of Holothuria atra and Stichopus chloronotus on bacteria, organic carbon and organic nitrogen in sediments of the Great Barrier Reef. Aust. J. Mar. Freshwater Res. 33, 255-266 (1982).

Murray, J., A.B. Thompson, A. Stagg, R. Hardy, K.J. Whittle and P.R. Mackie: On the origin of hydrocarbons in marine organisms. Rapp. P.-v. Re'un. Cons. int. Explor. Mer. 171, 84-90 (1977).

Shaw, D.G. and B.A. Baker: Hydrocarbons in the marine environment of Port Valdez, Alaska. Environ. Sci. Tech. 12, 1200-1204 (1978).

Shaw, D.G. and J.N. Wiggs: Hydrocarbons in the inter tidal environment of Kachemak Bay, Alaska. Mar. Pollut. Bull. 11, 297-300 (1980).

Stegeman, J.J. and J.M. Teal: Accumulation, release and retention of petroleum hydrocarbons by the oyster Crassostrea virginica. Mar. Biol. 22, 37-44 (1973).

Teal, J.M: Hydrocarbon uptake by deep sea benthos. In: Symposium on Sources, effects, and sinks of hydrocarbons in the aquatic environment, pp 358-371. Washington, D.C. : Institute of Biological Sciences 1976.

Teal, J.M. and J.W. Farrington: A comparison of hydro-carbons in animals and their benthic habitats. Rapp. P.-v. Re'un. Cons. int. Explor. Mer. 171, 79-83 (1977).

Thompson, S. and G. Eglinton: The presence of pollutant hydrocarbons in estuarine epipelagic diatom populations. Est. Coast. Mar. Sci. 6, 605-619 (1976).

U.S. National Academy of Science: Petroleum in the marine environment. Washington, D.C. 1975.

Whittle, K., P.R. Mackie and R. Hardy: Hydrocarbons in the marine eco-system. J. Sci. 70, 141-144 (1974).

Whittle, K.J., P.R. Mackie, R. Hardy, A.D. McIntyre and R.A.A. Blackman, R.A.A. (1977). The alkanes of marine organisms from the United Kingdom and surrounding waters. Rapp. P.-v. Re'un. Cons. int. Explor. Mer. 171, 72-78 (1977).

Wise, S.A., S.N. Chesler, F.R. Guenther, H.S. Hertz, L.R. Hilpert, W.E. May, and R.M. Parris: Interlaboratory comparison of determinations of trace level hydrocarbons in mussels. Anal. Chem. 52, 1828-1833 (1980).

Yearing, P., J.N. Gearing, T.F. Lytle and J.S. Lytle: Hydrocarbons in 60 northeast Gulf of Mexico shelf sediments : a preliminary survey. Geochim. et. Cosmochim. Acta. 40, 1005-1017 (1976).

Young, S.D., J.D. O'Connor and L. Muscatine: Organic material from scleractinian coral skeletons. II. Incorporation of ^{14}C into protein, chitin and lipid. Comp. Biochem. Physiol. 40B, 945-958 (1971).




Youngblood, W.W., M. Blumer, R.L. Guillard and F. Fiore: Saturated and unsaturated hydrocarbons in marine benthic algae. Mar. Biol. 8, 190-201 (1971).

Youngblood, W.W. and M. Blumer: Alkanes and alkenes in marine benthic algae. Mar. Biol. 21, 163-172 (1973).

LEGENDS TO FIGURES

Figure 1. Map of Capricorn Group showing collecting sites (marked with crosses).

Insert shows location of Capricorn Group relative to the Queensland coast.

Figure 2. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes , pristane , and significant unknowns . Carbon numbers refer to n-alkanes. Bars for pristane and unknowns are positioned according to their chromatographic positions relative to the n-alkanes. Unknowns in each graph are listed from left to right. SRD = straight run diesel, LCO = light cycle oil, DCB = decarbonized bottoms.

Graph 5, sediments - top 15cm - Capricorn Group, pristane/n-C₁₇:1, sulfur, C₂₅H₄₈A, C₂₅H₅₀A; graph 6, sediments - Heron Island - top 2cm, n-C₁₅:1, n-C₁₇:1, n-C₁₉:1, C₂₁H₃₆, C₂₅H₄₈A, and C₂₅H₅₀A.

Figure 3. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes, pristane and significant unknowns. Designations as in fig. 2. Unknowns from left to right in each graph: graph 1, Chlorodesmis - Capricorn Group, n-C₁₇:1, n-C₁₉:1, n-C₂₁:1, n-C₂₃:1, n-C₂₅:1; graph 2, Holothuria - Capricorn Group, n-C₁₇:1, C₂₅H₄₈A unknown, mixture of C₂₅ unknowns, uncharacterized unknown(s); graph 3, Fungia - Capricorn Group, C₃₃H₆₆ unknown; graph 4, Acropora - Capricorn Group, pristane/n-C₁₇:1, n-C₁₉:1, uncharacterized unknown.

Figure 4. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes, pristane and significant unknowns. Designations are as in fig. 2. Unknowns from left to right in each graph: graph 1, Tridacna -muscle - Capricorn Group, n-C₁₇:1, n-C₁₉:1; graph 3, Parrot Fish - Capricorn Group, pristane/n-C₁₇:1; graph 4, Coral Trout - Capricorn Group, pristane/n-C₁₇:1.

Figure 5. Mass spectra of C₂₅H₄₈A unknown in Capricorn Group and NGBR top 15cm sediments, in top 2cm sediments from Heron Island and in Holothuria atra from Capricorn Group and NGBR.

Figure 6. Mass spectra of C₂₅H₅₀A unknown in Capricorn Group and NGBR top 15cm sediments and in top 2cm sediments from Heron Island.

Figure 7. Mass spectra of C₂₁H₃₆ unknown in top 2cm sediments from Heron Island.

Figure 8. Map showing collection sites (marked by X) on Arlington Reef. Insert shows location of Arlington relative to the Queensland coast.

Figure 9. Map showing collection sites (marked by X) in Lizard Island area. Insert shows location of Lizard Island area relative to the Queensland coast.

Figure 10. Map showing collection site (X) on Northwest Reef. Insert shows location of Northwest Reef relative to the Queensland coast and Torres Strait.

Figure 11. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes, pristane and significant unknowns. Designations are as in fig. 2. Unknowns from left to right in each graph: graph 1, sediments - NGBR - top 15cm, pristane/n-C₁₇:1, sulfur, C₂₅H₄₈A, C₂₅H₅₀A; graph 3, Chlorodesmis - NGBR, n-C₁₇:1, n-C₁₉:1, n-C₂₁:1, n-C₂₃:1, n-C₂₅:1.

Figure 12. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes, pristane and significant unknowns. Designations as in fig. 2. Unknowns from left to right in each graph: graph 2, Acropora - NGBR, pristane/n-C₁₇:1, uncharacterized unknown(s), uncharacterized unknown(s); graph 4, Tridacna - kidney - NGBR, uncharacterized unknown.

Figure 13. Graphs of mean percentage of resolved hydrocarbons minus squalene of n-alkanes, pristane and significant unknowns. Designations as in fig. 2. Unknowns from left to right in each graph: graph 1, Holothuria - NGBR, n-C₁₇:1, uncharacterized unknown(s), C₂₅H₄₈A unknown, C₂₅H₅₀B unknown, C₂₅H₄₈B and C₂₅H₄₈C unknowns (single bar), uncharacterized unknown(s); graph 2, Holothuria - FWB - Lizard Island, same as in graph 1, Holothuria - NGBR; graph 3, Parrot Fish - NGBR, pristane/n-C₁₇:1; graph 4, Coral Trout - NGBR, pristane/n-C₁₇:1.

TABLE 1. Heron Reef Water Samples.

| Components | Reef Flat - high tide | | Ocean Side of Reef Crest - high tide | |
|---|--------------------------------------|--------------------------------------|---|--------------------------------------|
| | unfiltered | filtered | unfiltered | filtered |
| | $\mu\text{g/l}$ \bar{X} (SD) | $\mu\text{g/l}$ \bar{X} (SD) | $\mu\text{g/l}$ \bar{X} (SD) | $\mu\text{g/l}$ \bar{X} (SD) |
| n-C ₁₅ | 0.007 (0.002) | 0.022 (0.024) | 0.035 (0.019) | 0.012 (0.017) |
| n-C ₁₇ + pristane + n-C ₁₇ :1 | 0.012 (0.005) | 0.011 (0.009) | 0.060 (0.022) | 0.020 (0.008) |
| n-C ₁₈ | 0.008 (0.005) | 0.009 (0.004) | 0.013 (0.007) | 0.014 (0.001) |
| n-C ₁₉ | 0.007 (0.004) | 0.004 (0.002) | 0.008 (0.002) | 0.004 (0.000) |
| n-C ₂₀ | 0.012 (0.005) | 0.006 (0.003) | 0.033 (0.027) | 0.011 (0.001) |
| n-C ₂₁ | 0.004 (0.002) | 0.004 (0.002) | 0.003 (0.000) | 0.010 (0.007) |
| n-C ₂₂ | 0.004 (0.002) | 0.007 (0.008) | 0.021 (0.030) | 0.018 (0.011) |
| n-C ₂₃ | 0.004 (0.002) | 0.006 (0.004) | 0.006 (0.004) | 0.013 (0.005) |
| n-C ₂₄ | 0.006 (0.004) | 0.009 (0.006) | 0.035 (0.034) | 0.022 (0.000) |
| n-C ₂₅ | 0.014 (0.015) | 0.014 (0.006) | 0.013 (0.004) | 0.029 (0.013) |
| n-C ₂₇ | 0.010 (0.006) | 0.016 (0.015) | 0.010 (0.009) | 0.022 (0.004) |
| n-C ₂₉ | 0.010 (0.007) | 0.014 (0.011) | 0.019 (0.016) | 0.035 (0.006) |
| n-C ₃₀ | 0.003 (0.003) | 0.008 (0.012) | n.d. | 0.012 (0.017) |
| n-C ₃₁ | 0.003 (0.004) | 0.006 (0.008) | 0.020 (0.015) | 0.010 (0.011) |
| n-C ₃₂ | 0.001 (0.001) | n.d. | n.d. | 0.003 (0.005) |
| squalene + n-C ₂₈ | 0.457 (0.658) | 0.235 (0.073) | 0.426 (0.167) | 0.123 (0.016) |
| Total alkanes | 0.104 (0.025) | 0.134 (0.073) | 0.269 (0.168) | 0.237 (0.015) |
| Total resolved hydrocarbons-squalene | 0.160 (0.051) | 0.158 (0.085) | 0.487 (0.324) | 0.340 (0.018) |
| Total resolved hydrocarbons | 0.617 (0.658) | 0.393 (0.156) | 0.913 (0.157) | 0.461 (0.033) |
| UCM | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 0.617 (0.658) | 0.393 (0.156) | 0.913 (0.157) | 0.461 (0.033) |

TABLE 2

SEDIMENTS

(Top 15 cm)

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|---|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|
| | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg dry wt. x (SD) | ug/g lipid wt. x (SD) |
| n-c ₁₅ | 3.1 (0.8) | 201.1 (12.6) | 4.5 (-) | 313.6 (-) | 11.1 (5.0) | 1386.8 (459.4) | 18.2 (1.5) | 1506.7 (796.7) | 39.7 (8.6) | 1605.1 (287.6) | 3.0 (1.2) | 182.7 (36.4) | 76.0 (23.3) | 2142.0 (263.9) |
| n-c ₁₇ + pristane + n-c ₁₇ :1 | 78.9 (2.6) | 3282.1 (3963.2) | 82.1 (-) | 5769.1 (-) | 70.4 (8.4) | 9015.5 (113.8) | 82.2 (14.5) | 6613 (2970.3) | 241.6 (33.6) | 9773.4 (994.0) | 106.4 (15.1) | 6507.0 (165.5) | 571.2 (143.0) | 16178.2 (1057.4) |
| n-c ₁₈ | 7.6 (1.4) | 533.5 (199.4) | 3.6 (-) | 253.6 (-) | 1.3 (1.7) | 143.3 (202.7) | 7.2 (0.6) | 619.2 (413.7) | 4.3 (0.5) | 174.6 (13.6) | 4.9 (2.4) | 291.8 (98.7) | 11.9 (16.8) | 298.3 (421.8) |
| n-c ₁₉ | 15.3 (4.3) | 1085.8 (510.3) | 13.2 (-) | 933.6 (-) | 4.0 (1.0) | 501.0 (69.37) | 8.4 (1.4) | 685.0 (313.5) | 16.4 (1.3) | 660.5 (29.0) | 9.2 (2.7) | 556.0 (76.4) | 35.2 (6.1) | 1003.6 (12.9) |
| n-c ₂₀ | 1.4 (0.5) | 95.0 (54.2) | 0.5 (-) | 36.4 (-) | 0.7 (0.1) | 97.3 (29.2) | 2.7 (0.3) | 226.5 (120.5) | 0.7 (0.0) | 27.3 (2.2) | 1.2 (0.9) | 62.7 (46.2) | 1.0 (0.6) | 24.6 (12.9) |
| n-c ₂₁ + C ₂₅ H ₄₈ A unknown | 10.7 (2.9) | 717.5 (57.7) | 13.6 (-) | 961.8 (-) | 4.6 (2.1) | 597.0 (349.3) | 21.8 (0.1) | 1847.5 (1099.6) | 14.4 (2.2) | 580.4 (66.5) | 7.9 (4.5) | 467.0 (192.4) | 14.5 (2.9) | 412.3 (6.5) |
| n-c ₂₂ | 2.9 (2.3) | 213.5 (199.4) | 0.5 (-) | 38.2 (-) | 1.1 (0.4) | 306.0 (206.5) | 3.0 (1.4) | 221.5 (37.9) | 0.5 (0.8) | 21.1 (29.8) | 1.9 (1.9) | 107.4 (93.9) | 2.3 (0.8) | 66.3 (10.1) |
| n-c ₂₃ | 2.9 (1.8) | 213.8 (164.4) | 0.5 (-) | 40.9 (-) | 0.9 (0.4) | 111.0 (41.0) | 2.7 (1.1) | 203.2 (45.0) | 0.9 (0.5) | 33.3 (22.4) | 1.9 (2.2) | 108.3 (112.2) | 2.3 (0.7) | 80.7 (35.6) |
| n-c ₂₄ | 2.0 (2.0) | 146.8 (161.7) | 0.4 (-) | 29.1 (-) | 0.4 (0.6) | 49.2 (69.5) | 2.3 (1.0) | 132.7 (24.5) | 0.4 (0.5) | 16.6 (23.5) | 1.4 (1.9) | 74.6 (103.5) | 1.2 (0.7) | 34.7 (11.8) |
| n-c ₂₅ | 2.1 (1.4) | 160.0 (122.6) | 1.5 (-) | 106.4 (-) | 1.9 (0.0) | 234.7 (30.2) | 4.1 (0.1) | 348.8 (220.9) | 2.2 (0.4) | 84.9 (10.9) | 3.2 (0.3) | 189.7 (10.4) | 25.5 (29.5) | 821.1 (992.9) |
| n-c ₂₇ | 1.2 (0.2) | 84.4 (28.0) | 1.2 (-) | 85.5 (-) | 0.9 (0.3) | 100.9 (16.5) | 2.5 (1.3) | 179.4 (15.8) | 0.8 (0.3) | 33.1 (10.1) | 1.3 (0.1) | 76.5 (7.0) | 1.1 (0.3) | 29.4 (4.2) |
| n-c ₂₉ | 0.8 (0.2) | 54.1 (1.6) | 1.2 (-) | 78.9 (-) | 0.4 (0.1) | 51.4 (2.2) | 2.7 (1.4) | 193.7 (17.0) | 0.8 (0.1) | 31.2 (6.4) | 0.9 (0.3) | 56.5 (26.6) | 0.8 (0.3) | 23.4 (5.4) |
| n-c ₃₀ | 1.1 (0.0) | 70.0 (14.1) | 0.9 (-) | 60.0 (-) | 0.4 (0.0) | 59.7 (9.0) | 3.8 (1.0) | 302.8 (116.2) | 0.9 (0.4) | 38.9 (17.2) | 0.7 (0.4) | 50.5 (38.8) | 1.5 (0.6) | 41.5 (7.2) |
| n-c ₃₁ | 1.2 (0.6) | 87.4 (63.4) | 1.3 (-) | 95.0 (-) | 0.4 (0.6) | 54.2 (76.6) | 4.5 (1.7) | 342.2 (87.7) | 1.2 (1.7) | 48.7 (68.9) | 1.4 (0.3) | 91.7 (29.6) | 2.3 (0.7) | 66.8 (5.7) |
| n-c ₃₂ | n.d. | n.d. | 0.07 (-) | 4.6 (-) | 0.1 (0.1) | 13.0 (18.4) | 1.3 (0.3) | n.d. | n.d. | n.d. | 0.1 (0.1) | 8.5 (12.0) | n.d. | n.d. |
| squalene + n-c ₂₈ | 21.9 (8.1) | 1573.5 (859.3) | 40.2 (-) | 2822.7 (-) | 18.6 (4.8) | 2368.0 (313.9) | 35.3 (3.8) | 2933.2 (1496.9) | 33.3 (6.3) | 1342.6 (206.3) | 19.3 (5.2) | 1170.9 (117.3) | 34.6 (0.4) | 1004.7 (199.7) |
| sulfur | 19.0 (7.8) | 1262.4 (273.6) | 11.0 (-) | 775.4 (-) | 12.8 (4.0) | 1615.7 (295.5) | 5.8 (1.7) | 451.3 (158.4) | 25.2 (6.2) | 1019.8 (209.5) | 11.4 (0.3) | 664.8 (51.1) | 28.7 (5.2) | 846.1 (309.0) |
| Total alkanes | 130.8 (8.0) | 9101.5 (2362.7) | 125.2 (-) | 8807.3 (-) | 98.3 (15.1) | 12554.8 (264.2) | 167.0 (26.0) | 13518.0 (6314.9) | 324.7 (51.0) | 13130.9 (1577.4) | 145.4 (32.0) | 8831.3 (471.4) | 747.3 (165.8) | 21222.8 (765.6) |
| Total resolved hydrocarbons-squalene | 158.3 (1.0) | 10957.9 (2124.3) | 145.6 (-) | 10232.7 (-) | 124.4 (34.9) | 15747.8 (2381.3) | 181.2 (27.6) | 14685.3 (6908.0) | 355.9 (57.7) | 14395.9 (1798.1) | 157.9 (26.5) | 9445.1 (34.1) | 798.3 (156.1) | 22729.9 (208.8) |
| Total resolved hydrocarbons | 180.5 (7.0) | 12531.4 (2983.6) | 185.7 (-) | 13055.5 (-) | 143.0 (39.7) | 18115.8 (2695.3) | 216.9 (31.4) | 17618.5 (8464.9) | 389.2 (64.0) | 15738.5 (2004.4) | 174.2 (31.5) | 10616.0 (151.4) | 833.0 (155.6) | 23734.6 (9.1) |
| ucm | 881.6 (21.3) | 61115.4 (13667.8) | 510.2 (-) | 35861.8 (-) | 108.6 (153.6) | 15324.0 (21671.4) | 1978.9 (291.9) | 115464.3 (125774.0) | 169.4 (42.7) | 6902.6 (1986.5) | 112.6 (159.2) | 6141.2 (8684.9) | 649.0 (145.8) | 18424.6 (718.7) |
| Total hydrocarbons | 1061.9 (28.3) | 73646.8 (16651.4) | 695.9 (-) | 48917.3 (-) | 251.6 (113.8) | 33439.8 (18976.2) | 2209.5 (241.3) | 193749.5 (133236.1) | 558.6 (21.3) | 22641.0 (17.9) | 286.7 (190.7) | 16757.2 (8836.3) | 1481.9 (301.5) | 42159.2 (727.8) |
| % lipid | 0.0010 (0.000) | | 0.0010 (-) | | 0.0005 (0.0000) | | 0.0010 (0.0006) | | 0.0018 (0.0000) | | 0.0012 (0.0002) | | 0.0025 (0.0004) | |

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TABLE 3

CHLORODESMIS
(Turtle weed)

| Components | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--------------------------------------|------------------------------|-------------------------------|------------------------------|-------------------------------|------------------------------|-------------------------------|------------------------------|-------------------------------|------------------------------|-------------------------------|------------------------------|-------------------------------|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-c ₁₅ | 589.5 (29.0) | 73.8 (1.52) | n.d. | n.d. | 546.9 (-) | 47.0 (-) | 1065.5 (256.7) | 71.7 (16.3) | 1122.0 (149.9) | 73.8 (1.5) | 1021.5 (258.1) | 88.4 (33.7) |
| n-c ₁₇ | 21322.5 (2868.7) | 2698.5 (1028.8) | 69047.4 (-) | 9748.7 (-) | 38854.8 (-) | 3335.8 (-) | 43326.0 (10033.8) | 2926.4 (718.1) | 51044.5 (7814.2) | 3352.7 (3.9) | 32844.0 (6710.4) | 2754.0 (191.3) |
| n-c ₁₈ | 152.5 (65.8) | 20.1 (13.0) | 980.5 (-) | 138.4 (-) | 160.5 (-) | 13.8 (-) | 279.0 (169.7) | 18.9 (11.7) | 386.0 (49.5) | 25.9 (7.2) | 257.0 (31.1) | 12.6 (7.8) |
| n-c ₁₉ | 11381.5 (8477.5) | 1549.8 (1413.5) | 91978.0 (-) | 12986.2 (-) | 17198.4 (-) | 1476.6 (-) | 31323.5 (5227.6) | 2114.8 (382.6) | 34558.0 (6822.2) | 2262.0 (99.2) | 22305.5 (3932.2) | 1873.9 (76.7) |
| n-c ₂₀ | 20.4 (5.1) | 2.5 (0) | 7.0 (-) | 1.0 (-) | 7.9 (-) | 0.7 (-) | 7.7 (10.9) | 0.5 (0.7) | 6.3 (8.8) | 1.1 (0.2) | 6.0 (8.5) | 0.6 (0.8) |
| n-c ₂₁ | 1298.5 (229.8) | 158.0 (12.3) | 1246.4 (-) | 176.0 (-) | 556.2 (-) | 47.7 (-) | 1723.0 (50.9) | 116.2 (1.8) | 2006.5 (492.9) | 130.9 (12.1) | 1340.0 (147.1) | 113.1 (2.9) |
| n-c ₂₂ | 138.0 (14.1) | 17.0 (2.6) | 65.2 (-) | 9.2 (-) | 8.2 (-) | 0.7 (-) | 134.5 (10.6) | 9.1 (0.8) | 10.3 (2.4) | 6.8 (0.5) | 3.4 (4.8) | 0.3 (0.4) |
| n-c ₂₃ | 2331.5 (388.2) | 284.1 (25.2) | 2709.5 (-) | 382.6 (-) | 2060.6 (-) | 176.9 (-) | 4048.5 (385.4) | 272.8 (22.0) | 2972.5 (1968.4) | 243.2 (16.8) | 2305.5 (174.7) | 195.1 (11.8) |
| n-c ₂₄ | n.d. | n.d. | 17.2 (-) | 2.4 (-) | 5.6 (-) | 0.5 (-) | 25.6 (5.5) | 1.7 (0.4) | 1.2 (1.6) | 0.7 (1.0) | 7.0 (9.9) | 0.7 (0.9) |
| n-c ₂₅ | 65.1 (60.6) | 7.2 (5.6) | 124.5 (-) | 17.6 (-) | 94.2 (-) | 8.1 (-) | 177.5 (36.1) | 12.0 (2.6) | 124.0 (31.1) | 8.1 (0.7) | 44.3 (33.0) | 4.0 (3.3) |
| n-c ₂₇ | 2.5 (3.5) | 0.3 (0.4) | 6.0 (-) | 0.9 (-) | 207.3 (-) | 17.8 (-) | 25.6 (10.8) | 1.7 (0.8) | 236.1 (320.9) | 17.3 (23.8) | 8.1 (5.2) | 0.7 (0.4) |
| n-c ₂₉ | n.d. | n.d. | 4.2 (-) | 0.6 (-) | n.d. | n.d. | 16.0 (4.1) | 1.1 (0.3) | 1.7 (2.5) | 0.1 (0.2) | 21.0 (29.7) | 2.0 (2.8) |
| n-c ₃₀ | 22.2 (31.5) | 2.3 (3.2) | n.d. | n.d. | n.d. | n.d. | 7.3 (10.3) | 0.5 (0.7) | 1.9 (2.7) | 0.1 (0.2) | n.d. | n.d. |
| n-c ₃₁ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 55.3 (45.9) | 3.8 (3.2) | 4.2 (6.0) | 0.3 (0.4) | n.d. | n.d. |
| n-c ₃₂ | 9.3 (13.2) | 1.0 (1.3) | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| squalene + n-c ₂₈ | 21.0 (29.7) | 2.1 (3.0) | 6.3 (-) | 0.9 (-) | 8.2 (-) | 0.7 (-) | 91.3 (32.0) | 6.2 (2.2) | 56.4 (29.6) | 3.6 (1.4) | 15.9 (8.7) | 1.3 (0.6) |
| n-c ₁₇ :1 | 3211.5 (241.1) | 403.5 (131.2) | 5661.2 (-) | 799.3 (-) | 6314.5 (-) | 542.1 (-) | 18768.0 (16235.1) | 1244.3 (1096.0) | 6755.0 (1500.5) | 441.3 (30.5) | 4528.0 (915.0) | 229.8 (237.6) |
| n-c ₁₉ :1 | 18051.5 (11232.4) | 2423.2 (1966.5) | 139210.8 (-) | 19654.9 (-) | 35245.3 (-) | 3026.0 (-) | 47318.0 (6068.4) | 3193.7 (454.5) | 49842.5 (10621.5) | 3258.4 (195.0) | 36184.0 (5360.0) | 3045.8 (37.9) |
| n-c ₂₁ :1 | 2053.0 (323.9) | 250.4 (24.4) | 1997.1 (-) | 282.0 (-) | 929.6 (-) | 79.8 (-) | 2608.0 (371.9) | 175.7 (22.6) | 3184.5 (767.2) | 207.7 (18.3) | 2213.0 (120.2) | 187.5 (15.4) |
| n-c ₂₃ :1 | 1093.0 (212.1) | 132.7 (8.0) | 1585.6 (-) | 223.9 (-) | 627.6 (-) | 53.9 (-) | 1765.0 (233.4) | 118.9 (14.0) | 1660.0 (86.6) | 61.2 (8.6) | 1367.0 (24.0) | 116.4 (17.8) |
| Total alkanes | 37032.3 (10263.9) | 4814.5 (2507.3) | 166192.4 (-) | 23463.4 (-) | 59701.1 (-) | 5125.6 (-) | 82211.8 (14825.0) | 5550.9 (1078.5) | 93148.2 (16180.9) | 6108.3 (120.6) | 60166.9 (10594.6) | 5054.6 (206.1) |
| Total resolved hydrocarbons-squalene | 61923.3 (21701.0) | 8047.3 (4651.5) | 315330.6 (-) | 44520.8 (-) | 102963.3 (-) | 8839.8 (-) | 153252.3 (4082.2) | 10336.3 (422.1) | 154040.5 (27638.7) | 10096.9 (257.9) | 103911.0 (15870.0) | 8743.8 (149.5) |
| Total resolved hydrocarbons | 61944.7 (21671.2) | 8049.5 (4648.5) | 315336.9 (-) | 44521.7 (-) | 102971.5 (-) | 8840.5 (-) | 153343.5 (4114.0) | 10342.5 (424.4) | 154097.0 (27667.7) | 10100.4 (259.3) | 103926.8 (15878.8) | 8745.1 (150.0) |
| ucm | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 61944.7 (21671.2) | 8049.5 (4648.5) | 315336.9 (-) | 44521.7 (-) | 102971.5 (-) | 8840.5 (-) | 153343.5 (4114.0) | 10342.5 (424.4) | 154097.0 (27667.7) | 10100.4 (259.3) | 103926.8 (15878.8) | 8745.1 (150.0) |
| % lipid | 0.83 (0.21) | | 0.70 (-) | | 1.16 (-) | | 1.49 (0.02) | | 1.53 (0.23) | | 1.19 (0.16) | |

TABLE 4

FUNGIA
(Coral)

| Components | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-c ₁₅ | n.d. | n.d. | 2.3 (3.2) | 4.1 (5.7) | 5.1 (7.1) | 7.7 (11.0) | 17.5 (24.8) | 14.5 (20.5) | 38.5 (54.4) | 52.8 (74.7) | n.d. | n.d. |
| n-c ₁₇ | 100.4 (93.0) | 270.8 (308.9) | 90.2 (127.5) | 160.3 (226.7) | 80.3 (34.2) | 154.9 (6.9) | 76.2 (12.3) | 149.4 (111.9) | 109.5 (154.8) | 150.4 (212.7) | 107.3 (6.4) | 57.1 (11.6) |
| n-c ₁₈ | 8.2 (11.5) | 24.0 (34.0) | 18.2 (25.7) | 32.3 (45.7) | 29.7 (5.4) | 64.5 (35.4) | 23.2 (5.3) | 44.1 (30.9) | 18.6 (24.3) | 26.3 (32.4) | 21.7 (10.6) | 11.9 (7.3) |
| n-c ₁₉ | n.d. | n.d. | 61.1 (10.1) | 143.8 (31.7) | 15.7 (7.5) | 36.1 (28.5) | 9.3 (13.1) | 7.7 (10.9) | 83.3 (2.6) | 160.2 (68.3) | 11.5 (9.7) | 6.4 (6.0) |
| n-c ₂₀ | 1.1 (1.5) | 1.6 (2.2) | 7.9 (8.3) | 15.3 (12.8) | 11.3 (9.1) | 27.4 (28.3) | 6.3 (3.8) | 9.9 (3.4) | 10.1 (7.0) | 16.7 (5.7) | 8.0 (7.0) | 4.5 (4.3) |
| n-c ₂₁ | n.d. | n.d. | 4.9 (2.9) | 10.5 (2.6) | 8.5 (5.4) | 20.0 (18.1) | 2.8 (4.0) | 2.3 (3.3) | 5.4 (0.7) | 10.1 (2.8) | 9.3 (8.3) | 5.2 (5.1) |
| n-c ₂₂ | 1.0 (1.3) | 1.4 (2.0) | 3.4 (4.8) | 6.0 (8.5) | 6.7 (3.7) | 15.5 (13.3) | 2.5 (3.5) | 2.1 (2.9) | 0.8 (1.2) | 1.13 (1.6) | 6.6 (4.2) | 3.6 (2.7) |
| n-c ₂₃ | n.d. | n.d. | 6.3 (2.6) | 16.5 (12.1) | 2.5 (1.8) | 6.0 (5.9) | 1.3 (1.8) | 1.1 (1.5) | 4.8 (0.4) | 9.3 (4.3) | 2.5 (1.6) | 1.3 (1.0) |
| n-c ₂₄ | n.d. | n.d. | 3.5 (0.9) | 8.0 (1.1) | 1.1 (1.5) | 1.6 (2.3) | 1.3 (1.8) | 1.0 (1.5) | 3.1 (0.9) | 6.2 (4.1) | 2.0 (1.9) | 1.1 (1.2) |
| n-c ₂₅ | 4.6 (3.7) | 8.4 (3.5) | 10.2 (7.1) | 21.4 (7.9) | 5.1 (2.5) | 11.8 (9.5) | 7.7 (1.0) | 15.3 (11.8) | 13.1 (8.1) | 28.0 (25.4) | 5.1 (2.5) | 2.8 (1.7) |
| n-c ₂₇ | 2.9 (2.7) | 7.9 (9.0) | 4.9 (0.9) | 11.6 (5.9) | 5.3 (3.7) | 12.6 (12.0) | 9.5 (10.7) | 29.7 (39.7) | 3.0 (0.7) | 5.4 (0.8) | 5.4 (3.4) | 2.6 (1.7) |
| n-c ₂₉ | 2.7 (1.3) | 6.7 (5.6) | 4.0 (0.3) | 9.5 (2.9) | 4.3 (4.3) | 10.7 (12.5) | 13.8 (14.3) | 42.0 (55.2) | 4.8 (1.5) | 9.7 (6.4) | 3.6 (1.8) | 2.0 (1.2) |
| n-c ₃₀ | 2.2 (0.4) | 5.2 (3.3) | 5.2 (3.2) | 14.0 (12.4) | 3.4 (4.8) | 9.1 (12.9) | 9.0 (12.7) | 30.4 (43.0) | 2.62 (0.9) | 4.7 (0.4) | 1.6 (2.3) | 0.9 (1.3) |
| n-c ₃₁ | 33.5 (27.4) | 88.6 (95.1) | 6.9 (9.7) | 12.2 (17.3) | 16.5 (8.1) | 31.3 (3.9) | 14.0 (0.3) | 29.8 (26.0) | 0.5 (0.7) | 1.2 (1.7) | 23.8 (0.1) | 12.6 (1.8) |
| n-c ₃₂ | 0.6 (0.9) | 0.9 (1.2) | 2.3 (3.3) | 17.2 (10.2) | 4.0 (4.4) | 10.0 (12.1) | 1.9 (2.7) | 6.5 (9.2) | 1.2 (1.7) | 2.9 (4.1) | 0.4 (0.5) | 0.2 (0.2) |
| squalene + n-c ₂₈ | 142.5 (201.5) | 215.6 (305.0) | 279.1 (320.7) | 825.4 (1036.0) | 43.9 (49.9) | 72.1 (69.5) | 25.5 (0.6) | 54.2 (47.4) | 64.9 (59.0) | 146.5 (162.0) | 177.4 (244.9) | 103.4 (143.5) |
| unknown, between n-c ₃₁ and n-c ₃₂ | 50.4 (19.0) | 122.0 (93.4) | 28.9 (16.6) | 77.9 (66.9) | 13.2 (18.6) | 20.2 (28.5) | 9.0 (0.1) | 19.0 (16.4) | 36.3 (27.0) | 59.0 (24.1) | 14.4 (12.0) | 7.2 (5.3) |
| Total alkanes | 157.0 (129.0) | 415.5 (446.7) | 230.9 (190.5) | 473.2 (250.0) | 199.1 (1.8) | 419.0 (164.7) | 196.2 (30.7) | 385.8 (290.5) | 317.7 (254.3) | 494.4 (222.0) | 208.4 (59.0) | 112.8 (47.3) |
| Total resolved hydrocarbons-squalene | 228.4 (162.8) | 591.7 (594.4) | 349.3 (280.7) | 719.1 (360.2) | 221.8 (30.1) | 453.8 (115.9) | 212.3 (40.7) | 410.7 (298.6) | 517.5 (300.8) | 744.1 (366.4) | 237.2 (67.2) | 128.4 (53.8) |
| Total resolved hydrocarbons | 370.8 (38.6) | 807.3 (289.4) | 628.3 (40.0) | 1544.5 (675.8) | 265.8 (80.1) | 525.9 (46.4) | 237.9 (40.2) | 465.0 (346.0) | 529.0 (317.2) | 890.5 (204.4) | 414.6 (312.1) | 231.8 (197.3) |
| ucm | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 370.8 (38.6) | 807.3 (289.4) | 628.3 (40.0) | 1544.5 (675.8) | 265.8 (80.1) | 525.9 (46.4) | 237.9 (40.2) | 465.0 (346.0) | 529.0 (317.2) | 890.5 (204.4) | 414.6 (312.1) | 231.8 (197.3) |
| % lipid | 0.050 (0.022) | | 0.044 (0.017) | | 0.051 (0.020) | | 0.075 (0.064) | | 0.057 (0.023) | | 0.190 (0.028) | |

TABLE *5

ACROPORA sp.
(Coral)

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-c ₁₅ | n.d. | n.d. | 17.5 (24.7) | 138.9 (196.5) | n.d. | n.d. | 29.2 (16.3) | 308.6 (237.0) | 8.3 (0.3) | 67.0 (1.6) | n.d. | n.d. | 55.2 (92.7) | 69.9 (120.3) |
| n-c ₁₇ + pristane + n-c ₁₇ :1 | 115.6 (96.4) | 926.1 (967.9) | 178.5 (107.1) | 1202.8 (545.8) | 201.3 (47.7) | 2170.3 (166.5) | 271.6 (248.0) | 2260.1 (2105.9) | 34.3 (4.9) | 279.1 (42.9) | 203.6 (62.9) | 1784.2 (458.4) | 639.0 (103.4) | 949.4 (785.6) |
| n-c ₁₈ | 42.9 (39.1) | 348.4 (382.4) | 35.9 (9.8) | 248.9 (26.8) | 54.7 (22.0) | 582.0 (144.3) | 29.4 (11.7) | 242.8 (103.7) | 2.8 (0.1) | 22.4 (0.8) | 56.3 (20.0) | 516.3 (148.7) | 106.5 (11.7) | 187.1 (57.8) |
| n-c ₁₉ + n-c ₁₉ :1 | 136.8 (103.2) | 1082.0 (1070.1) | 98.5 (111.5) | 632.3 (673.2) | 39.5 (18.8) | 417.1 (136.1) | 35.2 (24.5) | 292.0 (210.4) | 5.9 (4.1) | 48.1 (33.5) | 218.3 (58.5) | 1645.2 (624.1) | 139.7 (25.3) | 239.8 (45.6) |
| n-c ₂₀ | 17.8 (5.3) | 130.4 (82.6) | 12.1 (0.3) | 86.2 (16.5) | 12.0 (4.1) | 127.7 (23.9) | 6.8 (0.8) | 56.2 (8.7) | 5.1 (1.4) | 41.6 (11.9) | 11.3 (2.2) | 99.4 (14.5) | 6.5 (1.9) | 11.8 (6.9) |
| n-c ₂₁ | 11.7 (4.8) | 87.0 (63.2) | 10.8 (1.5) | 77.7 (23.3) | 13.5 (9.9) | 139.2 (85.0) | 4.1 (0.3) | 33.6 (3.6) | 2.8 (0.1) | 22.4 (0.8) | 7.7 (1.5) | 67.5 (9.8) | 3.7 (1.0) | 6.5 (3.4) |
| n-c ₂₂ | 11.2 (7.3) | 86.8 (79.4) | 9.7 (0.3) | 68.5 (9.6) | 10.3 (14.6) | 100.7 (142.4) | 3.6 (0.2) | 29.6 (0.5) | 3.6 (2.1) | 29.3 (17.6) | 8.5 (0.8) | 74.8 (3.4) | 6.4 (1.7) | 11.5 (6.2) |
| n-c ₂₃ | 10.0 (6.0) | 77.0 (67.4) | 8.5 (1.6) | 61.1 (21.6) | 6.3 (9.0) | 61.7 (87.2) | 3.4 (0.7) | 28.1 (7.0) | 16.3 (20.4) | 132.8 (166.6) | 5.0 (2.5) | 43.6 (19.2) | 2.5 (0.7) | 4.6 (2.6) |
| n-c ₂₄ | 8.8 (5.0) | 67.4 (57.7) | 8.6 (0.8) | 60.4 (4.7) | 6.2 (8.8) | 60.3 (85.3) | 2.8 (0.1) | 23.1 (0.1) | 6.3 (5.6) | 51.1 (47.5) | 7.0 (1.7) | 61.2 (11.7) | 3.6 (0.9) | 6.6 (3.8) |
| n-c ₂₅ | 27.8 (25.9) | 225.9 (251.2) | 34.3 (25.9) | 227.8 (142.8) | 21.2 (6.0) | 228.2 (28.1) | 6.7 (0.8) | 54.9 (4.9) | 277.9 (377.7) | 2274.9 (3093.5) | 15.0 (1.4) | 132.2 (4.8) | 8.8 (2.9) | 15.5 (7.7) |
| n-c ₂₇ | 8.4 (4.2) | 63.5 (50.7) | 10.6 (1.2) | 74.3 (4.3) | 12.0 (4.7) | 135.8 (73.2) | n.d. | n.d. | 6.6 (9.3) | 53.8 (76.1) | 9.5 (0.5) | 84.5 (8.7) | 4.4 (0.9) | 8.0 (4.3) |
| n-c ₂₉ | 22.6 (21.5) | 184.3 (207.8) | 76.9 (92.5) | 490.6 (564.3) | 16.9 (1.8) | 184.2 (10.6) | 3.6 (0.8) | 29.4 (7.4) | 114.6 (159.5) | 134.2 (169.5) | 14.1 (1.3) | 125.2 (18.4) | 11.3 (6.6) | 22.4 (20.0) |
| n-c ₃₀ | 8.3 (4.6) | 51.4 (10.3) | 2.3 (3.2) | 17.9 (25.3) | 8.8 (4.1) | 93.6 (29.8) | 1.5 (0.4) | 12.7 (3.8) | 0.4 (0.6) | 3.4 (4.9) | 7.6 (1.5) | 66.9 (9.8) | 9.8 (6.6) | 19.7 (19.3) |
| n-c ₃₁ | 6.0 (0.5) | 42.3 (19.2) | 14.1 (9.5) | 94.7 (50.5) | 17.8 (2.8) | 192.7 (0.9) | 11.7 (5.4) | 96.3 (47.6) | 3.5 (4.2) | 28.6 (33.8) | 15.1 (0.8) | 132.9 (0.1) | 6.8 (2.7) | 12.8 (9.3) |
| n-c ₃₂ | 5.6 (1.0) | 40.4 (21.8) | 10.6 (5.4) | 72.1 (25.3) | 21.6 (19.3) | 219.4 (175.2) | 3.0 (4.3) | 25.4 (35.9) | 0.7 (0.9) | 5.3 (7.5) | 12.3 (5.0) | 107.5 (38.1) | 1.7 (2.9) | 2.1 (3.6) |
| squalene + n-c ₂₈ | 154.6 (208.9) | 801.1 (1047.3) | 176.0 (80.4) | 1297.6 (782.0) | 150.6 (173.2) | 1809.2 (2172.0) | 175.7 (235.6) | 1471.3 (1978.0) | 438.0 (619.4) | 3532.5 (4995.7) | 9.6 (12.9) | 2262.7 (2975.2) | 12.1 (4.4) | 20.7 (8.1) |
| unknown, between n-c ₂₁ and n-c ₂₂ | 32.9 (17.4) | 250.9 (205.8) | 27.9 (18.7) | 209.5 (166.0) | 24.8 (12.4) | 262.0 (92.4) | 24.4 (16.5) | 201.9 (141.9) | 5.0 (0.1) | 40.9 (1.2) | 34.2 (3.9) | 301.6 (18.1) | 26.8 (14.2) | 44.6 (19.3) |
| Total alkanes | 456.0 (347.7) | 3413.1 (3311.4) | 528.8 (332.7) | 3554.2 (1727.0) | 442.1 (164.2) | 4712.7 (1019.1) | 425.5 (317.3) | 3528.7 (2714.9) | 391.2 (442.9) | 3194.1 (3627.9) | 586.6 (28.7) | 5178.0 (26.9) | 1019.0 (57.9) | 1723.8 (428.8) |
| Total resolved hydrocarbons-squalene | 513.2 (341.6) | 4000.3 (3698.1) | 678.3 (220.1) | 4682.7 (748.1) | 520.2 (195.3) | 5543.7 (1221.4) | 510.0 (371.9) | 4232.4 (3188.4) | 1363.5 (1752.9) | 11148.7 (1103.6) | 675.5 (22.6) | 5975.0 (523.1) | 1268.0 (197.9) | 2180.4 (464.2) |
| Total resolved hydrocarbons | 667.8 (132.8) | 4801.4 (2650.9) | 854.2 (139.7) | 5980.2 (33.9) | 670.7 (22.1) | 7352.8 (950.6) | 685.5 (607.4) | 5703.7 (5166.4) | 1802.0 (1132.8) | 14681.2 (3892.1) | 922.8 (345.9) | 8239.7 (3498.3) | 1280.0 (197.9) | 2201.1 (470.9) |
| ucm | 1883.5 (2.9) | 13061.1 (4900.8) | 2283.0 (1892.2) | 15070.9 (10691.9) | 4793.2 (1320.4) | 53860.1 (23043.3) | 3947.0 (594.0) | 32260.2 (3793.6) | 5355.0 (3671.3) | 43629.0 (30240.6) | 2550.5 (2646.7) | 21907.3 (22169.3) | 2642.0 (1714.5) | 4341.3 (2656.6) |
| Total hydrocarbons | 2551.3 (135.7) | 17862.3 (7551.9) | 3137.3 (2031.9) | 21051.1 (10658.1) | 5463.9 (1298.3) | 61212.9 (23993.9) | 4633.5 (13.4) | 37963.9 (1372.8) | 17157.5 (4804.8) | 58310.2 (39588.6) | 3473.0 (2300.9) | 30145.9 (18671.0) | 3922.3 (1722.9) | 6542.5 (2490.5) |
| % lipid | 0.015 (0.006) | | 0.014 (0.003) | | 0.009 (0.001) | | 0.012 (-) * | | 0.012 (-) * | | 0.011 (0) | | 0.060 (0.19) | |

* % lipid corrected to 0.01225 (SD 0.0035) = mean (SD) of Acropora from the other sites.

TABLE 6

TRIDACNA - MUSCLE TISSUE
(Clam)

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|---|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|
| | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) |
| n-c ₁₅ | 9.6 (13.6) | 2.5 (3.5) | 10.0 (8.7) | 3.1 (2.7) | 9.6 (9.0) | 3.1 (2.9) | n.d. | n.d. | 11.2 (17.7) | 5.3 (8.9) | 5.3 (5.1) | 1.8 (1.6) | 3.4 (5.8) | 0.7 (1.3) |
| n-c ₁₇ + n-c _{17:1} | 27.2 (8.0) | 6.4 (1.2) | 16.1 (1.8) | 5.1 (0.5) | 14.7 (7.9) | 5.0 (2.2) | 13.3 (20.3) | 2.9 (3.6) | 10.4 (8.5) | 3.5 (2.6) | 13.9 (0.9) | 5.3 (1.1) | 28.0 (25.5) | 6.9 (6.6) |
| n-c ₁₈ | n.d. | n.d. | 3.4 (3.1) | 1.2 (1.0) | 3.7 (3.7) | 1.3 (1.2) | 1.2 (2.4) | 0.5 (0.9) | 3.6 (4.2) | 1.0 (1.2) | 3.1 (2.7) | 1.1 (1.0) | 6.9 (7.4) | 1. (1.6) |
| n-c ₁₉ | n.d. | n.d. | 1.0 (1.7) | 0.3 (0.6) | 0.7 (1.2) | 0.2 (0.4) | 1.3 (1.6) | 0.4 (0.5) | 1.5 (1.8) | 0.5 (0.5) | 0.5 (0.9) | 0.2 (0.3) | 18.4 (27.7) | 4.2 (6.0) |
| n-c ₂₀ | n.d. | n.d. | 1.6 (1.5) | 0.5 (0.5) | 0.4 (0.8) | 0.1 (0.2) | 0.6 (1.2) | 0.2 (0.5) | 0.7 (1.3) | 0.2 (0.4) | 0.2 (0.4) | 0.1 (0.2) | 22.7 (36.0) | 5.2 (7.9) |
| n-c ₂₁ | n.d. | n.d. | 0.7 (1.2) | 0.2 (0.4) | 0.5 (0.8) | 0.1 (0.2) | n.d. | n.d. | 0.4 (0.8) | 0.1 (0.2) | 0.4 (0.8) | 0.2 (0.3) | 6.2 (6.2) | 1.6 (1.5) |
| n-c ₂₂ | 4.4 (6.2) | 1.0 (1.4) | 2.1 (1.8) | 0.6 (0.5) | 1.3 (1.5) | 0.3 (0.5) | 6.0 (11.9) | 1.4 (2.7) | 0.7 (1.4) | 0.2 (0.4) | n.d. | n.d. | 35.0 (39.2) | 8.0 (8.4) |
| n-c ₂₃ | 5.0 (7.1) | 1.1 (1.6) | 0.9 (1.5) | 0.3 (0.5) | 0.3 (0.5) | 0.1 (0.2) | 0.1 (0.3) | 0.1 (0.1) | 0.3 (0.5) | 0.1 (0.1) | 0.4 (0.8) | 0.1 (0.2) | 19.1 (28.2) | 4.4 (6.1) |
| n-c ₂₄ | n.d. | n.d. | 1.7 (1.5) | 0.5 (0.4) | 0.3 (0.5) | 0.4 (0.7) | 1.7 (3.0) | 0.1 (0.1) | 1.5 (2.1) | 0.5 (0.8) | 0.3 (0.5) | 0.1 (0.2) | 30.6 (53.0) | 6.8 (11.7) |
| n-c ₂₅ | n.d. | n.d. | 12.3 (2.1) | 3.7 (1.1) | 4.2 (0.4) | 1.5 (0.3) | 3.0 (3.9) | 0.8 (1.0) | 4.4 (3.6) | 1.6 (1.3) | 5.4 (1.9) | 2.1 (1.0) | 66.6 (85.8) | 13.8 (19.5) |
| n-c ₂₇ | n.d. | n.d. | 2.3 (1.8) | 1.0 (0.1) | 4.2 (2.6) | 1.4 (0.8) | 4.8 (2.5) | 1.2 (0.5) | 1.6 (1.8) | 0.5 (0.5) | 4.5 (0.8) | 1.7 (0.5) | 32.6 (39.8) | 7.8 (9.0) |
| n-c ₂₉ | n.d. | n.d. | 1.6 (0.3) | 0.5 (0.1) | 1.9 (1.2) | 0.7 (0.4) | 2.0 (1.5) | 0.6 (0.4) | 0.8 (0.6) | 0.3 (0.2) | 2.1 (1.0) | 0.8 (0.5) | 74.0 (128.2) | 16.9 (29.3) |
| n-c ₃₀ | n.d. | n.d. | 2.3 (2.0) | 0.7 (0.6) | 1.0 (1.0) | 0.4 (0.5) | 0.5 (1.0) | 0.1 (0.2) | 0.4 (0.9) | 0.1 (0.3) | 0.8 (0.7) | 0.3 (0.2) | 6.8 (11.8) | 1.5 (2.6) |
| n-c ₃₁ | n.d. | n.d. | 5.3 (0.8) | 1.7 (0.4) | 3.0 (3.1) | 1.2 (0.5) | 5.1 (2.6) | 1.3 (0.6) | 2.8 (1.4) | 1.0 (0.3) | 3.6 (2.2) | 1.4 (1.0) | 93.3 (121.7) | 21.4 (27.8) |
| n-c ₃₂ | n.d. | n.d. | 1.2 (1.1) | 0.4 (0.3) | n.d. | n.d. | 0.5 (1.0) | 0.1 (0.3) | 0.2 (0.4) | 0.1 (0.1) | 0.9 (1.6) | 0.6 (1.0) | n.d. | n.d. |
| squalene + n-c ₂₈ | 4.4 (6.2) | 1.0 (1.4) | 112.6 (42.3) | 35.1 (10.8) | 432.6 (705.3) | 137.8 (222.6) | 55.5 (51.9) | 12.7 (10.1) | 21.8 (17.2) | 7.2 (4.9) | 39.4 (13.3) | 15.2 (6.8) | 120.0 (86.8) | 30.9 (20.5) |
| Total alkanes | 46.2 (7.6) | 11.0 (0.6) | 62.2 (19.7) | 19.5 (6.1) | 45.5 (14.4) | 15.5 (2.7) | 42.8 (22.2) | 11.5 (7.8) | 49.7 (38.0) | 19.8 (20.3) | 43.5 (8.4) | 16.2 (0.5) | 445.9 (334.7) | 102.4 (71.0) |
| Total resolved hydrocarbons-squalene | 82.9 (8.8) | 19.8 (0.2) | 67.1 (16.5) | 21.1 (5.1) | 47.5 (14.3) | 16.5 (4.0) | 52.2 (25.0) | 14.3 (10.0) | 57.8 (47.7) | 23.4 (25.8) | 47.9 (12.4) | 17.8 (1.6) | 1584.0 (1360.2) | 368.4 (297.7) |
| Total resolved hydrocarbons | 87.3 (15.0) | 20.8 (1.2) | 179.5 (36.9) | 56.0 (5.9) | 480.1 (697.2) | 154.3 (218.7) | 107.7 (47.0) | 27.0 (7.4) | 79.6 (53.4) | 30.6 (27.8) | 87.3 (15.4) | 33.0 (6.0) | 1703.7 (1417.3) | 399.3 (307.0) |
| ucm | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 2000.0 (3464.1) | 491.0 (850.4) |
| Total hydrocarbons | 87.3 (15.0) | 20.8 (1.2) | 179.5 (36.9) | 56.0 (5.9) | 480.1 (697.2) | 154.3 (218.7) | 107.7 (47.0) | 27.0 (7.4) | 79.6 (53.4) | 30.6 (27.8) | 87.3 (15.4) | 33.0 (6.0) | 3883.0 (3931.8) | 889.2 (834.7) |
| % lipid | 0.42 (0.05) | | 0.43 (0.23) | | 0.29 (0.05) | | 0.41 (0.14) | | 0.29 (0.07) | | 0.26 (0.06) | | 0.40 (0.08) | |

TABLE 7

TRIDACNA - KIDNEY TISSUE

(Clam)

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|---|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|--------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/g wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-c ₁₅ | 14.6 (25.3) | 0.2 (0.3) | 16.6 (14.5) | 0.3 (0.2) | n.d. | n.d. | 1.2 2.8 | 0.03 (0.08) | 68.3 (67.5) | 1.1 (1.2) | 4.0 (7.0) | 0.1 (0.1) | n.d. | n.d. |
| n-c ₁₇ + n-c _{17:1} | 232.7 (140.7) | 2.8 (1.7) | 87.7 (47.5) | 1.4 (0.8) | 335.3 (327.9) | 4.9 (5.1) | 294.9 (342.4) | 5.2 (6.1) | 203.0 (211.2) | 5.7 (3.5) | 199.3 (90.2) | 3.6 (1.9) | 165.5 (21.9) | 2.4 (0.1) |
| n-c ₁₈ | 45.1 (50.7) | 0.5 (0.6) | n.d. | n.d. | 26.8 (29.5) | 0.4 (0.4) | 137.5 (239.7) | 2.4 (4.3) | 17.5 (27.2) | 0.3 (0.5) | 62.6 (54.2) | 1.2 (1.0) | n.d. | n.d. |
| n-c ₁₉ + n-c _{19:1} | 17.8 (24.2) | 0.2 (0.3) | n.d. | n.d. | 75.5 (91.0) | 1.1 (1.4) | 132.1 (241.7) | 1.2 (1.9) | 27.3 (34.4) | 0.5 (0.6) | 32.3 (12.7) | 0.6 (0.3) | 22.7 (3.3) | 0.3 (0.0) |
| n-c ₂₀ | 6.3 (6.7) | 0.1 (0.1) | n.d. | n.d. | 7.7 (1.5) | 1.1 (0.0) | 19.3 (26.9) | 0.3 (0.4) | 17.9 (17.9) | 0.3 (0.3) | 8.5 (2.3) | 0.2 (0.0) | 5.2 (0.5) | 0.0 (0.0) |
| n-c ₂₁ | 3.1 (3.3) | 0.03 (0.04) | n.d. | n.d. | 4.0 (1.7) | 0.1 (0.0) | 22.1 (38.6) | 0.3 (0.5) | 21.8 (33.6) | 0.4 (0.6) | 5.6 (4.0) | 0.1 (0.1) | n.d. | n.d. |
| n-c ₂₂ | 3.8 (3.9) | 0.04 (0.05) | n.d. | n.d. | 2.3 (2.2) | 0.03 (0.03) | 13.5 (20.2) | 0.2 (0.3) | 9.2 (9.0) | 0.2 (0.2) | 4.8 (0.0) | 0.1 (0.1) | 2.8 (3.9) | 0.04 (0.06) |
| n-c ₂₃ | 4.0 (3.7) | 0.04 (0.04) | n.d. | n.d. | 1.7 (2.1) | 0.02 (0.03) | 8.7 (13.0) | 0.2 (0.2) | 6.4 (5.8) | 0.1 (0.1) | 3.4 (1.0) | 0.04 (0.04) | 2.2 (3.1) | 0.04 (0.05) |
| n-c ₂₄ | 2.2 (3.7) | 0.02 (0.04) | n.d. | n.d. | 0.4 (0.7) | 0.003 (0.006) | 5.3 (8.1) | 0.1 (0.1) | 7.7 (7.4) | 0.1 (0.1) | n.d. | n.d. | n.d. | n.d. |
| n-c ₂₅ | 9.8 (5.7) | 0.1 (0.1) | 8.4 (7.2) | 0.1 (0.1) | 7.7 (8.6) | 0.1 (0.1) | 17.3 (4.5) | 0.3 (0.1) | 62.1 (84.3) | 1.0 (1.3) | 12.8 (1.2) | 0.2 (0.1) | 11.5 (1.6) | 0.2 (0.1) |
| n-c ₂₇ | 8.4 (2.6) | 0.1 (0.0) | 1.1 (1.9) | 0.01 (0.02) | 7.5 (2.4) | 0.1 (0.0) | 9.6 (6.3) | 0.2 (0.1) | 12.1 (5.5) | 0.2 (0.1) | 7.0 (2.2) | 0.1 (0.1) | 8.5 (0.9) | 0.1 (0.0) |
| n-c ₂₉ | 2.3 (2.4) | 0.02 (0.02) | 11.6 (1.9) | 0.1 (0.1) | 14.2 (12.3) | 0.2 (0.1) | 5.4 (3.7) | 0.1 (0.1) | 5.8 (1.7) | 0.1 (0.0) | 5.6 (3.3) | 0.1 (0.1) | 5.1 (0.3) | 0.1 (0.0) |
| n-c ₃₀ | 1.6 (1.5) | 0.01 (0.01) | 4.8 (5.5) | 0.1 (0.1) | 4.3 (4.0) | 0.1 (0.1) | 4.7 (3.4) | 0.1 (0.1) | 9.8 (5.8) | 0.2 (0.1) | 6.8 (3.0) | 0.1 (0.0) | 8.1 (0.1) | 0.1 (0.0) |
| n-c ₃₁ | 19.1 (17.7) | 0.2 (0.2) | 39.5 (15.3) | 0.4 (0.1) | 24.9 (17.8) | 0.3 (0.2) | 3.6 (8.0) | 0.1 (0.1) | 15.1 (15.3) | 0.2 (0.2) | 12.4 (1.7) | 0.2 (0.1) | 29.5 (4.5) | 0.4 (0.1) |
| n-c ₃₂ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 2.2 (3.8) | 0.03 (0.06) | 7.1 (0.7) | 0.1 (0.0) |
| squalene + n-c ₂₈ | 21.7 (12.5) | 0.3 (0.2) | 51.1 (36.9) | 0.8 (0.6) | 177.0 (57.7) | 2.5 (0.7) | 20.3 (27.2) | 0.3 (0.4) | 30.0 (16.7) | 0.5 (0.2) | 41.9 (24.9) | 0.8 (0.6) | 6.2 (1.7) | 0.1 (0.0) |
| Total alkanes | 378.4 (247.7) | 4.4 (3.0) | 169.7 (46.9) | 2.7 (0.9) | 514.0 (385.1) | 7.5 (5.9) | 625.2 (726.9) | 10.8 (12.7) | 484.0 (416.2) | 8.0 (7.3) | 556.5 (421.6) | 6.9 (3.4) | 267.8 (11.6) | 2.3 (2.8) |
| Total resolved hydrocarbons-squalene | 702.0 (795.6) | 8.3 (9.7) | 232.0 (74.1) | 3.6 (0.8) | 551.3 (375.9) | 8.0 (5.8) | 702.0 (805.3) | 11.5 (14.8) | 711.3 (337.8) | 11.4 (6.4) | 426.7 (103.9) | 7.7 (2.7) | 291.0 (11.3) | 4.2 (0.5) |
| Total resolved hydrocarbons | 723.7 (792.9) | 8.6 (9.6) | 283.0 (94.3) | 4.4 (1.3) | 728.7 (360.2) | 10.5 (5.7) | 967.4 (816.7) | 12.6 (14.1) | 741.3 (333.8) | 11.9 (6.3) | 468.0 (127.6) | 8.5 (3.2) | 297.0 (12.7) | 4.3 (0.5) |
| ucm | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 723.7 (792.9) | 8.6 (9.6) | 283.0 (94.3) | 4.4 (1.3) | 728.7 (360.2) | 10.5 (5.7) | 967.4 (816.7) | 12.6 (14.1) | 741.3 (333.8) | 11.9 (6.3) | 468.0 (127.6) | 8.5 (3.2) | 297.0 (12.7) | 4.3 (0.5) |
| % lipid | 8.48 (1.29) | | 6.39 (1.05) | | 7.01 (0.31) | | 5.85 (1.67) | | 6.39(0.51) | | 5.65(0.72) | | 6.94(1.13) | |

TABLE 8

HOLOTHURIA
(Sea Cucumber)

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND BOAT HARBOUR | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|
| | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) |
| n-c ₁₅ | 18.3 (3.0) | 1.6 (1.4) | n.d. | n.d. | 34.3 (23.6) | 4.7 (3.3) | 85.6 (32.7) | 8.3 (1.6) | 0.8 (1.5) | 0.1 (0.1) | 5.7 (8.1) | 0.9 (1.3) | 107.6 (-) | 13.4 (-) |
| n-c ₁₇ + n-c ₁₇ :1 | 309.0 (108.9) | 26.3 (23.4) | 166.1 (-) | 20.3 (-) | 429.0 (68.6) | 57.6 (9.5) | 390.5 (163.3) | 37.6 (8.6) | 129.8 (38.6) | 13.6 (2.7) | 230.0 (121.6) | 32.8 (13.2) | 387.9 (-) | 48.4 (-) |
| n-c ₁₈ | 7.3 (12.7) | 1.1 (1.9) | 46.9 (-) | 5.7 (-) | 14.9 (13.3) | 2.1 (1.8) | 12.9 (7.5) | 1.2 (0.5) | 2.8 (2.2) | 0.3 (0.2) | 18.4 (26.0) | 2.5 (3.5) | 17.8 (-) | 2.2 (-) |
| n-c ₁₉ | 62.9 (31.9) | 8.5 (3.6) | 48.0 (-) | 5.9 (-) | 35.5 (53.4) | 4.9 (7.3) | 38.2 (34.7) | 4.2 (4.3) | 13.5 (4.2) | 1.4 (0.5) | 31.5 (32.0) | 4.3 (4.1) | 60.4 (-) | 7.5 (-) |
| n-c ₂₀ | 22.8 (8.0) | 3.1 (0.6) | 19.4 (-) | 2.4 (-) | 32.2 (5.8) | 4.3 (0.9) | 24.4 (14.7) | 2.3 (1.0) | 12.1 (3.6) | 1.3 (0.6) | 19.9 (6.4) | 2.9 (0.5) | 8.4 (-) | 1.1 (-) |
| n-c ₂₁ | n.d. | n.d. | 20.0 (-) | 2.5 (-) | 0.9 (1.6) | 0.3 (0.5) | 10.2 (14.4) | 1.2 (1.7) | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-c ₂₂ | 1.3 (2.2) | 0.2 (0.3) | 18.3 (-) | 2.2 (-) | 2.6 (2.3) | 0.4 (0.3) | n.d. | n.d. | 9.9 (5.6) | 1.0 (0.4) | 4.2 (5.9) | 0.6 (0.8) | 2.7 (-) | 0.3 (-) |
| n-c ₂₃ | 7.9 (6.9) | 1.0 (0.9) | 12.7 (-) | 1.6 (-) | 3.3 (1.4) | 0.5 (0.2) | 8.7 (5.2) | 0.8 (0.4) | 5.2 (9.5) | 0.4 (0.8) | 5.8 (5.0) | 0.8 (0.6) | 2.3 (-) | 0.3 (-) |
| n-c ₂₄ | 6.3 (6.3) | 0.8 (0.7) | 10.5 (-) | 1.3 (-) | 3.3 (3.0) | 0.5 (0.4) | 16.4 (3.6) | 1.6 (0.0) | 5.3 (10.6) | 0.4 (0.9) | 12.4 (0.7) | 1.9 (0.4) | 3.1 (-) | 0.4 (-) |
| n-c ₂₅ | 11.0 (9.8) | 1.7 (1.6) | 15.6 (-) | 1.9 (-) | 41.3 (28.6) | 5.6 (4.1) | 215.8 (259.1) | 19.1 (21.7) | 25.6 (8.7) | 2.7 (0.5) | 32.5 (5.2) | 4.8 (0.1) | 15.4 (-) | 1.9 (-) |
| n-c ₂₇ | 131.7 (138.9) | 18.2 (3.5) | 6.2 (-) | 0.8 (-) | 106.0 (92.1) | 14.4 (12.7) | 102.3 (11.5) | 10.4 (3.2) | 70.4 (14.3) | 6.7 (3.2) | 148.5 (111.0) | 20.9 (13.4) | 37.7 (-) | 4.7 (-) |
| n-c ₂₉ | 13.3 (16.4) | 2.0 (2.7) | 66.4 (-) | 8.1 (-) | 18.7 (5.4) | 1.9 (1.6) | 22.8 (9.8) | 2.2 (0.5) | 18.0 (21.6) | 1.7 (1.7) | 16.1 (22.6) | 2.1 (3.0) | 22.6 (-) | 2.8 (-) |
| n-c ₃₀ | 20.1 (20.1) | 3.0 (3.0) | 24.8 (-) | 3.0 (-) | 24.9 (7.4) | 3.4 (1.1) | 40.0 (17.1) | 3.9 (0.9) | 18.5 (17.2) | 1.8 (1.3) | 22.9 (2.3) | 3.4 (0.8) | 65.9 (-) | 8.2 (-) |
| n-c ₃₁ | 3.6 (3.9) | 0.6 (0.6) | 16.7 (-) | 2.0 (-) | 3.9 (3.4) | 0.5 (0.5) | 17.6 (2.5) | 1.8 (0.1) | 12.6 (16.5) | 1.1 (1.3) | 18.1 (9.3) | 2.8 (1.8) | 7.6 (-) | 0.9 (-) |
| n-c ₃₂ | 1.5 (1.7) | 0.2 (0.3) | 8.4 (-) | 1.0 (-) | 0.6 (1.1) | 0.1 (0.1) | n.d. | n.d. | 16.9 (30.9) | 1.4 (2.5) | 19.3 (5.0) | 2.8 (0.4) | 2.9 (-) | 0.4 (-) |
| squalene + n-c ₂₈ | 338.7 (202.8) | 50.3 (32.4) | 2846.4 (-) | 347.8 (-) | 47.4 (24.6) | 6.4 (3.5) | 57.0 (36.6) | 5.4 (2.5) | 388.3 (186.6) | 44.1 (24.5) | 448.2 (600.8) | 72.7 (98.4) | 475.2 (-) | 59.3 (-) |
| C ₂₅ H ₄₈ A unknown | 144.3 (51.6) | 19.8 (5.6) | 56.9 (-) | 7.0 (-) | 144.3 (33.5) | 19.4 (4.9) | 289.5 (115.3) | 28.0 (5.7) | 176.0 (22.7) | 18.9 (4.2) | 202.0 (93.3) | 29.0 (9.6) | 159.6 (-) | 19.9 (-) |
| mixture of C ₂₅ unknowns | 0.5 (0.8) | 0.1 (0.1) | 5.4 (-) | 0.7 (-) | 28.6 (39.4) | 3.9 (5.4) | 80.1 (40.8) | 7.7 (2.5) | 41.9 (15.1) | 4.6 (2.3) | 85.5 (46.3) | 12.2 (5.1) | 2.7 (-) | 0.4 (-) |
| unknown, between n-c ₂₂ and n-c ₂₃ | 2.7 (4.6) | 0.4 (0.7) | 9.4 (-) | 1.2 (-) | 7.2 (7.3) | 1.0 (1.0) | 70.7 (35.0) | 6.8 (2.1) | 15.0 (4.8) | 2.8 (2.3) | 9.3 (5.7) | 1.3 (0.7) | n.d. | n.d. |
| Total alkanes | 507.7 (271.7) | 68.3 (30.5) | 480.2 (-) | 58.7 (-) | 748.9 (147.6) | 101.1 (23.1) | 985.1 (455.0) | 94.6 (25.9) | 341.6 (154.8) | 12.0 (23.4) | 585.1 (320.9) | 29.5 (40.6) | 742.5 (-) | 92.7 (-) |
| Total resolved hydrocarbons-squalene | 688.0 368.0 | 92.3 (39.4) | 639.7 (-) | 78.2 (-) | 1138.4 (245.9) | 153.8 (38.1) | 1688.5 (835.1) | 161.6 (49.9) | 648.5 (185.9) | 68.1 (14.6) | 970.5 (449.0) | 139.2 (46.2) | 1461.0 (-) | 182.4 (-) |
| Total resolved hydrocarbons | 1066.7 (328.2) | 148.8 (44.3) | 3486.1 (-) | 426.0 (-) | 1185.3 (270.5) | 160.2 (41.5) | 1746.5 (871.9) | 167.0 (52.5) | 1037.3 (96.4) | 112.1 (27.0) | 1418.0 (151.3) | 211.9 (52.2) | 1936.2 (-) | 241.7 (-) |
| ucm | 1079.3 (483.4) | 127.6 (8.0) | 577.3 (-) | 73.4 (-) | 9995.3 (9400.8) | 1364.4 (1306.0) | 3509.5 (815.3) | 361.4 (152.9) | 9696.5 (9212.4) | 1119.6 (1174.0) | 5163.0 (2984.0) | 733.5 (335.4) | n.d. | n.d. |
| Total hydrocarbons | 1989.0 (475.4) | 276.4 (47.1) | 4063.4 (-) | 496.6 (-) | 11181.3 (9625.8) | 1524.6 (1340.3) | 5255.5 (55.9) | 528.4 (100.5) | 10734.3 (9205.6) | 1231.8 (1187.6) | 6582.0 (2832.7) | 944.9 (283.7) | 1936.2 (-) | 241.7 (-) |
| % lipid | 0.72 (0.13) | | 0.82 (0.13) | | 0.75 (0.03) | | 1.01 (0.20) | | 0.95 (0.19) | | 0.68 (0.10) | | 0.80 (-) | |

TABLE 9

SCARUS sp.
(Parrot Fish)

| Components | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg dry wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg dry wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg dry wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg dry wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg dry wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-C ₁₅ | n.d. | n.d. | 28.3 (11.9) | 72.6 (45.6) | n.d. | n.d. | 16.8 (2.8) | 21.4 (9.0) | 9.8 (8.5) | 8.6 (7.6) |
| n-C ₁₇ + pristane +n-c ₁₇ :1 | 221.7 (127.6) | 304.9 (232.3) | 126.8 (59.8) | 372.0 (220.2) | 319.3 (274.2) | 397.7 (277.6) | 179.2 (138.5) | 183.6 (48.9) | 151.4 (100.5) | 164.8 (32.5) |
| n-C ₁₈ | n.d. | n.d. | 1.6 (2.3) | 3.3 (4.6) | 9.4 (18.9) | 17.8 (36.4) | 3.3 (3.1) | 5.4 (4.9) | 5.0 (0.7) | 7.9 (5.4) |
| n-C ₁₉ | n.d. | n.d. | 2.8 (0.4) | 6.8 (2.6) | 6.7 (4.5) | 10.1 (8.4) | 2.0 (1.9) | 3.3 (3.0) | 1.7 (1.5) | 3.5 (4.1) |
| n-C ₂₀ | 0.8 (1.3) | 1.1 (2.0) | 2.2 (0.1) | 5.4 (1.1) | 4.2 (4.1) | 6.2 (7.2) | 0.9 (1.6) | 1.8 (3.0) | 1.4 (1.2) | 3.1 (4.2) |
| n-C ₂₁ | n.d. | n.d. | 0.9 (1.2) | 1.7 (2.4) | 3.0 (3.1) | 4.9 (5.6) | 1.0 (1.7) | 1.9 (3.2) | 0.6 (1.1) | 2.1 (3.6) |
| n-C ₂₂ | 0.7 (1.4) | 1.0 (2.1) | 1.3 (0.9) | 2.9 (1.4) | n.d. | n.d. | 2.1 (2.2) | 2.2 (2.0) | 0.7 (1.2) | 2.4 (4.2) |
| n-C ₂₃ | n.d. | n.d. | 0.6 (0.9) | 1.3 (1.8) | 1.6 (3.6) | 1.7 (3.7) | 1.2 (1.0) | 2.0 (1.8) | 1.0 (0.9) | 2.2 (2.7) |
| n-C ₂₄ | n.d. | n.d. | 0.7 (0.9) | 1.3 (1.9) | 4.9 (9.6) | 9.0 (18.7) | 3.3 (3.4) | 3.0 (1.3) | 0.9 (0.9) | 1.4 (1.4) |
| n-C ₂₅ | 2.6 (3.5) | 3.6 (5.1) | 4.6 (0.7) | 11.0 (0.9) | 1.6 (3.5) | 9.2 (9.1) | 15.7 (15.8) | 14.3 (6.0) | 4.1 (0.7) | 7.5 (7.2) |
| n-C ₂₇ | n.d. | n.d. | 7.8 (3.0) | 18.1 (2.7) | n.d. | n.d. | 4.8 (5.3) | 7.8 (8.0) | 1.2 (2.0) | 4.0 (7.0) |
| n-C ₂₉ | n.d. | n.d. | 6.8 (9.6) | 13.8 (19.4) | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₀ | 0.5 (0.9) | 0.8 (1.3) | n.d. | n.d. | 1.8 (1.8) | 2.9 (3.2) | n.d. | n.d. | 1.2 (1.3) | 1.0 (1.1) |
| n-C ₃₁ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₂ | n.d. | n.d. | n.d. | n.d. | 0.9 (1.2) | 1.8 (1.7) | n.d. | n.d. | 0.4 (0.7) | 0.3 (0.6) |
| Squalene + n-c ₂₈ | 916.1 (362.8) | 1033.0 (847.0) | 1465.1 (432.1) | 3449.3 (197.7) | 849.0 (279.9) | 1122.1 (418.8) | 4907.2 (6776.6) | 7178.2 (10597.6) | 1369.6 (151.7) | 2476.0 (2311.3) |
| Total alkanes | 226.3 (130.6) | 319.5 (248.5) | 184.3 (52.6) | 449.0 (213.1) | 362.8 (262.8) | 465.9 (278.1) | 230.3 (150.2) | 246.6 (46.9) | 179.2 (105.4) | 206.3 (18.8) |
| Total resolved hydrocarbons-squalene | 236.7 (128.2) | 321.7 (241.3) | 189.2 (59.5) | 479.1 (255.8) | 423.6 (225.2) | 544.9 (232.2) | 432.8 (494.3) | 373.4 (215.9) | 189.3 (102.3) | 231.2 (35.4) |
| Total resolved hydrocarbons | 1163.9 (408.5) | 1251.7 (865.9) | 1654.3 (372.7) | 3928.4 (58.1) | 1082.4 (696.8) | 1694.8 (552.8) | 5339.9 (6552.6) | 7551.6 (10452.7) | 1562.1 (125.2) | 2710.2 (2337.9) |
| UCM | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 1163.9 (408.5) | 1251.7 (865.9) | 1654.3 (372.7) | 3928.4 (58.1) | 1082.4 (696.8) | 1694.8 (552.8) | 5339.9 (6552.6) | 7551.6 (10452.7) | 1562.1 (125.2) | 2710.2 (2337.9) |
| % lipid | 0.187 | (0.223) | 0.043 | (0.008) | 0.077 | (0.019) | 0.094 | (0.059) | 0.087 | (0.050) |

TABLE 10

CORAL TROUT

| Components | POLMAISE REEF | | MASTHEAD ISLAND | | WISTARI REEF | | HERON ISLAND | | ONE TREE ISLAND | | WRECK ISLAND | |
|--|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|
| | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) | ug/kg wet wt. x (SD) | ug/g lipid wt. x (SD) |
| n-c ₁₅ | 27.5 (7.2) | 8.2 (4.1) | 49.6 (60.4) | 2.7 (3.1) | 34.7 (20.2) | 15.1 (4.7) | n.d. | n.d. | 18.8 (16.6) | 14.1 (7.2) | 23.5 (20.6) | 20.8 (20.9) |
| n-c ₁₇ + pristane + n-c _{17:1} | 190.1 (284.3) | 37.5 (24.4) | 327.4 (328.9) | 19.4 (15.0) | 213.3 (205.0) | 98.0 (78.6) | 236.3 (329.3) | 103.6 (81.4) | 240.6 (293.5) | 120.8 (62.4) | 97.6 (69.1) | 98.1 (64.5) |
| n-c ₁₈ | 6.2 (1.1) | 3.8 (3.1) | n.d. | n.d. | 8.0 (2.3) | 4.8 (3.5) | 24.1 (36.3) | 9.0 (10.8) | 8.4 (5.7) | 6.3 (10.4) | 6.1 (2.1) | 8.8 (6.5) |
| n-c ₁₉ | 6.4 (4.0) | 3.0 (2.0) | n.d. | n.d. | 5.9 (1.8) | 3.4 (2.6) | 26.9 (21.8) | 8.1 (6.2) | 3.9 (1.4) | 3.6 (2.0) | 2.7 (2.9) | 5.0 (7.4) |
| n-c ₂₀ | 2.8 (0.2) | 1.8 (1.5) | n.d. | n.d. | 3.3 (0.5) | 2.2 (2.2) | 3.6 (3.6) | 3.0 (4.7) | 2.6 (1.1) | 2.4 (1.2) | 2.5 (2.6) | 4.5 (6.5) |
| n-c ₂₁ | 2.6 (0.8) | 1.4 (0.9) | n.d. | n.d. | 2.2 (0.5) | 1.4 (1.3) | 0.7 (1.1) | 0.2 (0.3) | 2.0 (0.6) | 2.5 (2.7) | 5.6 (4.3) | 10.1 (12.2) |
| n-c ₂₂ | 3.2 (2.0) | 2.2 (1.8) | n.d. | n.d. | 2.5 (0.9) | 2.0 (2.5) | 2.5 (2.3) | 1.7 (2.3) | 2.3 (0.9) | 2.0 (0.9) | 3.1 (2.2) | 4.1 (2.7) |
| n-c ₂₃ | 4.6 (2.2) | 2.3 (1.3) | n.d. | n.d. | 3.0 (1.6) | 2.6 (3.1) | 4.1 (4.8) | 4.8 (6.8) | 2.2 (0.9) | 2.6 (2.6) | 3.1 (4.7) | 3.3 (5.3) |
| n-c ₂₄ | 2.1 (1.4) | 1.6 (1.4) | n.d. | n.d. | 3.4 (2.7) | 3.6 (5.2) | 6.4 (6.0) | 6.2 (7.8) | 1.6 (0.9) | 1.2 (0.4) | 5.6 (8.2) | 12.0 (19.8) |
| n-c ₂₅ | 3.5 (1.9) | 2.7 (2.3) | 8.4 (7.4) | 0.5 (0.6) | 8.0 (2.9) | 6.4 (7.9) | 11.8 (14.7) | 5.5 (8.2) | 13.9 (11.1) | 14.3 (10.9) | 16.4 (19.3) | 33.3 (49.2) |
| n-c ₂₇ | 3.4 (0.2) | 2.3 (1.9) | n.d. | n.d. | 5.6 (2.9) | 5.1 (6.8) | 0.9 (1.4) | 0.4 (0.6) | 2.3 (1.1) | 2.5 (1.6) | 1.6 (1.9) | 1.7 (1.5) |
| n-c ₂₉ | 3.1 (3.4) | 1.0 (0.4) | n.d. | n.d. | 4.6 (1.3) | 3.3 (3.7) | 0.3 (0.6) | 0.1 (0.2) | 1.5 (1.5) | 1.1 (1.5) | n.d. | n.d. |
| n-c ₃₀ | 2.1 (3.0) | 1.2 (1.4) | 1.3 (2.3) | 0.1 (0.1) | 1.0 (0.9) | 0.7 (1.0) | 2.6 (2.3) | 2.6 (3.4) | 0.9 (1.6) | 0.9 (1.5) | n.d. | n.d. |
| n-c ₃₁ | 5.8 (4.0) | 2.4 (1.0) | n.d. | n.d. | 7.8 (4.0) | 7.0 (8.6) | 24.8 (29.0) | 8.0 (9.5) | 3.6 (3.4) | 2.5 (3.2) | n.d. | n.d. |
| n-c ₃₂ | 1.9 (1.9) | 1.1 (1.3) | n.d. | n.d. | n.d. | n.d. | 3.5 (3.7) | 4.5 (5.1) | 0.6 (0.7) | 1.2 (1.6) | 21.6 (37.4) | 50.2 (87.0) |
| squalene + n-c ₂₈ | 630.2 (503.4) | 243.2 (88.0) | 962.5 (408.9) | 179.0 (224.4) | 890.8 (650.0) | 467.1 (294.6) | 649.4 (426.6) | 663.4 (494.1) | 855.9 (522.6) | 651.4 (193.5) | 553.4 (236.8) | 610.1 (114.0) |
| Total alkanes | 258.6 (309.7) | 73.1 (19.9) | 386.7 (395.1) | 22.7 (18.2) | 304.3 (208.5) | 124.9 (107.5) | 315.3 (377.3) | 150.8 (90.3) | 305.3 (315.5) | 171.2 (46.6) | 178.4 (48.5) | 222.2 (99.9) |
| Total resolved hydrocarbons-squalene | 324.8 (298.2) | 116.9 (40.7) | 411.3 (584.5) | 27.7 (26.2) | 325.7 (201.0) | 174.1 (104.5) | 381.3 (361.5) | 228.2 (158.7) | 368.4 (292.5) | 139.1 (101.0) | 379.9 (220.2) | 486.2 (290.4) |
| Total resolved hydrocarbons | 956.0 (800.7) | 360.1 (126.3) | 1373.8 (861.7) | 101.4 (33.4) | 1216.5 (852.6) | 641.1 (397.6) | 1030.6 (530.3) | 668.2 (355.1) | 1224.3 (813.9) | 536.1 (399.3) | 933.3 (350.3) | 1096.3 (402.9) |
| ucm | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 955.0 (800.7) | 360.1 (126.3) | 1373.8 (861.7) | 101.4 (33.4) | 1216.5 (852.6) | 641.1 (397.6) | 1030.6 (530.3) | 668.2 (355.1) | 1224.3 (813.9) | 536.1 (399.3) | 933.3 (350.3) | 1096.3 (402.9) |
| % lipid | 0.356 (0.409) | | 1.49 (0.40) | | 0.26 (0.21) | | 0.140 (0.130) | | 0.15 (0.130) | | 0.097 (0.058) | |

TABLE 11. Heron Island surface sediments (top 2cm).

| Components | $\mu\text{g}/\text{kgm}$ dry weight \bar{X} (SD) | $\mu\text{g}/\text{g}$ lipid weight \bar{X} (SD) |
|--|---|---|
| n-C ₁₄ | 1.9 (0.4) | 30.9 (11.9) |
| n-C ₁₅ + n-C ₁₅ :1 | 57.7 (5.6) | 922.4 (247.9) |
| n-C ₁₇ | 168.1 (24.1) | 2715.3 (928.0) |
| n-C ₁₈ | 8.5 (1.8) | 138.7 (54.0) |
| n-C ₁₉ + n-C ₁₉ :1 | 21.9 (2.9) | 353.4 (117.0) |
| n-C ₂₀ | 1.9 (0.2) | 30.8 (10.9) |
| n-C ₂₁ + C ₂₅ H ₄₈ ^A unknown | 40.0 (4.4) | 640.2 (182.4) |
| n-C ₂₂ | 2.7 (0.2) | 43.4 (12.1) |
| n-C ₂₃ | 6.1 (0.6) | 98.1 (26.1) |
| n-C ₂₄ | 2.2 (0.1) | 35.6 (9.6) |
| n-C ₂₅ | 10.2 (0.9) | 162.8 (46.4) |
| n-C ₂₇ | 2.4 (1.0) | 38.9 (17.0) |
| n-C ₂₉ | 2.0 (0.7) | 31.7 (12.2) |
| n-C ₃₀ | 2.2 (0.6) | 34.5 (11.9) |
| n-C ₃₁ | 1.9 (0.5) | 29.4 (8.5) |
| n-C ₃₂ | 0.2 (0.3) | 3.4 (4.6) |
| squalene + n-C ₂₈ | 79.3 (13.0) | 1277.9 (438.4) |
| n-C ₁₇ :1 | 162.2 (24.2) | 2584.1 (706.1) |
| C ₂₁ H ₃₆ unknown | 82.5 (14.8) | 1295.9 (275.5) |
| C ₂₅ H ₅₀ ^A unknown | 15.0 (1.4) | 240.2 (66.4) |
| Total alkanes | 290.1 (37.2) | 4669.3 (1488.9) |
| Total resolved hydrocarbons-squalene | 658.6 (90.6) | 10242.7 (2867.5) |
| Total resolved hydrocarbons | 720.2 (75.1) | 11521.4 (3212.6) |
| UCM | trace | trace |
| Total hydrocarbons | 720.2 (75.1) | 11521.4 (3212.6) |
| % lipid | 0.007 (0.001) | |

TABLE 12. \bar{X} values and standard deviations (SD) of classes of hydrocarbons in water, sediments and organisms from Capricorn Group. $\mu\text{g/kg}$ wet weight for water and organisms, $\mu\text{g/kg}$ dry weight for sediments.

n.d. = not detected; [values for top 4cm of sediments from Heron Island]

| | Water | <u>Tridacna</u> (muscle) | Parrot Fish | <u>Fungia</u> | Coral Trout | <u>Tridacna</u> (kidney) | Sediments | <u>Acropora</u> | <u>Holothuria</u> | <u>Chloro-</u> <u>desmis</u> |
|---|-------|-----------------------------|------------------|------------------|-----------------|-----------------------------|---|--------------------|--------------------|---------------------------------|
| Total "alkanes" | 0.19 | 105.1 (150.4) | 236.7 (74.3) | 218.2 (54.3) | 291.4 (69.1) | 427.9 (163.7) | 248.4 (232.2) [290.1] [(37.2)] | 549.9 (217.2) | 627.3 (214.3) | 83075.5 (45170.3) |
| Total resolved hydrocarbons minus squalene in f_1 fraction | 0.29 | 277.1 (576.4) | 294.3 (123.8) | 294.4 (120.4) | 365.2 (34.1) | 516.6 (203.2) | 274.1 (243.8) [658.6] [(90.6)] | 789.8 (367.6) | 1033.5 (418.2) | 148570.2 (88817.8) |
| UCM | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. | 630.0 (664.5) [n.d.] | 3350.6 (1347.1) | 4288.7 (4196.2) | n.d. |
| UCM + total resolved hydrocarbons minus squalene | 0.29 | 277.1 (576.4) | 294.3 (123.8) | 294.4 (120.4) | 365.2 (34.1) | 516.6 (203.2) | 904.1 (701.4) [658.6] [(90.6)] | 4140.4 (1496.8) | 5322.2 (4164.8) | 148570.2 (8817.8) |

TABLE 13. \bar{X} values ($\mu\text{g/g}$ lipid weight) and standard deviations (SD) of classes of hydrocarbons in water, sediments and organisms from Capricorn Group.

n.d. = not detected; n.a. = not analysed.

| | <u>Tridacna</u> (kidney) | <u>Tridacna</u> (muscle) | Coral Trout | Parrot Fish | <u>Fungia</u> | <u>Holo-</u> <u>thuria</u> | <u>Chloro-</u> <u>desmis</u> | Water | <u>Acropora</u> | Sediments |
|---|-----------------------------|-----------------------------|------------------|------------------|------------------|-------------------------------|---------------------------------|-------|----------------------|---|
| Total "alkanes" | 6.1 (3.1) | 28.0 (33.0) | 109.1 (84.9) | 337.5 (117.0) | 383.5 (138.5) | 65.3 (34.3) | 8352.9 (7416.6) | n.a. | 3556.5 (1056.6) | 12452.4 (4399.9) [4669.3] [(1488.9)] |
| Total resolved hydrocarbons minus squalene in f_1 fraction | 7.8 (3.1) | 68.8 (132.2) | 195.4 (157.2) | 390.1 (124.6) | 508.0 (229.7) | 125.1 (45.0) | 15097.5 (14440.5) | n.a. | 5394.81 (2816.7) | 14027.8 (4547.5) [10242.7] [(2867.5)] |
| UCM | n.d. | n.d. | n.d. | n.d. | n.d. | 540.0 (542.3) | n.d. | n.a. | 26304.3 (17786.8) | 45604.8 (60428.9) [n.d.] |
| UCM + total resolved hydrocarbons minus squalene | 7.8 (3.1) | 68.8 (132.2) | 195.4 (157.2) | 390.1 (124.6) | 508.0 (229.7) | 665.1 (541.5) | 15097.5 (14440.5) | n.a. | 31699.2 (19700.1) | 59632.6 (60469.7) [10242.7] [(2867.5)] |
| Percentage lipid | 6.67 (0.94) | 0.36 (0.07) | 0.42 (0.53) | 0.10 (0.05) | 0.08 (0.06) | 0.82 (0.12) | 1.16 (0.34) | n.a. | 0.02 (0.02) | 0.001 (0.0006) [0.007] [(0.001)] |

TABLE 14. Mean percentage of UCM in the total of UCM + resolved hydrocarbons-squalene ($\mu\text{g/g}$ lipid weight)

| Collecting site | Sediment | Type of sample <u>Holothuria</u> | <u>Acropora</u> |
|------------------------------|----------------|-------------------------------------|-----------------|
| Polmaise Reef | 84.8 | 58.0 | 76.6 |
| Masthead Island | 77.8 | 48.4 | 76.3 |
| Wistari Reef | 49.3 | 89.9 | 90.7 |
| Heron Island Boat Harbour | 92.3 | 69.1 | 88.4 |
| Heron Island | 32.4 | 94.3 | 79.6 |
| One Tree Island | 39.4 | 84.0 | 78.6 |
| Wreck Island | 44.8 | 0 | 66.6 |
| \bar{X} | 60.1 | 63.4 | 79.5 |
| (SD) | (± 24.2) | (± 32.6) | (± 8.1) |

TABLE 15. Positive correlations (significant at the 5% level) found in all pairwise comparisons of sediments and organisms at the localities listed in Tables 1-10. Correlation/regression analyses performed for $\mu\text{g/g}$ lipid of individual alkanes and totals listed in Tables 2-10.

Key: $n\text{-C}_{19} = \text{C}_{19}\text{n-alkane}$;

A = total alkanes; S = squalene;

R = total resolved hydrocarbons; R-S = total resolved hydrocarbons-squalene;

UCM = unresolved complex mixture; T = total hydrocarbons

| | | | | | | | | |
|--|--------------------------------|-------------------|-------------------|-------------------|-------------------|-----|-----|---|
| Coral Trout vs Parrot Fish | $n\text{-C}_{18}$ | $n\text{-C}_{19}$ | $n\text{-C}_{23}$ | $n\text{-C}_{27}$ | $n\text{-C}_{29}$ | | | |
| Coral Trout vs <u>Tridacna</u> (muscle) | $n\text{-C}_{21}$ | $n\text{-C}_{24}$ | $n\text{-C}_{25}$ | | | R-S | R | T |
| <u>Holothuria</u> vs <u>Acropora</u> | $n\text{-C}_{20}$ | $n\text{-C}_{29}$ | | | | UCM | T | |
| <u>Holothuria</u> vs <u>Chlorodesmis</u> | $n\text{-C}_{18}$ | $n\text{-C}_{23}$ | | | | R | | |
| <u>Holothuria</u> vs <u>Tridacna</u> (muscle) | $n\text{-C}_{30}$ | $n\text{-C}_{32}$ | | | | | | |
| Parrot Fish vs <u>Tridacna</u> (kidney) | $n\text{-C}_{29}$ | $n\text{-C}_{30}$ | | | | | | |
| <u>Chlorodesmis</u> vs <u>Fungia</u> | $n\text{-C}_{17}/$ pristane | $n\text{-C}_{27}$ | | | | | | |
| <u>Tridacna</u> (muscle) vs Sediments | $n\text{-C}_{25}$ | | | | | A | R-S | R |
| Coral Trout vs Sediments | $n\text{-C}_{25}$ | | | | | R-S | | |
| <u>Acropora</u> vs <u>Tridacna</u> (kidney) | $n\text{-C}_{25}$ | | | | | T | | |
| <u>Tridacna</u> (muscle) vs <u>Tridacna</u> (kidney) | $n\text{-C}_{15}$ | | | | | S | | |
| <u>Holothuria</u> vs <u>Fungia</u> | | | | | | T | | |
| <u>Holothuria</u> vs <u>Tridacna</u> (kidney) | | | | | | R | | |
| Coral Trout vs <u>Acropora</u> | | | | | | S | | |
| <u>Tridacna</u> (muscle) vs <u>Fungia</u> | | | | | | S | | |
| <u>Tridacna</u> (kidney) vs <u>Fungia</u> | | | | | | S | | |
| <u>Holothuria</u> vs Sediments | $n\text{-C}_{19}$ | | | | | | | |
| Coral Trout vs <u>Tridacna</u> (kidney) | $n\text{-C}_{32}$ | | | | | | | |
| Coral Trout vs <u>Chlorodesmis</u> | $n\text{-C}_{21}$ | | | | | | | |
| Parrot Fish vs <u>Fungia</u> | $n\text{-C}_{25}$ | | | | | | | |
| <u>Acropora</u> vs Sediments | $n\text{-C}_{32}$ | | | | | | | |
| <u>Tridacna</u> (kidney) vs Sediments | $n\text{-C}_{19}$ | | | | | | | |
| <u>Chlorodesmis</u> vs Sediments | $n\text{-C}_{31}$ | | | | | | | |

TABLE 16. Positive correlations (significant at the 5% level) found in all pairwise comparisons of sediments and organisms at the localities listed in Tables 1-10. Correlation/regression analyses performed for $\mu\text{g}/\text{kg}$ wet or dry weight of individual alkanes listed in Tables 2-10. For meanings of symbols in table see Table 15.

| | | | | | | | |
|--|-------------------|---|-------------------|-------------------|-----|-----|---|
| Coral Trout vs Parrot Fish | n-C ₁₈ | n-C ₁₉ | n-C ₂₇ | n-C ₂₉ | | | |
| <u>Tridacna</u> (muscle) vs Sediments | n-C ₁₉ | n-C ₂₅ | | | A | R-S | R |
| <u>Acropora</u> vs Sediments | n-C ₁₅ | n-C ₁₇ / pristane/ n-C _{17:1} | | | A | R-S | |
| Parrot Fish vs <u>Tridacna</u> (kidney) | n-C ₂₉ | n-C ₃₀ | | | | | |
| <u>Holothuria</u> vs <u>Chlorodesmis</u> | n-C ₁₈ | n-C ₂₄ | | | | | |
| <u>Holothuria</u> vs <u>Acropora</u> | | | | | UCM | T | |
| <u>Acropora</u> vs <u>Tridacna</u> (muscle) | | | | | A | | |
| <u>Tridacna</u> (muscle) vs <u>Tridacna</u> (kidney) | | | | | S | | |
| <u>Tridacna</u> (muscle) vs <u>Fungia</u> | | | | | S | | |
| <u>Tridacna</u> (kidney) vs <u>Fungia</u> | | | | | S | | |
| <u>Holothuria</u> vs <u>Tridacna</u> (muscle) | n-C ₃₀ | | | | | | |
| Coral Trout vs <u>Tridacna</u> (muscle) | n-C ₂₁ | | | | | | |
| Coral Trout vs <u>Tridacna</u> (kidney) | n-C ₃₂ | | | | | | |
| Parrot Fish vs <u>Fungia</u> | n-C ₂₅ | | | | | | |
| <u>Acropora</u> vs <u>Tridacna</u> (kidney) | n-C ₂₅ | | | | | | |
| <u>Acropora</u> vs <u>Chlorodesmis</u> | n-C ₂₀ | | | | | | |
| <u>Chlorodesmis</u> vs Sediments | n-C ₃₁ | | | | | | |
| <u>Fungia</u> vs Sediments | n-C ₃₂ | | | | | | |

TABLE 17. Results of Spearman's rank correlation analyses of hydrocarbon concentration (wet or dry weight) versus percent lipid and hydrocarbon concentration (lipid weight) versus percentage lipid.

| Species and hydrocarbon components | Result of correlation analyses ² | | |
|------------------------------------|---|--|----------------------------------|
| | Hydrocarbon concentration (wet or dry weight) versus percentage lipid | Hydrocarbon concentration (lipid weight) versus percentage lipid | n values (NGBR samples included) |
| Sediments, R-S ¹ | s.+ | s.- | 13 |
| " , UCM | n.s. | n+ | 13 |
| " , T | n.s. | s.- | 13 |
| <u>Chlorodesmis</u> , R-S | s.+ | s.- | 10 |
| " , T | s.+ | s.- | 10 |
| <u>Fungia</u> , R-S | n.s. | s.- | 10 |
| " , T | n.s. | n.s. | 10 |
| <u>Acropora</u> , R-S | n.s. | s.- | 10 |
| " , UCM | n.s. | s.- | 10 |
| " , T | n.s. | s.- | 10 |
| <u>Iridacna</u> (muscle), R-S | n.s. | s.- | 30 |
| " " , T | n.s. | s.- | 30 |
| <u>Iridacna</u> (kidney), R-S | n.s. | n.s. | 28 |
| " " , T | n.s. | n.s. | 28 |
| <u>Holothuria</u> , R-S | n.s. | n.s. | 33 |
| " , UCM | n.s. | n.s. | 33 |
| " , T | n.s. | n.s. | 33 |
| Parrot Fish, R-S | n.s. | s.- | 24 |
| " " , T | n.s. | s.- | 24 |
| Coral Trout, R-S | n.s. | s.- | 23 |
| " " , T | n.s. | s.- | 23 |

1. Abbreviations are as in Tables 15 and 16.

2. n.s., not significant; s.+ significant positive correlation; s.- significant negative correlation.

TABLE 18. Sediments (top 15cm).

| Components | Arlington Reef (Cairns area) | | Eyrie Reef (Lizard Is. area) | | First Beach Lizard Island | | Freshwater Beach Lizard Island | | Carter Reef (Lizard Is. area) | | Northwest Reef (Torres Strait) | |
|---|---|--|---|--|---|--|---|--|---|--|---|--|
| | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} | $\mu\text{g}/\text{kg}$ dry wt. \bar{x} | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} |
| | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) | (SD) |
| n-C ₁₅ | 14.6 (-) | 405.0 (-) | 1.8 (1.0) | 24.2 (13.4) | 2.9 (-) | 33.8 (-) | 2.5 (0.0) | 33.4 (2.6) | 19.9 (17.8) | 225.2 (195.0) | n.d. | n.d. |
| n-C ₁₇ + pristane + n-C ₁₇ :1 | 61.1 (-) | 1694.6 (-) | 38.1 (5.4) | 504.1 (79.6) | 238.6 (182.4) | 2741.8 (2049.1) | 25.3 (7.8) | 332.6 (73.9) | 181.9 (63.4) | 2122.1 (835.0) | 11.4 (1.3) | 383.3 (48.5) |
| n-C ₁₈ | 6.6 (-) | 182.3 (-) | 7.7 (2.8) | 101.9 (35.8) | 28.8 (24.7) | 329.8 (277.8) | 5.5 (1.8) | 62.5 (27.5) | 6.1 (2.3) | 71.5 (29.5) | 2.6 (0.1) | 87.6 (3.4) |
| n-C ₁₉ | 5.0 (-) | 139.2 (-) | 7.3 (4.7) | 95.6 (60.4) | 41.6 (58.8) | 473.8 (670.1) | 14.5 (0.8) | 194.4 (29.8) | 9.3 (5.6) | 108.7 (69.5) | 2.8 (0.4) | 94.7 (17.0) |
| n-C ₂₀ | 1.0 (-) | 28.9 (-) | 3.3 (3.3) | 43.1 (42.9) | 1.1 (0.1) | 11.8 (1.3) | 5.1 (2.1) | 69.7 (35.2) | 0.9 (0.1) | 10.1 (2.4) | 2.0 (1.0) | 38.1 (4.7) |
| n-C ₂₁ + C ₂₅ H ₄₈ A unknown | 14.5 (-) | 401.5 (-) | 6.6 (5.2) | 172.5 (189.1) | 10.3 (2.8) | 118.6 (29.2) | 11.1 (7.3) | 152.4 (111.5) | 5.0 (4.7) | 59.2 (56.1) | 6.8 (1.2) | 227.8 (35.9) |
| n-C ₂₂ | n.d. | n.d. | 4.5 (4.9) | 79.3 (92.9) | 1.0 (0.5) | 11.2 (6.6) | 18.4 (15.6) | 256.2 (230.4) | 2.2 (1.1) | 25.6 (14.5) | 1.1 (0.2) | 36.3 (7.3) |
| n-C ₂₃ | 0.8 (-) | 21.5 (-) | 5.8 (6.5) | 76.1 (84.9) | 0.9 (0.3) | 10.6 (2.9) | 20.7 (19.5) | 288.5 (286.2) | 1.5 (0.2) | 16.7 (1.1) | 1.5 (0.8) | 49.7 (25.8) |
| n-C ₂₄ | 0.6 (-) | 16.9 (-) | 4.2 (4.2) | 55.2 (54.6) | 0.6 (0.0) | 6.7 (0.2) | 16.4 (14.4) | 228.0 (213.4) | 2.5 (0.3) | 29.2 (5.2) | 1.4 (0.6) | 46.5 (19.9) |
| n-C ₂₅ | 1.5 (-) | 41.2 (-) | 4.3 (2.1) | 57.4 (28.6) | 187.1 (257.5) | 2205.6 (3037.8) | 8.9 (7.7) | 123.0 (113.6) | 2.1 (0.4) | 23.4 (3.1) | 2.1 (0.6) | 69.0 (20.8) |
| n-C ₂₇ | 1.3 (-) | 35.8 (-) | 3.0 (1.1) | 38.4 (13.4) | 5.3 (4.5) | 61.3 (52.8) | 11.7 (11.7) | 163.4 (170.8) | 2.0 (0.5) | 22.8 (4.4) | 2.3 (0.1) | 74.2 (3.6) |
| n-C ₂₉ | 0.9 (-) | 24.2 (-) | 3.1 (1.0) | 40.8 (12.0) | 5.2 (2.5) | 61.0 (31.1) | 35.7 (21.4) | 490.4 (329.5) | 4.3 (1.2) | 49.4 (16.1) | 2.0 (1.0) | 68.1 (34.4) |
| n-C ₃₀ | n.d. | n.d. | 3.0 (1.1) | 39.7 (14.6) | 5.0 (2.1) | 57.7 (25.2) | 25.3 (3.0) | 340.2 (69.9) | 3.0 (0.3) | 34.5 (5.2) | 0.9 (1.3) | 31.0 (43.8) |
| n-C ₃₁ | 0.1 (-) | 3.5 (-) | 3.0 (0.8) | 39.8 (10.5) | 4.1 (0.2) | 46.7 (3.7) | 32.7 (8.6) | 442.0 (153.8) | 4.3 (0.8) | 50.0 (11.5) | 0.7 (1.0) | 24.1 (34.0) |
| n-C ₃₂ | n.d. | n.d. | 1.7 (0.3) | 22.4 (3.4) | 2.8 (1.8) | 32.4 (21.0) | 15.8 (1.1) | 210.7 (4.1) | 2.1 (0.1) | 24.3 (0.1) | 0.3 (0.4) | 8.8 (12.4) |
| squalene + n-C ₂₈ | 19.4 (-) | 538.5 (-) | 42.7 (19.0) | 567.2 (259.9) | 122.6 (21.9) | 1405.5 (201.5) | 12.8 (7.8) | 176.2 (120.2) | 15.1 (4.7) | 176.0 (61.8) | 26.2 (5.3) | 879.0 (167.5) |
| sulfur | 21.4 (-) | 593.9 (-) | 4.8 (0.1) | 63.2 (3.2) | 2.3 (1.5) | 41.7 (8.2) | 2.2 (1.8) | 30.4 (27.2) | 2.5 (0.5) | 28.3 (7.0) | 5.4 (5.9) | 182.2 (199.5) |
| C ₂₅ H ₅₀ A unknown | 20.7 (-) | 574.2 (-) | 5.8 (3.2) | 76.0 (41.0) | 5.4 (1.1) | 62.1 (10.3) | n.d. | n.d. | 1.5 (2.1) | 18.1 (25.6) | 7.2 (1.2) | 239.9 (36.0) |
| Total alkanes | 107.9 (-) | 2994.6 (-) | 100.4 (36.1) | 1356.2 (409.6) | 535.7 (6.1) | 6185.5 (180.4) | 247.7 (99.2) | 3379.1 (1638.8) | 246.8 (60.7) | 2872.7 (840.1) | 36.8 (2.4) | 1238.7 (100.1) |
| Total resolved hydrocarbons-squalene | 185.2 (-) | 5138.5 (-) | 147.3 (79.3) | 1939.6 (1017.6) | 606.9 (82.9) | 7049.2 (1128.5) | 310.3 (177.2) | 4257.8 (2748.2) | 258.7 (68.9) | 3012.4 (941.4) | 70.7 (4.2) | 2378.3 (175.5) |
| Total resolved hydrocarbons | 204.6 (-) | 5676.9 (-) | 190.0 (60.4) | 2506.8 (757.8) | 860.6 (246.2) | 10013.3 (3093.2) | 323.2 (185.0) | 4433.9 (2868.7) | 273.9 (73.3) | 3188.5 (1003.2) | 96.8 (1.2) | 3257.3 (8.0) |
| UCM | n.d. | n.d. | 735.3 (406.6) | 9852.5 (5306.5) | 1071.3 (463.9) | 12486.1 (5676.4) | 3229.8 (331.0) | 42984.7 (484.7) | 642.5 (315.4) | 7522.5 (4008.6) | n.d. | n.d. |
| Total hydrocarbons | 204.6 (-) | 5676.9 (-) | 925.3 (467.0) | 12403.7 (6076.6) | 1747.3 (449.2) | 20323.0 (5691.9) | 3552.9 (145.9) | 47418.1 (2384.6) | 916.3 (388.8) | 10710.9 (5011.8) | 96.8 (1.2) | 3257.3 (8.0) |
| % lipid | 0.0036 (-) | | 0.0076(0.0001) | | 0.0084(0.0006) | | 0.0075(0.0007) | | 0.0087(0.0004) | | 0.0030(0.0001) | |

TABLE 19. Chlorodesmis (Turtle Weed).

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|--------------------------------------|---------------------------------|----------------------|------------------------------|----------------------|-----------------------------------|--------------------|
| | ug/kg wet wt. | ug/g lipid wt. | ug/kg wet wt. | ug/g lipid wt. | ug/kg wet wt. | ug/g lipid wt. |
| | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) |
| n-C ₁₅ | 1132.0 (285.0) | 185.9 (132.9) | 1070.0 (738.1) | 378.9 (97.3) | 527.9 (4.5) | 161.1 (32.5) |
| n-C ₁₇ | 28027.2 (16502.5) | 4972.1 (4745.5) | 21043.1 (8617.9) | 8749.4 (4897.8) | 13342.8 (1063.5) | 4036.8 (464.4) |
| n-C ₁₈ | 138.8 (92.6) | 25.0 (25.2) | 119.1 (27.4) | 54.3 (38.5) | 77.9 (8.6) | 24.0 (7.2) |
| n-C ₁₉ | 13801.9 (11663.4) | 2587.2 (2882.6) | 7308.7 (1714.2) | 3320.2 (2348.1) | 10045.3 (3739.9) | 2952.3 (546.6) |
| n-C ₂₀ | 11.6 (7.4) | 2.1 (2.1) | 12.5 (5.6) | 5.1 (2.6) | 15.7 (12.8) | 5.2 (4.9) |
| n-C ₂₁ | 860.6 (614.3) | 156.9 (162.4) | 471.7 (146.3) | 206.4 (133.5) | 553.3 (26.2) | 168.0 (24.7) |
| n-C ₂₂ | 18.9 (11.6) | 3.4 (3.3) | 28.7 (9.6) | 16.7 (17.5) | 6.1 (8.6) | 2.1 (3.0) |
| n-C ₂₃ | 1601.0 (1110.7) | 290.6 (297.0) | 829.7 (209.6) | 373.7 (259.0) | 1257.6 (205.7) | 377.4 (11.7) |
| n-C ₂₄ | 15.3 (7.9) | 2.7 (2.4) | 17.6 (3.0) | 9.6 (9.3) | 8.2 (2.8) | 2.5 (0.4) |
| n-C ₂₅ | 163.8 (91.1) | 28.9 (26.9) | 88.2 (23.1) | 39.6 (27.1) | 125.6 (32.9) | 37.4 (2.6) |
| n-C ₂₇ | 5.4 (7.6) | 0.6 (0.8) | n.d. | n.d. | n.d. | n.d. |
| n-C ₂₉ | 2.8 (0.1) | 0.5 (0.2) | 13.3 (5.9) | 5.4 (2.8) | 5.9 (1.5) | 1.8 (0.1) |
| n-C ₃₀ | 2.2 (3.0) | 0.2 (0.3) | 10.8 (2.4) | 4.9 (3.5) | 5.9 (0.3) | 1.8 (0.3) |
| n-C ₃₁ | n.d. | n.d. | 14.7 (4.0) | 6.6 (4.5) | 8.5 (2.2) | 2.7 (1.2) |
| n-C ₃₂ | 3.8 (5.3) | 0.4 (0.5) | 9.4 (3.3) | 4.1 (2.5) | 27.1 (38.3) | 9.4 (13.2) |
| squalene + n-C ₂₈ | 102.2 (89.7) | 19.3 (21.9) | 105.4 (1.7) | 53.0 (45.5) | 142.5 (63.1) | 41.6 (10.7) |
| n-C ₁₇ :1 | 7461.8 (5072.4) | 1350.4 (1368.2) | 8171.4 (3358.5) | 3395.0 (1895.8) | 2247.0 (609.5) | 667.1 (53.0) |
| n-C ₁₉ :1 | 32691.1 (24009.3) | 5986.2 (6269.7) | 27273.0 (11220.4) | 11328.4 (6322.0) | 17793.7 (2714.1) | 5345.1 (224.1) |
| n-C ₂₁ :1 | 1972.7 (1535.8) | 364.6 (391.7) | 1090.2 (306.2) | 484.1 (324.7) | 1328.0 (179.3) | 399.6 (23.8) |
| n-C ₂₃ :1 | 892.7 (690.6) | 164.9 (176.6) | 282.7 (61.7) | 129.5 (93.1) | 506.3 (125.7) | 256.9 (158.7) |
| Total alkanes | 37826.9 (41653.6) | 7470.9 (9395.2) | 31037.2 (11484.9) | 13174.4 (7844.1) | 26022.4 (5000.9) | 7786.4 (13.2) |
| Total resolved hydrocarbons-squalene | 90037.7 (63029.7) | 16365.7 (16790.2) | 68104.2 (26485.5) | 28625.8 (16562.3) | 48492.8 (8257.8) | 14541.3 (348.3) |
| Total resolved hydrocarbons | 90139.8 (63119.5) | 16384.9 (16812.0) | 68209.6 (26487.1) | 28678.8 (16607.9) | 48635.3 (8320.9) | 14582.9 (337.4) |
| UHM | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 90139.8 (63119.5) | 16384.9 (16812.0) | 68209.6 (26487.1) | 28678.8 (16607.9) | 48635.3 (8320.9) | 14582.9 (337.4) |
| % lipid | 0.746(0.376) | | 0.318(0.276) | | 0.334(0.065) | |

TABLE 20. *Fungia* (coral).

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|--------------------------------------|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| | n-C ₁₅ | 12.4 (-) | 10.2 (-) | 22.4 (3.2) | 30.4 (12.1) | 22.2 (-) |
| n-C ₁₇ | 55.6 (-) | 45.5 (-) | 56.7 (4.7) | 76.6 (26.0) | 52.7 (-) | 43.9 (-) |
| n-C ₁₈ | 11.3 (-) | 9.3 (-) | 11.8 (3.6) | 16.4 (9.0) | 10.3 (-) | 8.6 (-) |
| n-C ₁₉ | 7.9 (-) | 6.5 (-) | 6.7 (3.6) | 9.6 (7.1) | 6.0 (-) | 5.0 (-) |
| n-C ₂₀ | 3.5 (-) | 2.9 (-) | 6.0 (0.9) | 8.1 (3.3) | n.d. | n.d. |
| n-C ₂₁ | n.d. | n.d. | 3.2 (1.8) | 3.9 (1.2) | n.d. | n.d. |
| n-C ₂₂ | n.d. | n.d. | 5.3 (7.4) | 5.7 (8.1) | n.d. | n.d. |
| n-C ₂₃ | 5.2 (-) | 4.2 (-) | 4.4 (2.2) | 5.4 (1.4) | 3.4 (-) | 2.8 (-) |
| n-C ₂₄ | 5.8 (-) | 4.8 (-) | 5.4 (4.7) | 6.4 (4.2) | 2.3 (-) | 1.9 (-) |
| n-C ₂₅ | 11.2 (-) | 9.2 (-) | 20.7 (10.3) | 29.4 (20.9) | 1.9 (-) | 1.6 (-) |
| n-C ₂₇ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-C ₂₉ | 14.8 (-) | 12.1 (-) | 4.1 (5.8) | 4.5 (6.4) | n.d. | n.d. |
| n-C ₃₀ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₁ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₂ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| squalene + n-C ₂₈ | 58.6 (-) | 47.9 (-) | 199.2 (167.4) | 196.1 (57.0) | 291.6 (-) | 243.0 (-) |
| Total alkanes | 127.7 (-) | 104.5 (-) | 146.3 (4.6) | 196.1 (57.0) | 98.9 (-) | 82.4 (-) |
| Total resolved hydrocarbons-squalene | 136.5 (-) | 111.7 (-) | 199.0 (1.6) | 265.6 (67.2) | 111.8 (-) | 93.1 (-) |
| Total resolved hydrocarbons | 195.0 (-) | 159.7 (-) | 398.2 (165.8) | 560.7 (359.9) | 403.4 (-) | 336.2 (-) |
| UCH | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 195.0 (-) | 159.7 (-) | 398.2 (165.8) | 560.7 (359.9) | 403.4 (-) | 336.2 (-) |
| % lipid | 0.122(-) | | 0.078(0.021) | | 0.120(-) | |

TABLE 22. *Iridacna* (muscle tissue) (clam).

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|--------------------------------------|------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|
| | $\mu\text{g}/\text{kg}$ wet wt. | $\mu\text{g}/\text{g}$ lipid wt. | $\mu\text{g}/\text{kg}$ wet wt. | $\mu\text{g}/\text{g}$ lipid wt. | $\mu\text{g}/\text{kg}$ wet wt. | $\mu\text{g}/\text{g}$ lipid wt. |
| | \bar{x} (SD) | \bar{x} (SD) | \bar{x} (SD) | \bar{x} (SD) | \bar{x} (SD) | \bar{x} (SD) |
| n-C ₁₅ | 7.8 (8.7) | 3.8 (4.2) | 10.9 (5.0) | 6.5 (1.2) | 1.7 (-) | 1.1 (-) |
| n-C ₁₇ | 9.2 (1.3) | 4.7 (0.9) | 7.7 (0.4) | 4.8 (1.1) | 2.8 (-) | 1.8 (-) |
| n-C ₁₈ | 7.2 (3.4) | 3.7 (1.8) | 6.5 (0.4) | 4.1 (1.3) | 5.2 (-) | 3.4 (-) |
| n-C ₁₉ | 6.8 (4.4) | 3.5 (2.3) | 5.1 (0.4) | 3.3 (1.1) | 2.3 (-) | 1.5 (-) |
| n-C ₂₀ | 7.5 (5.3) | 3.9 (2.7) | 5.9 (0.8) | 3.8 (1.5) | 5.0 (-) | 2.2 (-) |
| n-C ₂₁ | 11.3 (9.8) | 5.9 (5.0) | 8.3 (1.3) | 5.4 (2.3) | 4.6 (-) | 3.0 (-) |
| n-C ₂₂ | 12.6 (11.0) | 6.5 (5.6) | 7.8 (3.0) | 5.2 (3.3) | 9.6 (-) | 6.2 (-) |
| n-C ₂₃ | 14.5 (7.5) | 6.8 (3.6) | 11.8 (5.9) | 8.0 (5.7) | 16.6 (-) | 10.8 (-) |
| n-C ₂₄ | 10.6 (6.0) | 5.5 (3.2) | 10.3 (7.8) | 7.2 (6.7) | 17.3 (-) | 11.2 (-) |
| n-C ₂₅ | 9.5 (3.1) | 4.9 (1.6) | 7.9 (5.1) | 5.5 (4.6) | 13.8 (-) | 8.9 (-) |
| n-C ₂₇ | 5.8 (1.4) | 2.9 (0.7) | 4.4 (0.0) | 2.8 (0.7) | 3.9 (-) | 2.5 (-) |
| n-C ₂₉ | 2.2 (0.4) | 1.2 (0.3) | 2.7 (0.1) | 1.7 (0.6) | 2.3 (-) | 1.5 (-) |
| n-C ₃₀ | 1.6 (2.8) | 0.9 (1.5) | 0.6 (0.8) | 0.4 (0.6) | n.d. | n.d. |
| n-C ₃₁ | 0.9 (1.6) | 0.5 (0.8) | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₂ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| squalene + n-C ₂₈ | 146.4 (65.5) | 75.8 (36.9) | 70.7 (1.6) | 44.9 (13.4) | 113.4 (-) | 73.4 (-) |
| Total alkanes | 106.5 (46.2) | 54.6 (24.2) | 97.5 (14.4) | 63.0 (26.2) | 85.0 (-) | 55.0 (-) |
| Total resolved hydrocarbons-squalene | 137.9 (38.8) | 70.6 (21.4) | 194.1 (43.4) | 126.7 (61.5) | 230.9 (-) | 149.5 (-) |
| Total resolved hydrocarbons | 284.3 (99.8) | 146.4 (56.4) | 264.8 (45.0) | 171.6 (74.9) | 344.3 (-) | 222.9 (-) |
| UCM | trace | trace | trace | trace | trace | trace |
| Total hydrocarbons | 284.3 (99.8) | 146.4 (56.4) | 264.8 (45.0) | 171.6 (74.9) | 344.3 (-) | 222.9 (-) |
| % lipid | 0.197(0.012) | | 0.164(0.045) | | 0.154(-) | |

TABLE 23. *Iridacna* (kidney tissue) (clam).

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|--|---------------------------------|-------------------|------------------------------|-------------------|-----------------------------------|-------------------|
| | ug/kg wet wt. | ug/g lipid wt. | ug/kg wet wt. | ug/g lipid wt. | ug/kg wet wt. | ug/g lipid wt. |
| | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) | \bar{X} (SD) |
| n-C ₁₅ | 311.8 (222.8) | 7.2 (7.7) | 118.7 (-) | 1.5 (-) | 225.1 (57.7) | 6.8 (0.1) |
| n-C ₁₇ + n-C _{17:1} | 171.3 (208.6) | 4.5 (6.3) | 46.4 (-) | 0.6 (-) | 131.7 (85.2) | 3.8 (1.6) |
| n-C ₁₈ | 21.6 (2.6) | 0.5 (0.2) | 5.5 (-) | 0.1 (-) | 10.9 (15.4) | 0.4 (0.6) |
| n-C ₁₉ | 10.6 (12.6) | 0.3 (0.4) | n.d. | n.d. | 4.1 (5.7) | 0.2 (0.2) |
| n-C ₂₀ | 4.8 (4.2) | 0.1 (0.1) | 11.1 (-) | 0.1 (-) | 4.2 (5.9) | 0.2 (0.2) |
| n-C ₂₁ | 7.8 (13.6) | 0.1 (0.2) | 7.3 (-) | 0.1 (-) | 30.1 (42.5) | 1.1 (1.6) |
| n-C ₂₂ | 4.1 (7.1) | 0.1 (0.1) | n.d. | n.d. | 9.4 (2.1) | 0.3 (0.0) |
| n-C ₂₃ | 35.2 (56.8) | 0.5 (0.7) | 12.9 (-) | 0.2 (-) | 22.9 (20.4) | 0.7 (0.5) |
| n-C ₂₄ | 12.7 (22.0) | 0.2 (0.3) | 26.9 (-) | 0.3 (-) | n.d. | n.d. |
| n-C ₂₅ | 17.6 (11.8) | 0.3 (0.1) | 13.0 (-) | 0.2 (-) | 22.9 (32.4) | 0.6 (0.8) |
| n-C ₂₇ | 11.6 (11.5) | 0.2 (0.1) | 5.4 (-) | 0.1 (-) | 10.4 (2.3) | 0.3 (0.0) |
| n-C ₂₉ | 5.9 (7.2) | 0.1 (0.1) | n.d. | n.d. | 3.9 (5.4) | 0.1 (0.1) |
| n-C ₃₀ | 0.7 (1.2) | 0.0 (0.0) | n.d. | n.d. | n.d. | n.d. |
| n-C ₃₁ | 2.3 (2.0) | 0.1 (0.1) | n.d. | n.d. | 8.3 (11.7) | 0.2 (0.3) |
| n-C ₃₂ | 17.2 (29.8) | 0.3 (0.6) | n.d. | n.d. | n.d. | n.d. |
| squalene + n-C ₂₈ | 123.9 (175.5) | 2.3 (3.3) | 137.4 (-) | 1.8 (-) | 169.9 (228.2) | 4.4 (5.7) |
| unknown, between n-C ₂₀ and n-C ₂₁ | 30.7 (24.4) | 0.7 (0.8) | 9.9 (-) | 0.1 (-) | 32.8 (19.7) | 1.0 (0.4) |
| Total alkanes | 664.6 (422.8) | 14.9 (14.4) | 321.1 (-) | 4.1 (-) | 483.5 (147.5) | 14.4 (0.8) |
| Total resolved hydrocarbons-squalene | 1366.6 (854.7) | 26.1 (15.1) | 1367.0 (-) | 17.4 (-) | 623.2 (180.7) | 18.6 (0.8) |
| Total resolved hydrocarbons | 1490.5 (712.2) | 28.5 (12.0) | 1504.4 (-) | 19.2 (-) | 793.1 (408.9) | 23.0 (6.5) |
| UCM | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 1490.5 (712.2) | 28.5 (12.0) | 1504.4 (-) | 19.2 (-) | 793.1 (408.9) | 23.0 (6.5) |
| % lipid | 5.44(2.03) | | 7.86(-) | | 3.34(0.83) | |

TABLE 24. Holothuria (sea cucumber).

| Components | Arlington Reef (Cairns area) | | Eyrle Reef (Lizard Is. Area) | | First Beach Lizard Island | | Freshwater Beach Lizard Island | |
|--|---|--|---|--|---|--|---|--|
| | $\mu\text{g}/\text{kg}$ wet wt. \bar{x} (SD) | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} (SD) | $\mu\text{g}/\text{kg}$ wet wt. \bar{x} (SD) | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} (SD) | $\mu\text{g}/\text{kg}$ wet wt. \bar{x} (SD) | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} (SD) | $\mu\text{g}/\text{kg}$ wet wt. \bar{x} (SD) | $\mu\text{g}/\text{g}$ lipid wt. \bar{x} (SD) |
| n-C ₁₅ | 119.5 (15.1) | 12.2 (1.7) | 27.0 (12.3) | 2.8 (0.9) | 10.0 (13.1) | 0.7 (0.9) | 2.3 (3.2) | 0.3 (0.4) |
| n-C ₁₇ + n-C ₁₇ :1 | 352.2 (33.5) | 36.1 (4.3) | 496.6 (28.8) | 51.6 (4.0) | 428.8 (110.5) | 37.8 (8.2) | 203.3 (120.0) | 17.5 (5.7) |
| n-C ₁₈ | 44.5 (2.0) | 4.6 (0.4) | 40.3 (10.5) | 4.9 (0.7) | 19.4 (10.3) | 1.9 (1.3) | 18.5 (8.8) | 1.6 (0.3) |
| n-C ₁₉ | 25.9 (3.5) | 2.7 (0.4) | 6.6 (3.1) | 0.7 (0.4) | 22.9 (19.1) | 2.3 (1.8) | 3.4 (0.7) | 0.3 (0.1) |
| n-C ₂₀ | 8.3 (2.8) | 0.8 (0.3) | 6.5 (1.7) | 0.7 (0.1) | 2.7 (2.3) | 0.3 (0.3) | n.d. | n.d. |
| n-C ₂₁ | 76.1 (4.8) | 7.8 (0.8) | 91.7 (42.5) | 9.3 (3.2) | 27.4 (12.6) | 2.5 (1.3) | 41.9 (8.6) | 3.9 (0.4) |
| n-C ₂₂ | n.d. | n.d. | 191.9 (1.7) | 20.0 (2.5) | 30.1 (22.3) | 2.1 (2.6) | 447.9 (132.0) | 40.3 (0.1) |
| n-C ₂₃ | 10.4 (5.3) | 1.1 (0.5) | 2.7 (0.8) | 0.3 (0.1) | 8.2 (9.7) | 0.8 (0.8) | 2.4 (0.4) | 0.2 (0.0) |
| n-C ₂₄ | 6.0 (5.2) | 0.6 (0.5) | 2.3 (0.6) | 0.3 (0.1) | 12.5 (20.1) | 1.1 (1.8) | 3.7 (3.0) | 0.3 (0.1) |
| n-C ₂₅ | 39.0 (40.9) | 4.0 (4.2) | 12.2 (1.6) | 1.3 (0.0) | 45.2 (34.0) | 4.4 (3.7) | 16.6 (4.1) | 1.6 (0.1) |
| n-C ₂₇ | 29.3 (3.2) | 3.0 (0.4) | 48.1 (35.4) | 4.8 (3.0) | 69.2 (22.0) | 6.2 (2.4) | 347.0 (49.1) | 32.0 (4.9) |
| n-C ₂₉ | 34.6 (5.2) | 3.5 (0.7) | 19.6 (10.7) | 2.0 (0.8) | 34.4 (11.3) | 3.0 (1.0) | 22.4 (14.8) | 1.9 (0.8) |
| n-C ₃₀ | 22.8 (1.6) | 2.3 (0.2) | 10.1 (3.6) | 1.1 (0.2) | 29.0 (9.0) | 2.6 (1.0) | 14.0 (11.1) | 1.2 (0.6) |
| n-C ₃₁ | 1.4 (2.4) | 0.1 (0.2) | 5.2 (4.1) | 0.6 (0.4) | 9.0 (1.6) | 0.8 (0.2) | 9.2 (2.6) | 0.8 (0.0) |
| n-C ₃₂ | n.d. | n.d. | 0.4 (0.6) | 0.0 (0.0) | 4.8 (2.6) | 0.4 (0.2) | 5.9 (8.3) | 0.5 (0.6) |
| squalene + n-C ₂₈ | 499.4 (206.6) | 50.8 (20.6) | 692.3 (372.9) | 69.5 (29.1) | 401.9 (257.4) | 40.0 (27.4) | 182.6 (16.1) | 17.0 (3.5) |
| unknown, between n-C ₁₇ and n-C ₁₈ | n.d. | n.d. | 118.4 (19.9) | 12.5 (3.7) | n.d. | n.d. | 92.9 (72.1) | 7.6 (4.5) |
| C ₂₅ H ₄₈ A unknown | n.d. | n.d. | 3.6 (1.0) | 0.4 (0.1) | 85.9 (40.8) | 7.7 (4.1) | 28.8 (31.5) | 3.2 (3.7) |
| C ₂₅ H ₅₀ B unknown | 357.1 (47.1) | 36.5 (5.4) | 33.9 (13.3) | 3.5 (0.9) | n.d. | n.d. | 19.5 (27.6) | 1.5 (2.1) |
| C ₂₅ H ₄₈ B unknown | 798.6 (122.4) | 286.3 (27.1) | 223.5 (43.5) | 23.0 (1.4) | 3.2 (4.5) | 0.3 (0.3) | 176.8 (165.0) | 14.4 (10.7) |
| C ₂₅ H ₄₈ C unknown | n.d. | n.d. | 6.8 (3.3) | 0.7 (0.3) | 4.9 (1.3) | 0.5 (0.2) | 9.3 (1.2) | 0.9 (0.1) |
| Total alkanes | 770.1 (78.1) | 78.8 (9.8) | 952.7 (151.2) | 98.3 (2.4) | 753.5 (161.1) | 67.6 (18.3) | 1138.1 (358.9) | 102.1 (2.6) |
| Total resolved hydrocarbons-squalene | 4500.7 (224.8) | 460.4 (43.4) | 1477.0 (195.3) | 152.5 (0.4) | 1025.7 (212.4) | 91.4 (21.2) | 1538.1 (655.8) | 135.6 (19.7) |
| Total resolved hydrocarbons | 5000.1 (344.9) | 511.2 (48.7) | 2169.4 (568.2) | 222.1 (28.6) | 1427.6 (278.0) | 131.4 (45.4) | 1720.7 (671.9) | 152.5 (16.2) |
| UCM | n.d. | n.d. | trace | trace | trace | trace | trace | trace |
| Total hydrocarbons | 5000.1 (344.9) | 511.2 (48.7) | 2169.4 (568.2) | 222.1 (28.6) | 1427.6 (278.0) | 131.4 (45.4) | 1720.7 (671.9) | 152.5 (16.2) |
| % lipid | 0.980(0.050) | | 0.965(0.134) | | 1.148(0.294) | | 1.105(0.318) | |

TABLE 25. *Scarus* sp. (Parrot Fish).

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|---|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) | ug/kg wet wt. \bar{x} (SD) | ug/g lipid wt. \bar{x} (SD) |
| n-C ₁₅ | 27.0 (12.6) | 31.9 (13.4) | 11.2 (5.5) | 11.6 (6.5) | 15.2 (5.4) | 20.5 (6.9) |
| n-C ₁₇ + pristane + n-C ₁₇ :1 | 60.5 (20.2) | 74.9 (31.9) | 26.0 (17.8) | 25.9 (17.0) | 106.5 (32.0) | 145.5 (46.3) |
| n-C ₁₈ | 0.8 (1.3) | 0.9 (1.5) | 2.7 (1.8) | 2.7 (1.7) | 1.8 (3.2) | 2.1 (3.7) |
| n-C ₁₉ | 1.6 (0.4) | 1.3 (1.1) | 0.8 (1.1) | 0.8 (1.1) | 5.0 (1.9) | 6.8 (2.7) |
| n-C ₂₀ | n.d. | n.d. | 0.4 (0.6) | 0.4 (0.6) | 1.2 (2.1) | 1.4 (2.4) |
| n-C ₂₁ | 1.0 (0.2) | 1.2 (0.2) | 0.9 (0.7) | 0.9 (0.7) | 2.3 (4.0) | 3.7 (6.4) |
| n-C ₂₂ | 0.4 (0.4) | 0.5 (0.5) | 0.4 (0.6) | 0.4 (0.6) | 1.1 (1.9) | 1.5 (2.7) |
| n-C ₂₃ | 0.7 (0.8) | 0.9 (0.9) | 0.3 (0.5) | 0.3 (0.5) | n.d. | n.d. |
| n-C ₂₄ | 0.8 (0.3) | 1.0 (0.3) | 0.8 (0.6) | 0.8 (0.6) | n.d. | n.d. |
| n-C ₂₅ | 2.1 (0.4) | 2.5 (0.7) | 2.3 (1.6) | 2.3 (1.5) | 4.6 (1.5) | 6.2 (1.3) |
| n-C ₂₇ | n.d. | n.d. | n.d. | n.d. | 2.1 (3.7) | 2.5 (4.3) |
| n-C ₂₉ | 0.5 (0.9) | 0.7 (1.2) | 1.2 (0.9) | 1.2 (0.9) | 20.9 (19.7) | 30.3 (27.6) |
| n-C ₃₀ | n.d. | n.d. | n.d. | n.d. | 7.0 (12.2) | 9.7 (16.8) |
| n-C ₃₁ | n.d. | n.d. | n.d. | n.d. | 2.1 (3.6) | 2.4 (4.2) |
| n-C ₃₂ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| squalene + n-C ₂₈ | 245.5 (114.5) | 296.5 (130.8) | 308.0 (106.9) | 309.7 (94.9) | 496.9 (195.2) | 708.7 (372.5) |
| Total alkanes | 97.4 (5.7) | 118.6 (17.1) | 54.3 (20.7) | 54.6 (18.9) | 169.9 (59.7) | 232.7 (85.3) |
| Total resolved hydrocarbons-squalene | 133.6 (16.6) | 163.1 (32.5) | 128.7 (106.4) | 128.9 (102.6) | 195.8 (96.5) | 269.0 (136.3) |
| Total resolved hydrocarbons | 379.0 (123.7) | 459.6 (145.1) | 436.8 (122.4) | 438.6 (101.8) | 692.6 (209.1) | 977.7 (406.9) |
| UCH | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 379.0 (123.7) | 459.6 (145.1) | 436.8 (122.4) | 438.6 (101.8) | 692.6 (209.1) | 977.7 (406.9) |
| % lipid | 0.083(0.007) | | 0.099(0.006) | | 0.074(0.012) | |

TABLE 26. Coral Trout.

| Components | Arlington Reef (Cairns area) | | First Beach Lizard Island | | Northwest Reef (Torres Strait) | |
|---|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|
| | ug/kg wet wt. \bar{X} (SD) | ug/g lipid wt. \bar{X} (SD) | ug/kg wet wt. \bar{X} (SD) | ug/g lipid wt. \bar{X} (SD) | ug/kg wet wt. \bar{X} (SD) | ug/g lipid wt. \bar{X} (SD) |
| | n-C ₁₅ | 28.9 (42.9) | 6.1 (5.3) | 82.7 (62.5) | 47.1 (40.8) | n.d. |
| n-C ₁₇ + pristane + n-C ₁₇ :1 | 64.4 (75.4) | 21.1 (5.2) | 68.5 (24.5) | 36.8 (19.7) | 21.6 (3.9) | 23.3 (5.4) |
| n-C ₁₈ | 1.2 (1.0) | 1.2 (1.0) | 2.9 (2.6) | 10.8 (16.2) | 5.2 (3.3) | 5.5 (3.3) |
| n-C ₁₉ | 0.6 (0.6) | 0.6 (0.6) | 3.2 (5.6) | 2.0 (3.4) | 2.9 (1.5) | 3.0 (1.4) |
| n-C ₂₀ | 0.8 (0.7) | 0.7 (0.7) | n.d. | n.d. | 2.0 (0.4) | 2.1 (0.4) |
| n-C ₂₁ | 0.5 (0.4) | 0.4 (0.5) | 0.5 (0.8) | 0.2 (0.3) | 1.1 (0.2) | 1.1 (0.2) |
| n-C ₂₂ | 1.2 (1.3) | 0.5 (0.1) | 0.2 (0.4) | 0.1 (0.2) | 1.4 (0.5) | 1.4 (0.5) |
| n-C ₂₃ | 4.9 (8.0) | 0.9 (1.1) | 7.1 (6.5) | 4.0 (4.2) | 1.7 (0.2) | 1.8 (0.2) |
| n-C ₂₄ | 0.3 (0.3) | 0.3 (0.3) | 0.7 (0.7) | 0.3 (0.3) | 1.7 (0.5) | 1.7 (0.4) |
| n-C ₂₅ | 2.8 (0.4) | 1.8 (1.3) | 2.8 (0.4) | 1.5 (0.3) | 6.3 (2.5) | 6.3 (2.5) |
| n-C ₂₇ | n.d. | n.d. | n.d. | n.d. | 1.4 (2.5) | 1.4 (2.5) |
| n-C ₂₉ | 0.3 (0.6) | 0.3 (0.5) | 2.5 (0.5) | 1.5 (0.3) | 1.3 (1.4) | 1.2 (1.4) |
| n-C ₃₀ | n.d. | n.d. | 1.4 (1.6) | 1.3 (0.4) | n.d. | n.d. |
| n-C ₃₁ | n.d. | n.d. | 2.2 (0.9) | 0.7 (0.4) | n.d. | n.d. |
| n-C ₃₂ | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| squalene + n-C ₂₈ | 353.6 (159.5) | 197.3 (117.0) | 643.3 (294.8) | 343.2 (212.6) | 545.0 (38.8) | 585.5 (72.1) |
| Total alkanes | 122.3 (110.5) | 49.7 (12.3) | 177.2 (95.6) | 98.1 (68.2) | 45.7 (2.0) | 49.0 (3.1) |
| Total resolved hydrocarbons-squalene | 150.2 (97.7) | 73.2 (32.1) | 223.0 (150.3) | 125.0 (102.4) | 57.3 (3.6) | 61.3 (0.9) |
| Total resolved hydrocarbons | 503.8 (256.8) | 270.6 (148.9) | 866.3 (427.7) | 468.2 (311.3) | 602.3 (36.9) | 646.8 (72.6) |
| UCM | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Total hydrocarbons | 503.8 (256.8) | 270.6 (148.9) | 866.3 (427.7) | 468.2 (311.3) | 602.3 (36.9) | 648.8 (72.6) |
| % lipid | 0.297(0.331) | | 0.199(0.045) | | 0.094(0.006) | |

TABLE 27. \bar{X} values and standard deviations (S.D.) of hydrocarbon components in sediments and organisms from northern Great Barrier Reef sites. $\mu\text{g}/\text{kg}$ wet weight (organism) or $\mu\text{g}/\text{kg}$ dry weight (sediments).

| | Coral Trout | <u>Fungia</u> | Parrot Fish | <u>Tridacna</u> (muscle) | <u>Acropora</u> | Sediments | <u>Tridacna</u> (kidney) | <u>Holothuria</u> | <u>Chlorodesmis</u> |
|--|-----------------|-----------------|-----------------|-----------------------------|------------------|--------------------|-----------------------------|--------------------|----------------------|
| Total alkanes | 115.1 (66.0) | 124.3 (23.9) | 107.2 (58.4) | 96.3 (10.8) | 346.8 (111.6) | 212.6 (179.6) | 487.7 (171.8) | 903.6 (180.5) | 31628.8 (5924.4) |
| Total resolved hydrocarbon minus squalene in f_1 fraction | 143.5 (83.1) | 149.1 (44.9) | 152.7 (37.4) | 187.6 (46.8) | 559.7 (213.8) | 263.2 (188.1) | 1118.9 (429.4) | 2579.5 (1642.3) | 68878.2 (20783.3) |
| UCM in f_1 fraction | n.d. | n.d. | n.d. | trace | trace | 946.5 (1196.5) | n.d. | trace | n.d. |
| UCM + total resolved hydrocarbons minus squalene in f_1 fraction | 143.5 (83.1) | 149.1 (44.9) | 152.7 (37.4) | 187.6 (0.172) | 559.7 (213.8) | 1087.1 (1351.4) | 1118.9 (429.4) | 2579.5 (1642.3) | 68878.2 (20783.3) |

TABLE 28. \bar{X} values and standard deviations (S.D.) of hydrocarbon components in sediments and organisms from northern Great Barrier Reef sites. $\mu\text{g/g}$ lipid weight.

| | <u>Tridacna</u> (kidney) | <u>Coral</u> <u>Trout</u> | <u>Tridacna</u> (muscle) | <u>Fungia</u> | <u>Parrot</u> <u>Fish</u> | <u>Holothuria</u> | <u>Acropora</u> | <u>Sediments</u> | <u>Chlorodesmis</u> |
|--|-----------------------------|------------------------------|-----------------------------|------------------|------------------------------|-------------------|-------------------|----------------------|---------------------|
| Total alkanes | 11.1 (6.1) | 65.6 (28.1) | 57.5 (4.7) | 127.7 (60.3) | 135.3 (90.2) | 86.7 (16.3) | 846.5 (432.3) | 3004.5 (1795.1) | 9477.2 (3205.7) |
| Total resolved hydrocarbon minus squalene in f_1 fraction | 20.7 (4.7) | 86.5 (33.9) | 115.6 (40.6) | 156.8 (94.7) | 187.0 (73.0) | 210.0 (168.9) | 1248.7 (382.2) | 3962.6 (1923.7) | 19844.3 (7659.5) |
| UCM in f_1 fraction | n.d. | n.d. | trace | n.d. | n.d. | trace | trace | 12141.0 (15955.1) | n.d. |
| UCM and total resolved hydrocarbons minus squalene in f_1 fraction | 20.7 (4.7) | 86.5 (33.9) | 115.6 (40.6) | 156.8 (94.7) | 187.0 (73.0) | 210.0 (168.9) | 1248.7 (382.2) | 16103.6 (16368.4) | 19844.3 (7659.5) |
| Percentage lipid | 5.55 (2.26) | 0.197 (0.102) | 0.172 (0.023) | 0.107 (0.025) | 0.085 (0.013) | 1.050 (0.091) | 0.045 (0.019) | 0.007 (0.003) | 0.466 (0.243) |

Fig. 1

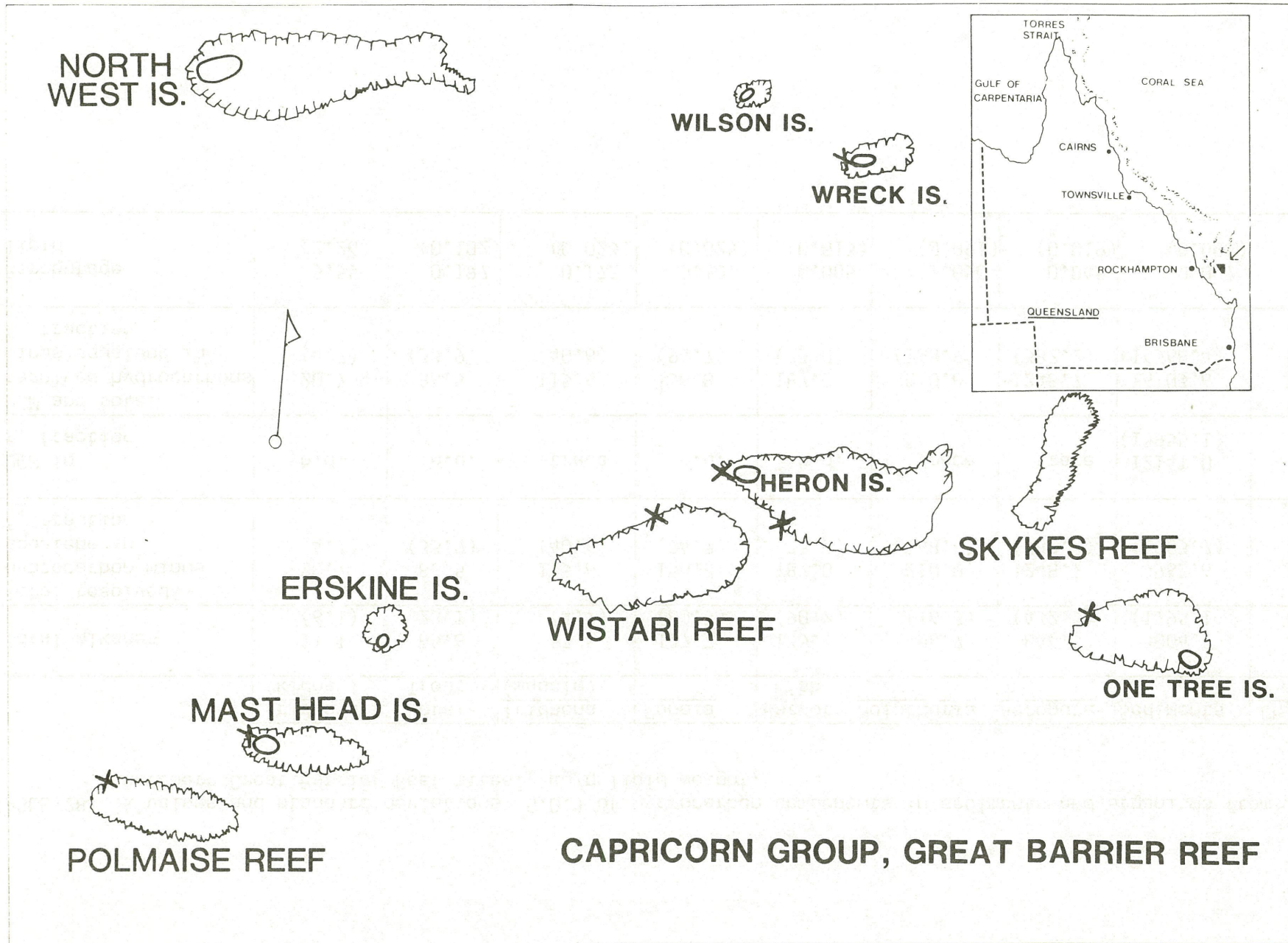
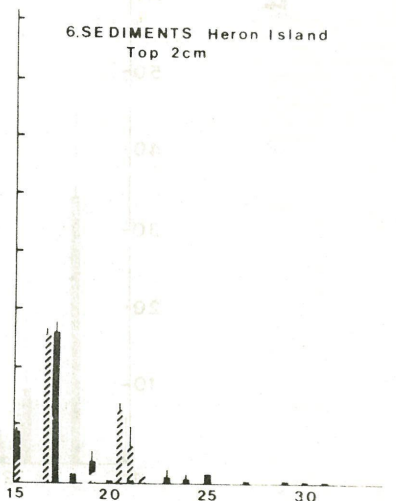
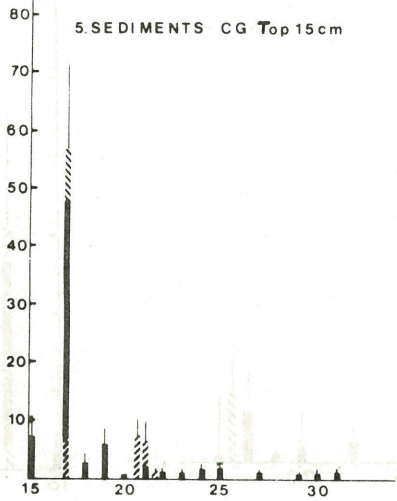
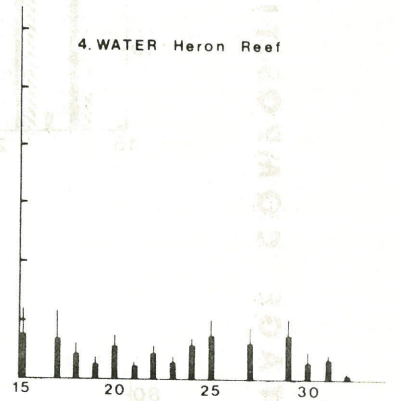
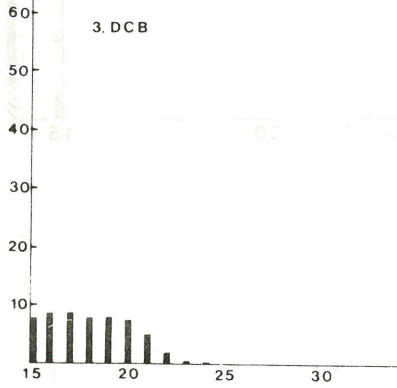
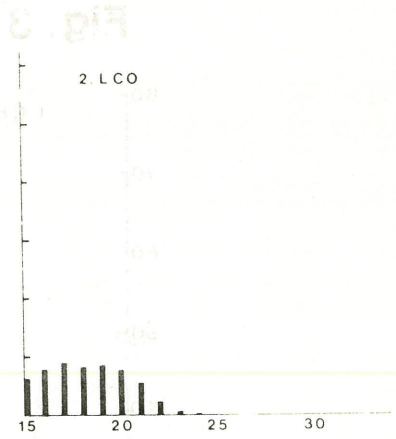
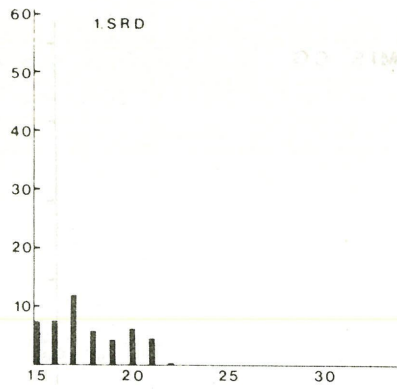


Fig. 2

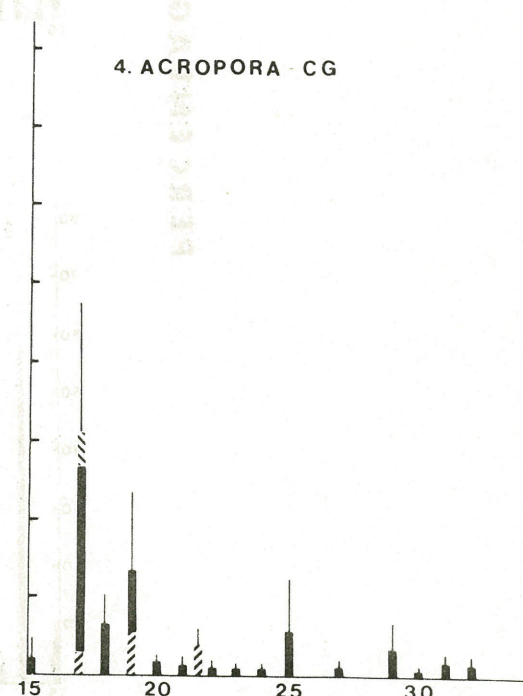
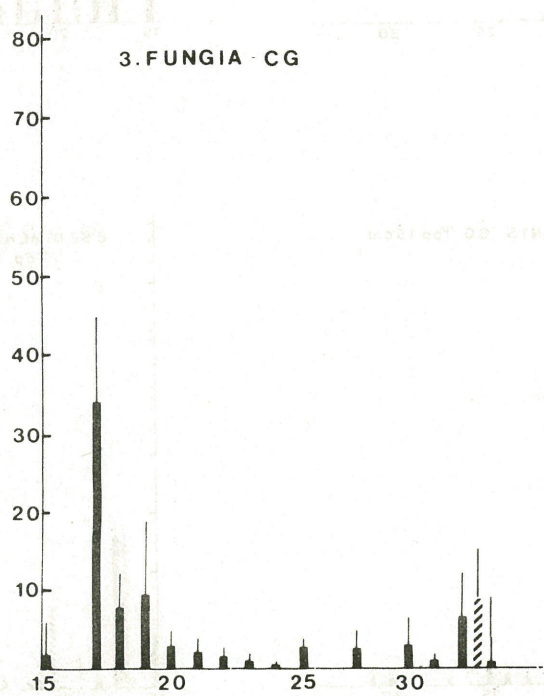
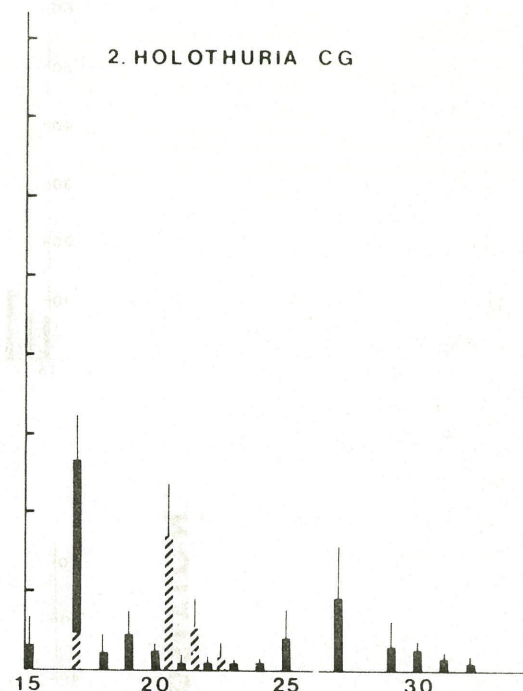
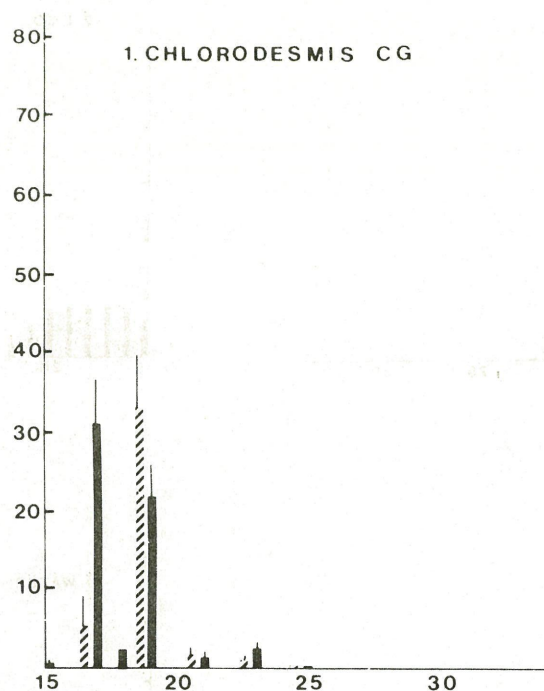
PERCENTAGE COMPOSITION



CARBON NUMBER

Fig. 3

PERCENTAGE COMPOSITION



CARBON NUMBER

Fig. 4

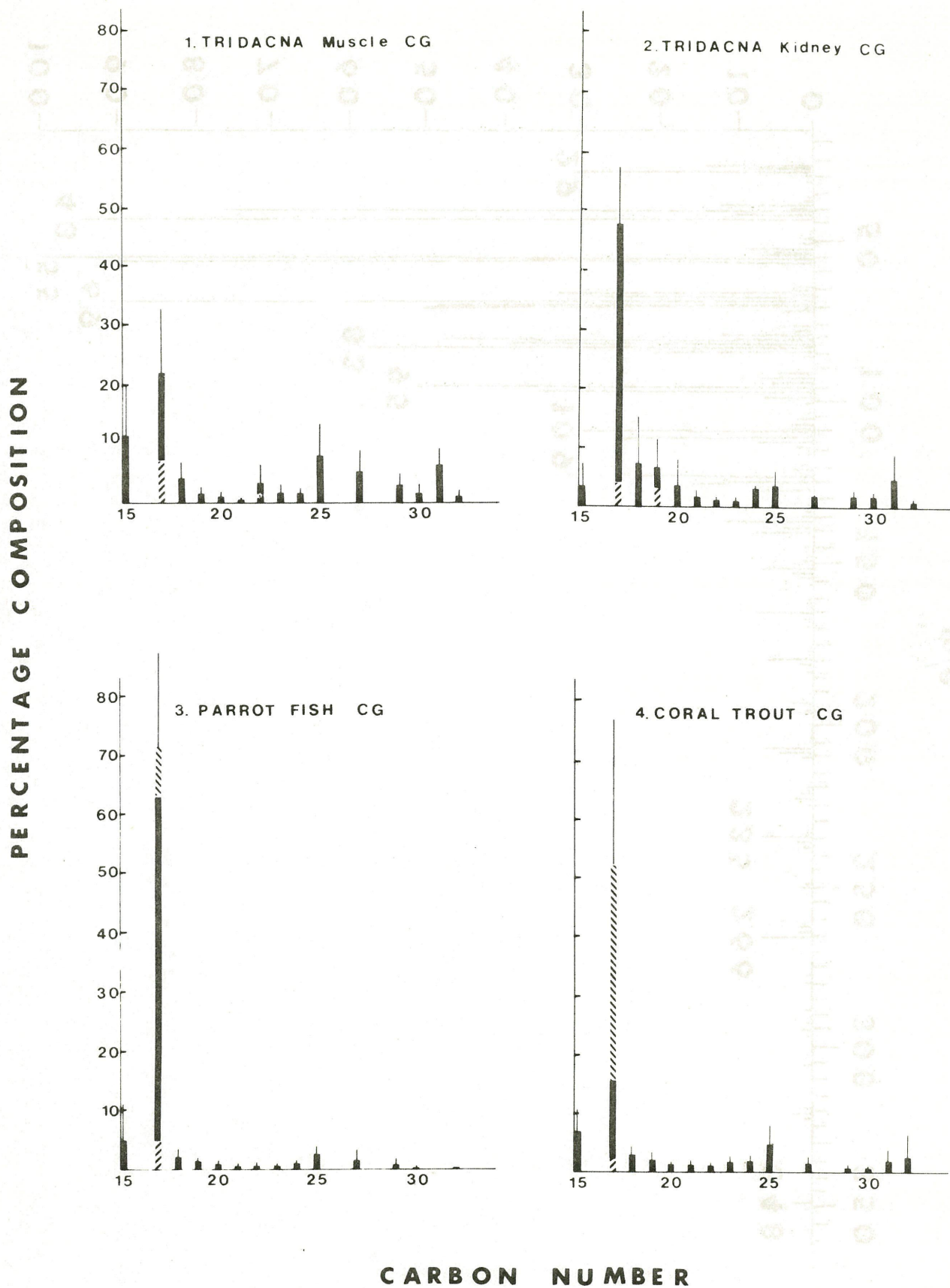


Fig. 5

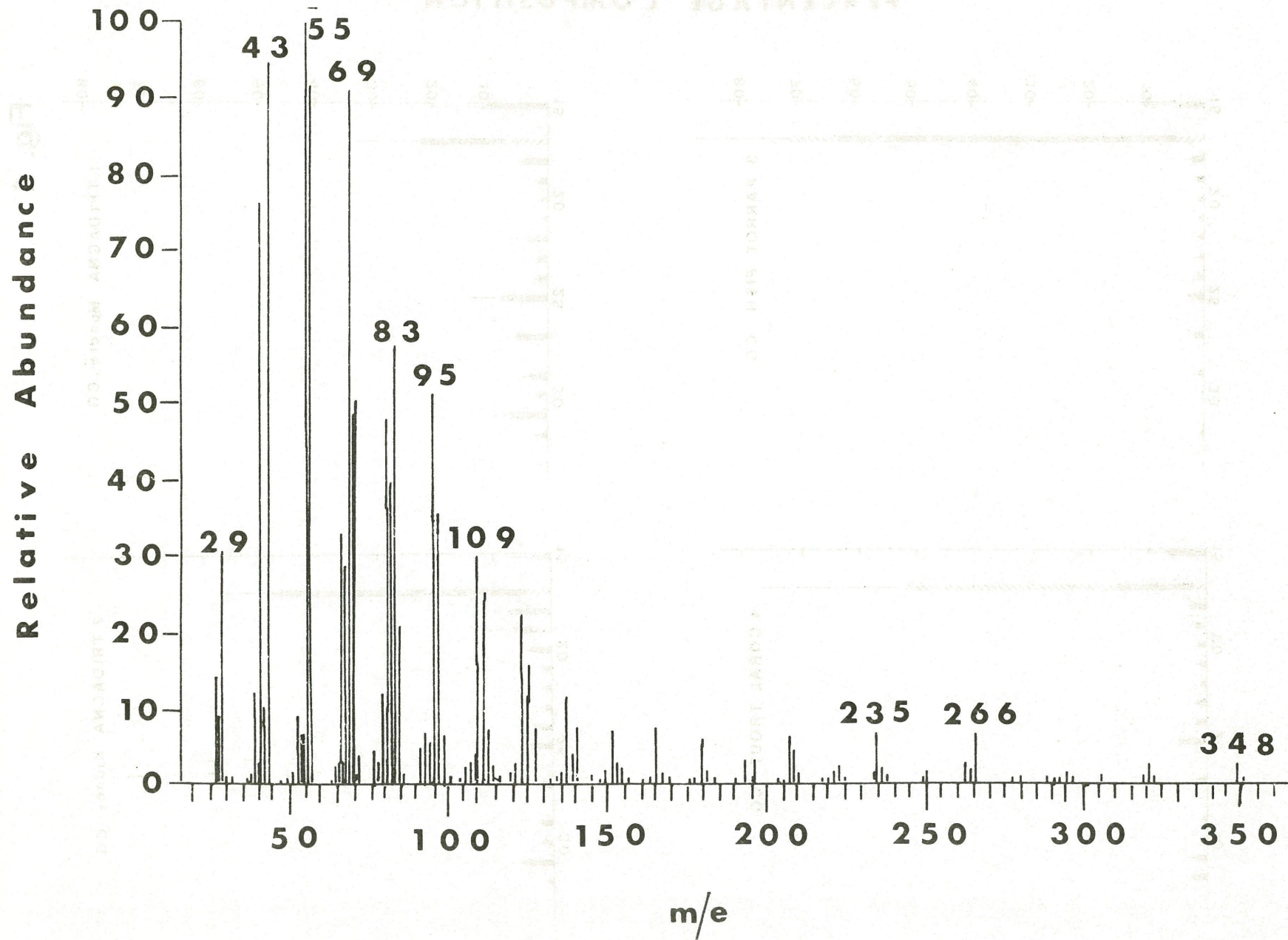


Fig. 6

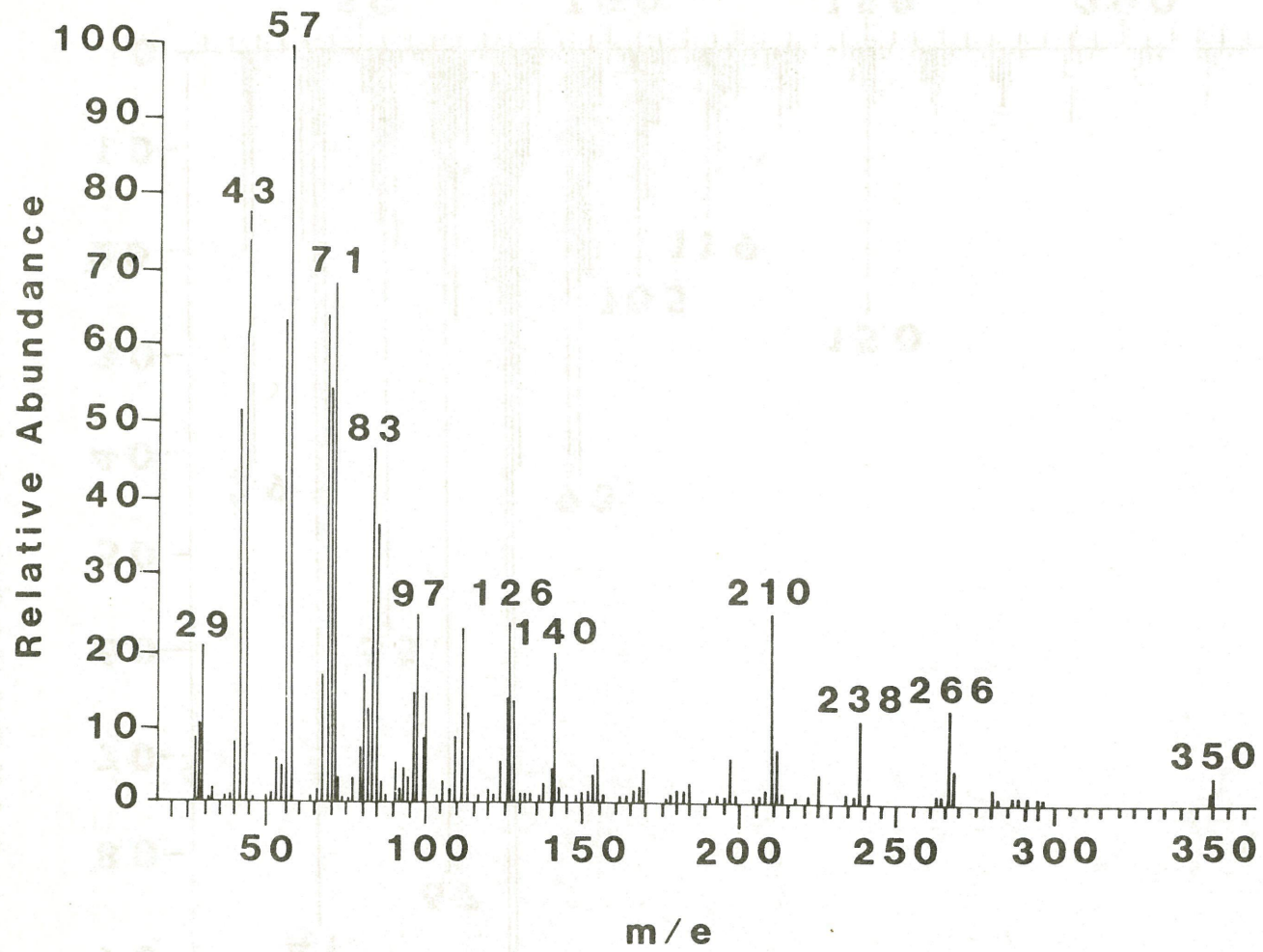


Fig. 7

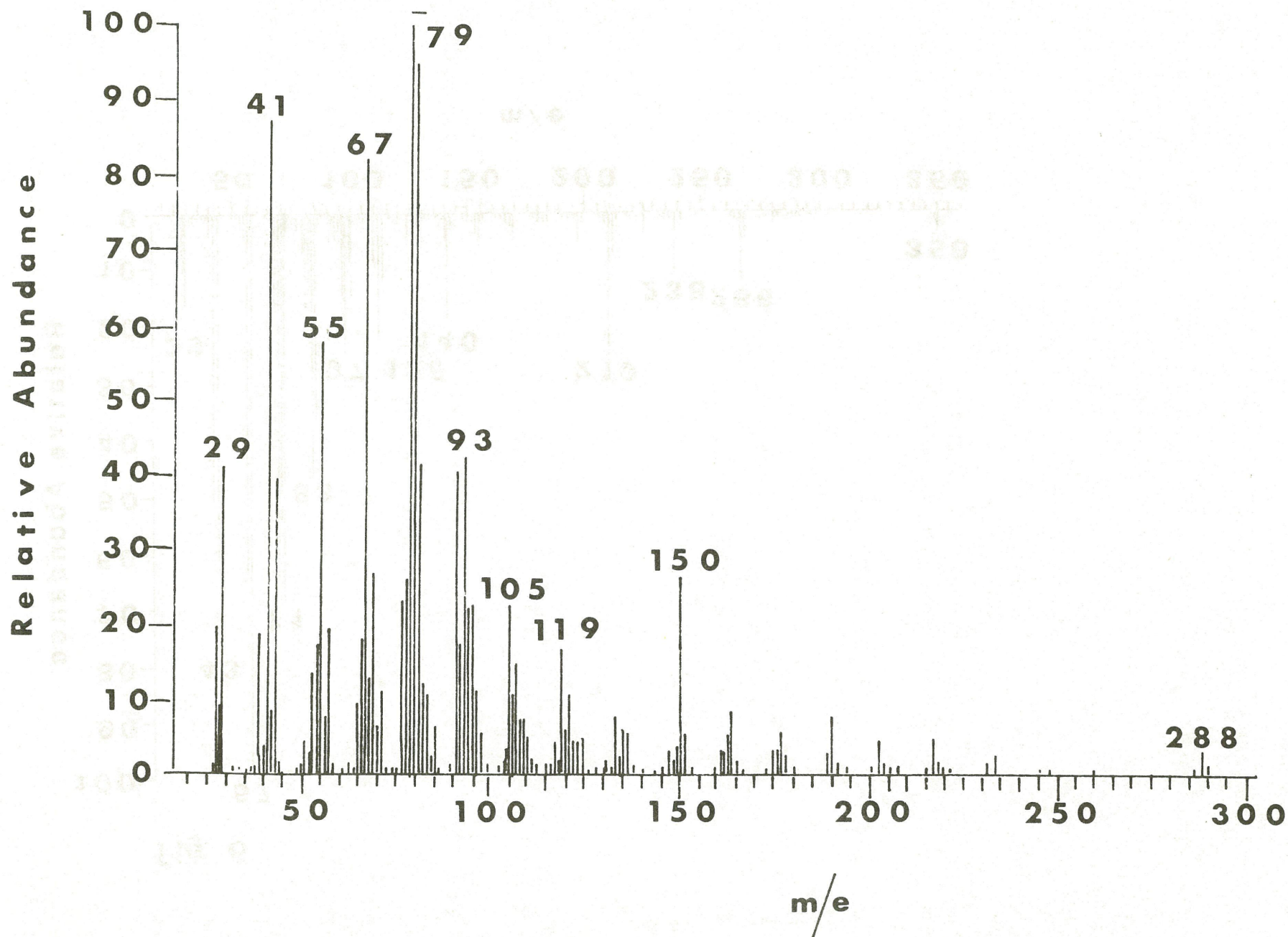


Fig. 8

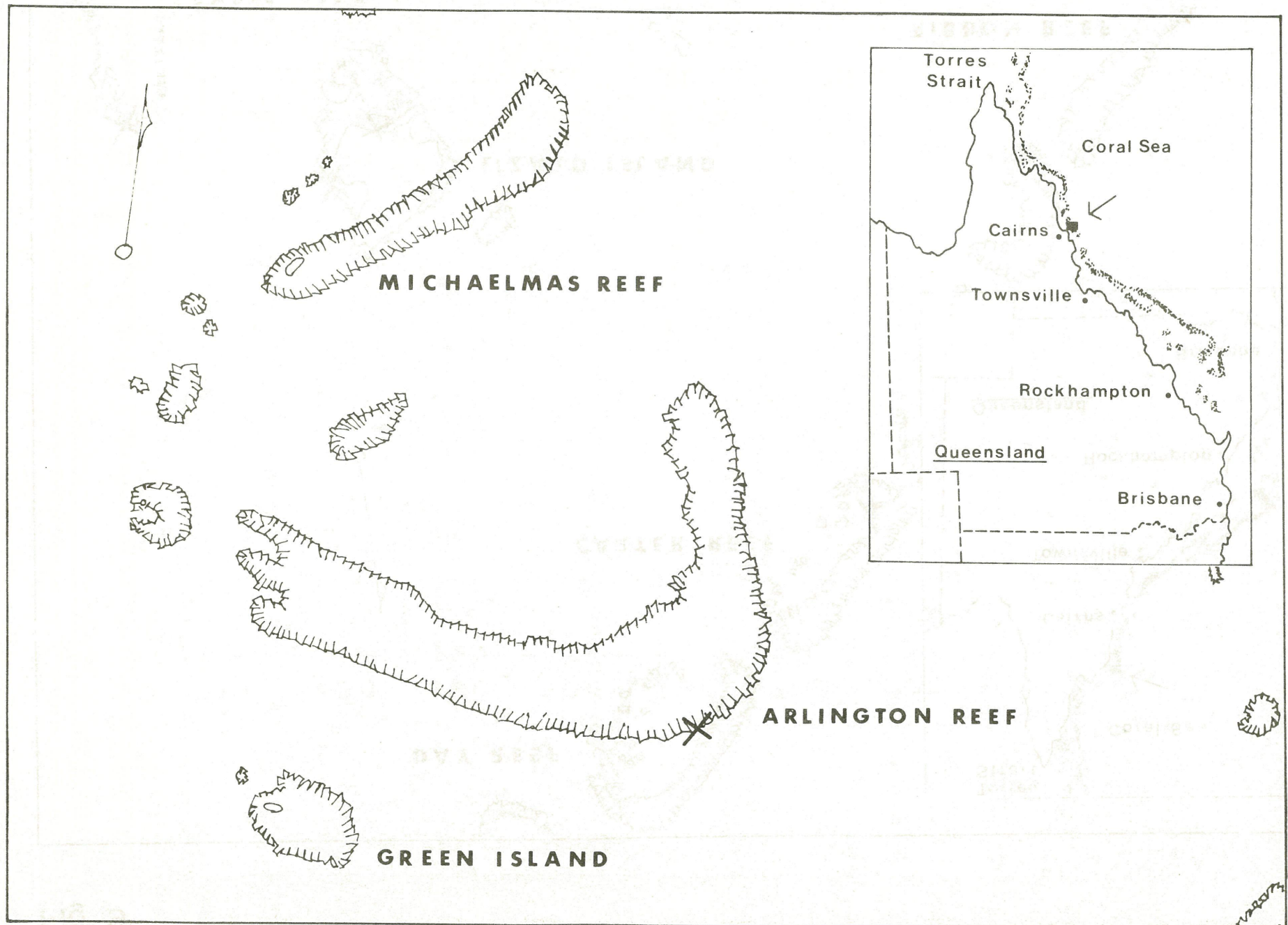


Fig. 9

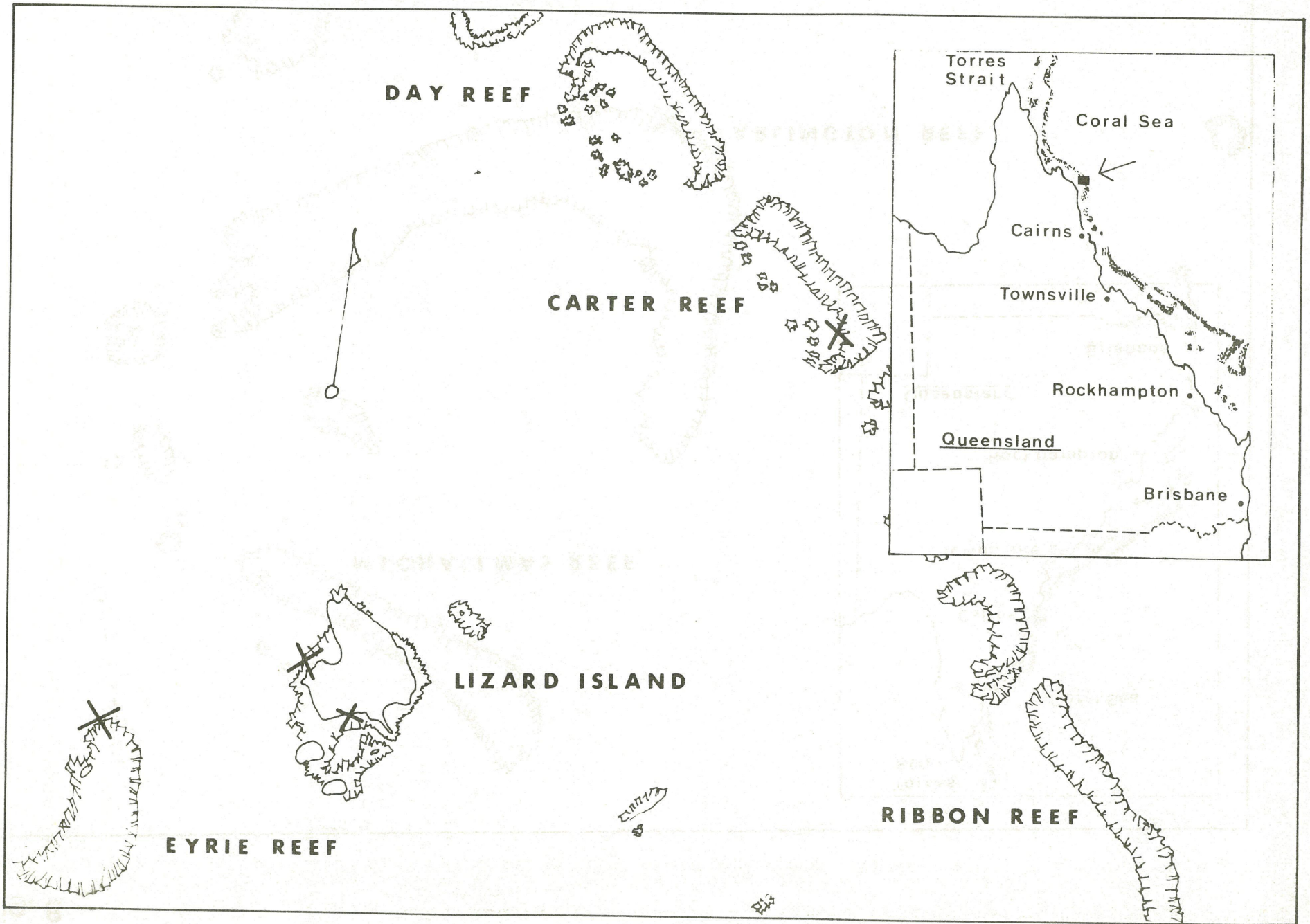


Fig. 10

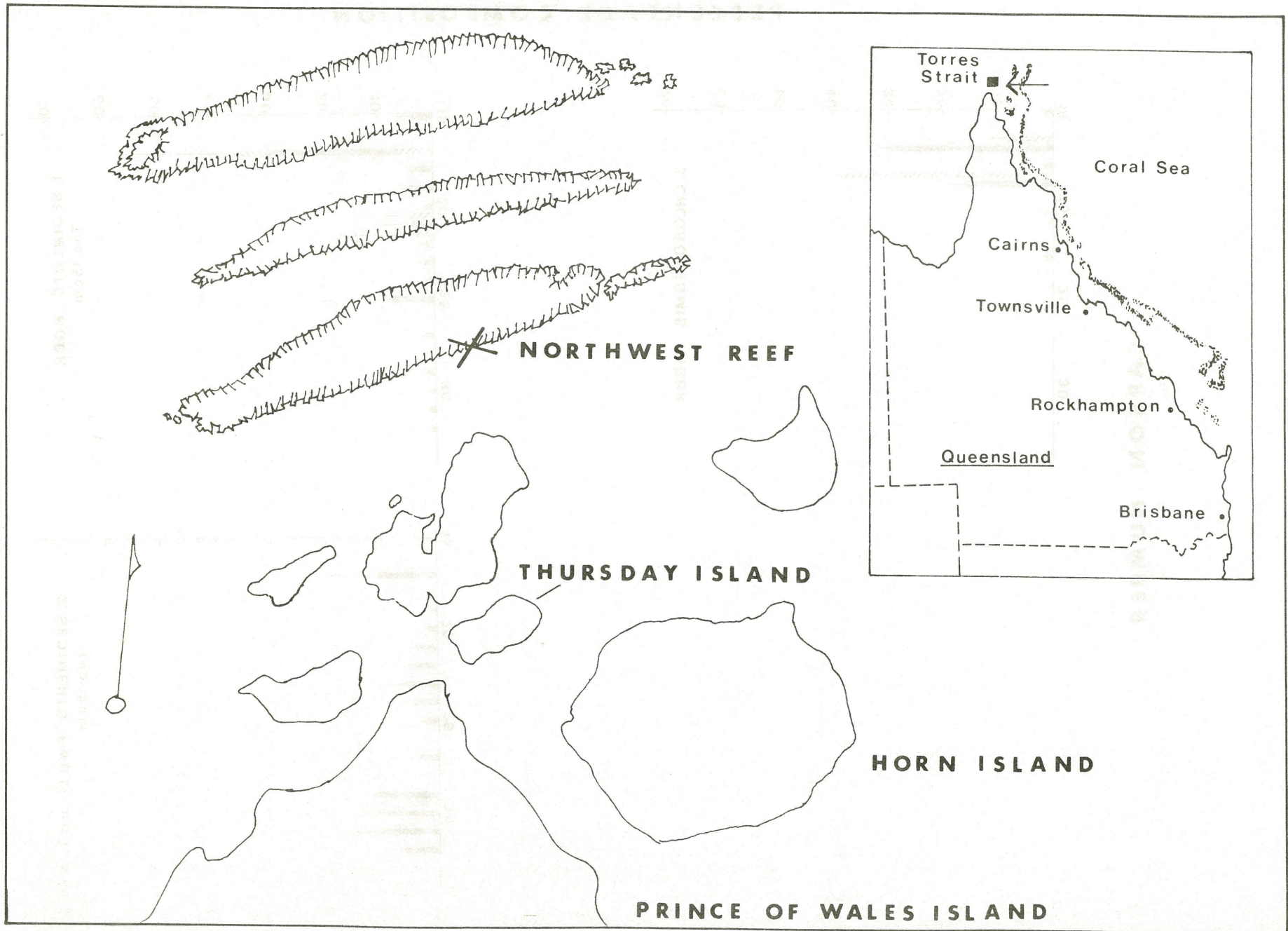


Fig. 11

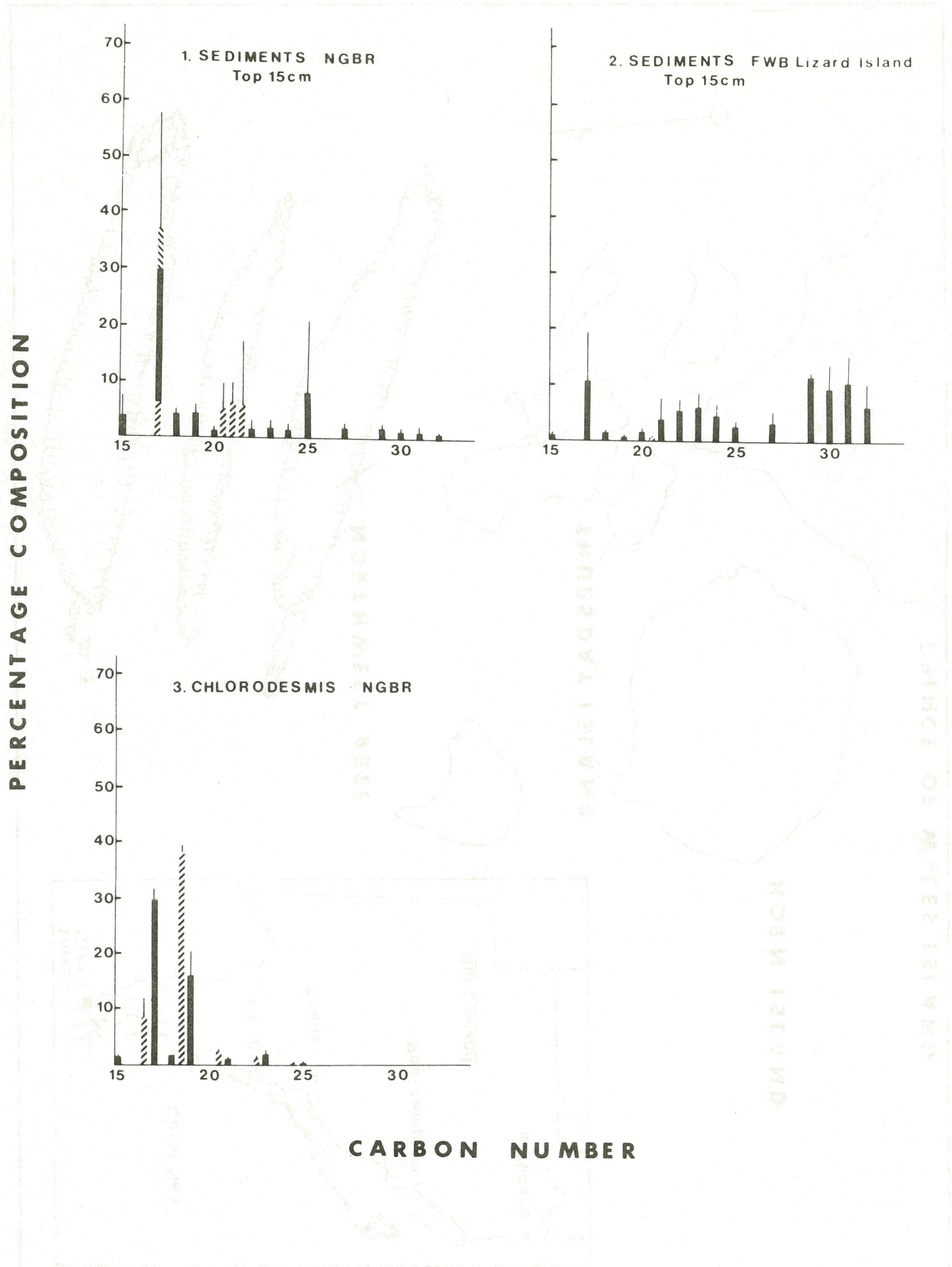
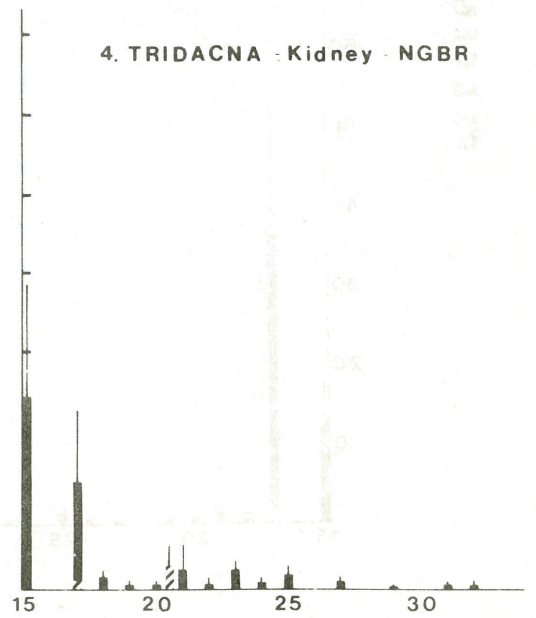
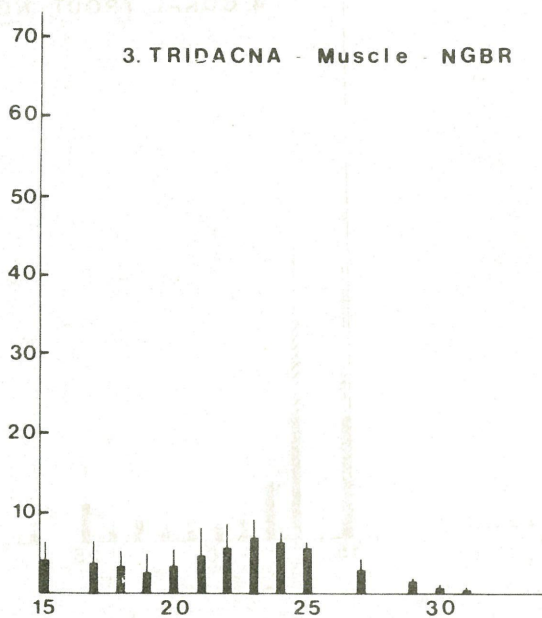
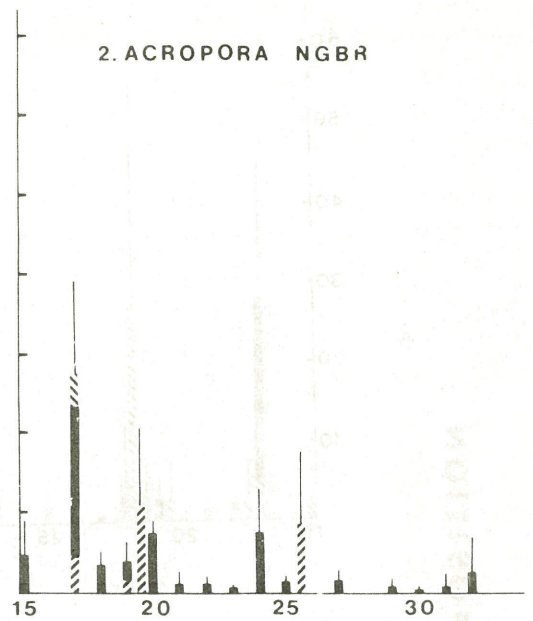
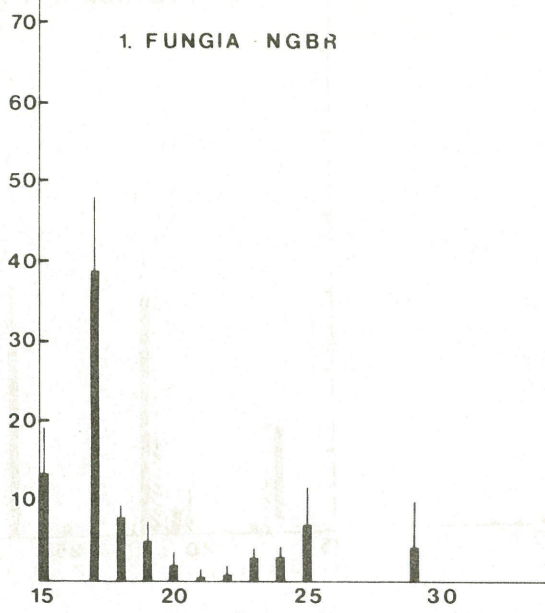


Fig. 12

PERCENTAGE COMPOSITION



CARBON NUMBER

Fig. 13

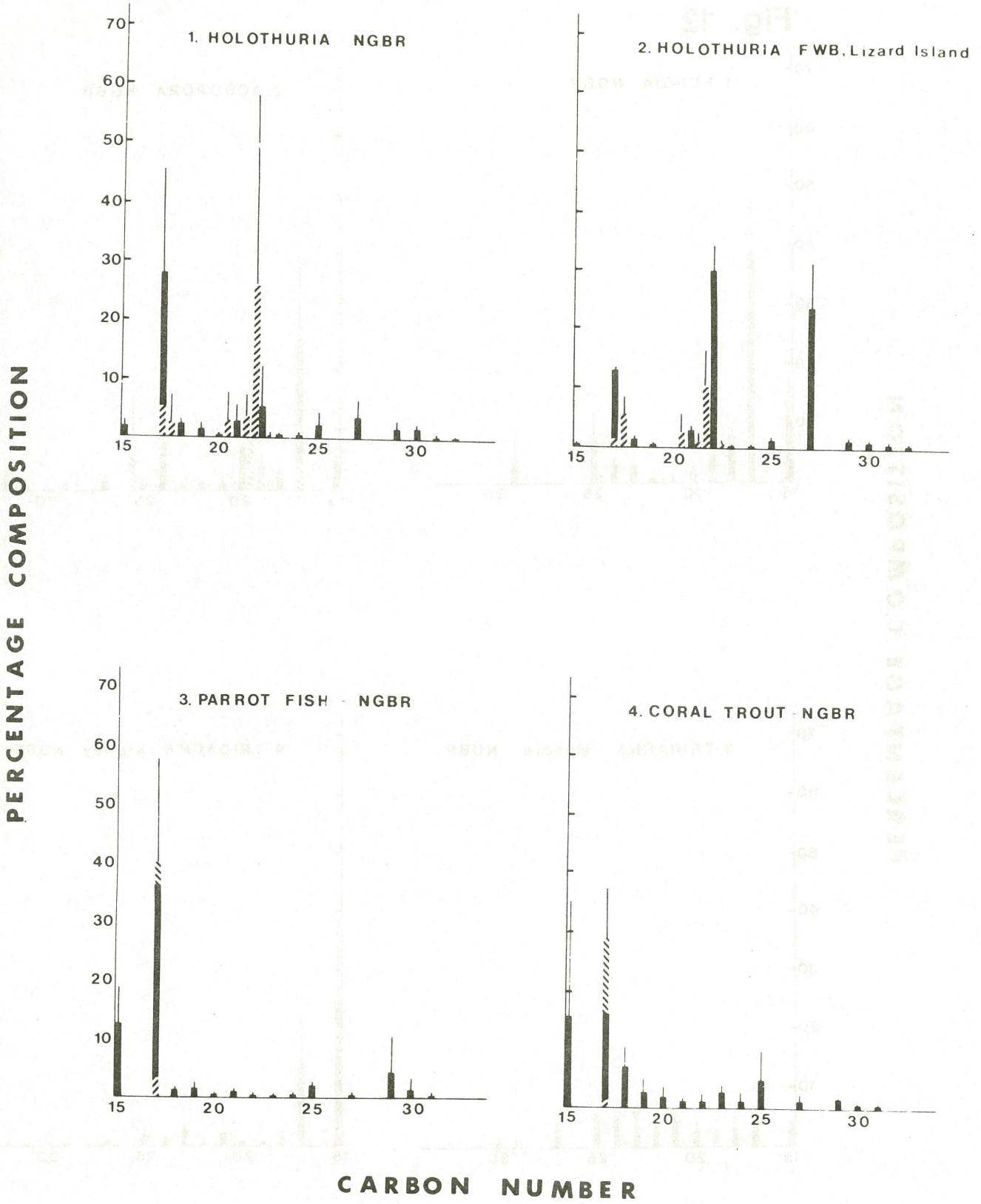


Fig. 14

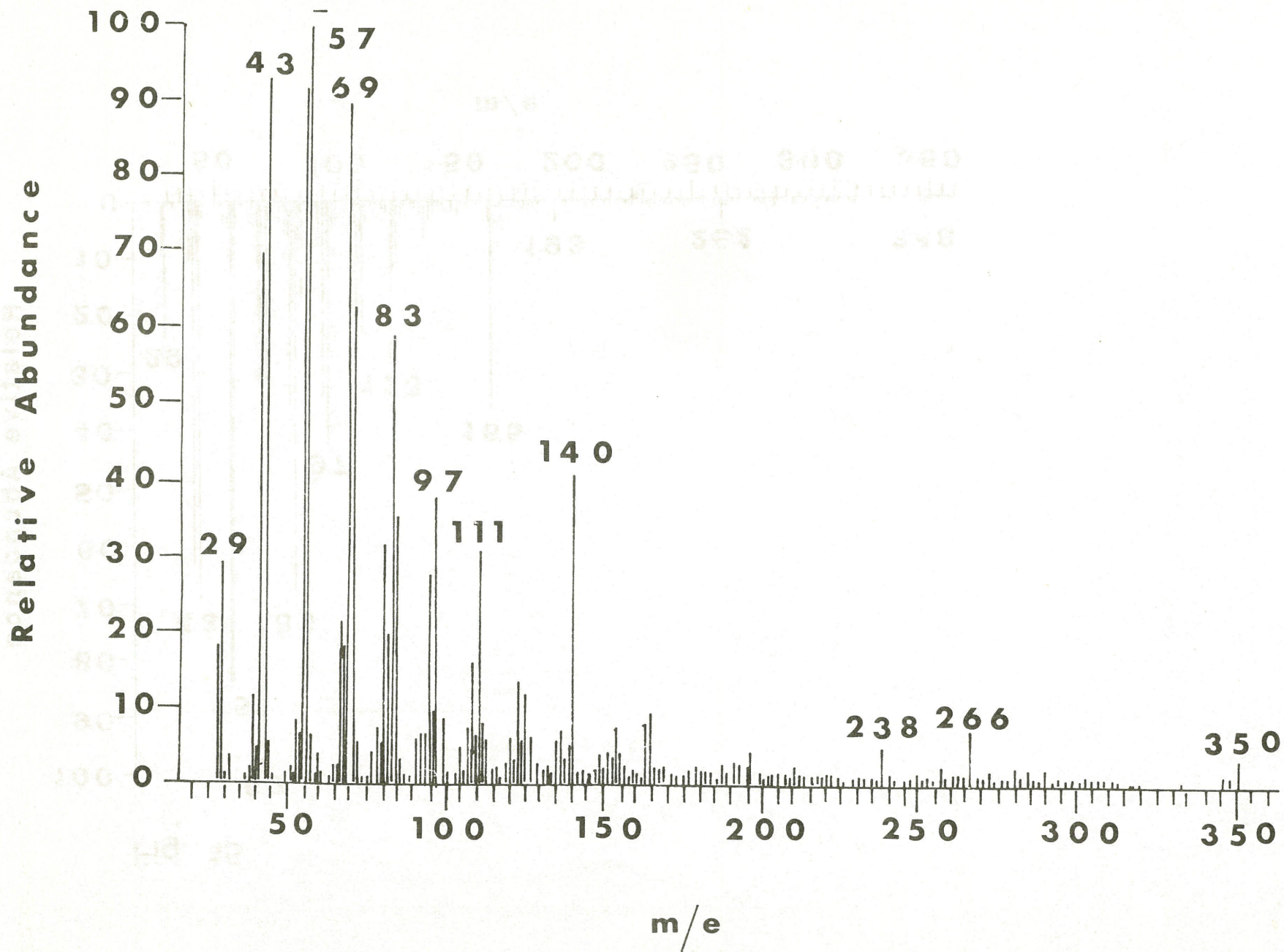
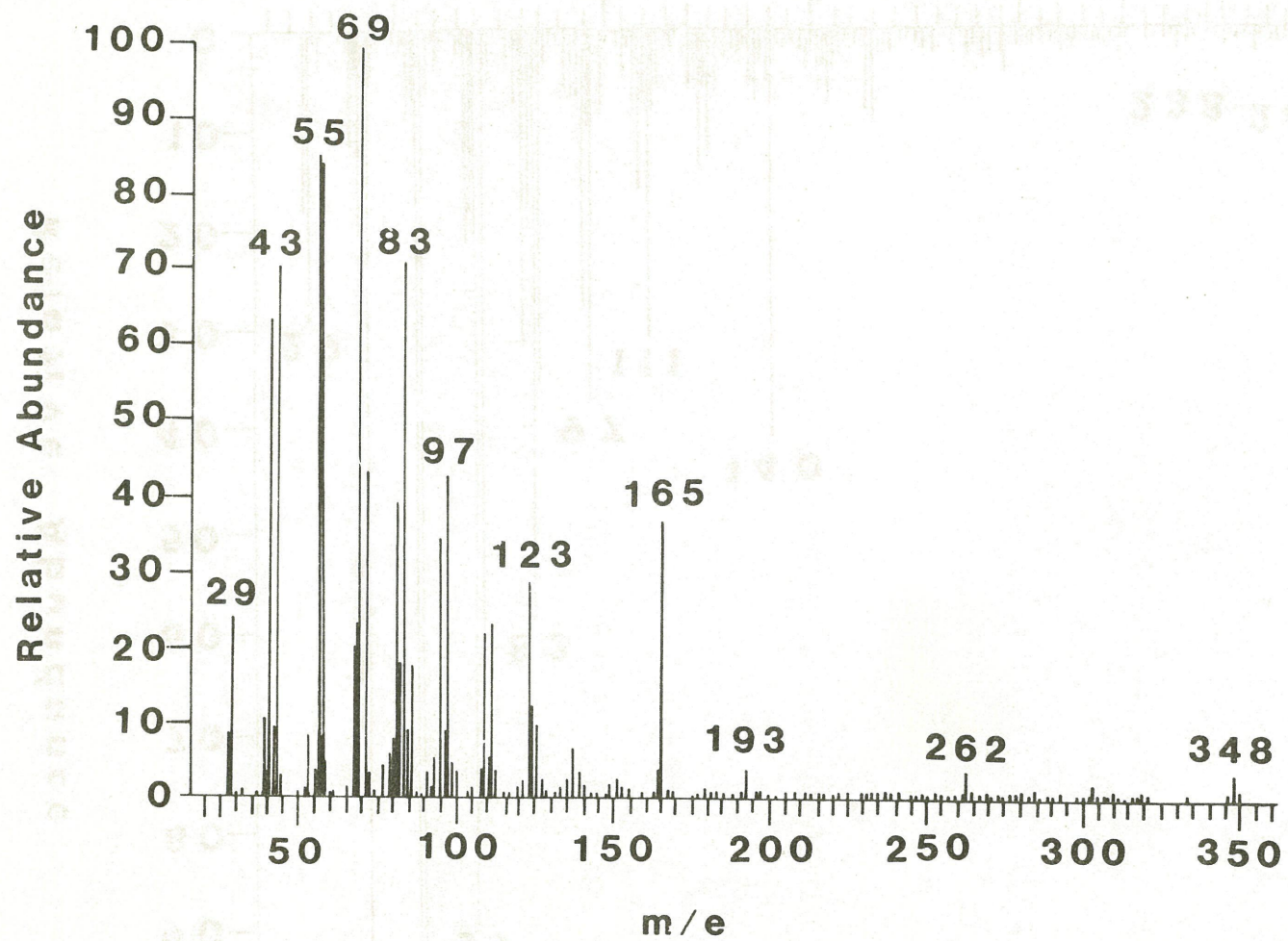


Fig. 15



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