A SUBTIDAL SURVEY OF THE TASMANIAN NORTHWEST COAST: A REPORT TO TIOXIDE AUSTRALIA PTY LTD.

BY:

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1. INTRODUCTION

The companies which purify and manufacture Titanium-containing compounds universally suffer from the problem that their waste products tend to be great in volume and potentially toxic. In most cases this has meant dumping as much as possible of the wastes into the sea (Knutzen 1983). In recent years considerable progress has been made in reducing the toxicity of the effluent by removing heavy metals and leaving a waste which is primarily a solution of sulphuric acid and iron sulphate. Upon entering the sea the acid is quickly neutralised and the iron sulphate is converted to relatively inert ferrous hydroxide. This latter process causes some localised anoxia but the primary effect is the formation of a floc of ferrous hydroxide (Knutzen 1983). The floc is the most readily recognisable sign of the wastes as it causes increases in turbidity in the water under turbulent conditions and at other times may form a blanketing layer over the sea floor unless swept into deep water and dispersed.

Complaints from local residents that the outfall from the Tioxide plant near Burnie was not only causing visual "pollution" by colouring the local waters but also that it was leading to a marked reduction in the local subtidal flora and fauna led the company to seek advice as to the validity of these claims. Dr W.J. Jones of Tioxide Australia then approached Drs Ritz and Thomas at the University of Tasmania to undertake a brief survey of the subtidal flora and fauna with a view to seeking evidence of pollution of any kind in the Burnie to Penguin region. This report sets out the results of the survey and places some interpretation upon them.

2. METHODS

Ten subtidal transects were surveyed in eight localities between Boat Harbour to the west and the Three Sisters rocks near Ulverstone to the east to gain a regional perspective and to bracket the region where effects of the Tioxide effluent might be experienced. Selection of the sampling localities was based on the results presented in a report on floc
dispersion by the Atomic Energy Commission (1982) and after discussions with local divers. In each case the transect was set at right angles to the coast out along a reef jutting out into the water. The rationale was to sample as nearly similar hard substrates at each site as possible to a maximum depth of 4m. All sampling was carried out by SCUBA divers. Due to the weather, the survey had to be carried out over several trips between 24 June and 10 July 1985.

2.1. Transect sampling

To get a general estimate of the fauna present the more obvious animals observed at 2m and 4m along the transect were noted and referred to as a "transect" estimate to differentiate it from the quadrat estimate. The list was then added to by the more concentrated quantitative sampling carried out using quadrats.

2.2. Quadrat sampling

Along each transect usually duplicate quadrats were surveyed at the 2m and 4m depths below mean low water (MLW). For the algae, estimates of percentage cover over an area of 5m² were obtained with the aid of a quadrat. Presence of all algal species in this area was noted and unknown plants were collected. For the animals two 0.25m² areas were stripped at 2m and 4m at each site with the exception of a trial 0.5m² at the 4m depth at Burnie. The species present and the number of individuals of each species were assessed.

2.3. Data analysis

The data set for the percentage cover of the algae was considered to be sufficiently robust to attempt to relate sites on the basis of the similarity in algal species. This analysis was carried out using a clustering algorithm call CLUSTAN. The remaining data based upon presence/absence for both algae and animals were analysed separately and together to provide correlations between sites and depths using a
3. RESULTS

3.1. SITE DESCRIPTIONS

The sites are marked on the map (Figure 1).

3.1.1. BOAT HARBOUR

Composed of a quartzitic reef, extensively faulted and steep-sided with rocky rubble in patches and sand appearing at 6m BMLW. Visibility was good (4-5m) despite moderate swells.

3.1.2. DOCTORS ROCKS

Composed of a quartzitic reef which changed rapidly into large boulders sitting on a sand substrate changing again by 4m depth to a predominantly sandy bottom with boulder erratics. Visibility was good (6-10m) despite an earlier report (Horwitz 1984) that this was an area of high turbidity at other times. Two transects were surveyed but the 4m sample had to be ignored in both cases as it did not provide sufficient rock substrate to be comparable with the other sites.

3.1.3. BURNIE

Composed of a quartzitic reef which dropped rapidly to a sandy bottom covered by boulders at 2m BMLW before sloping gently to 4m. Visibility varied from 4-5m at the 2m BMLW site to 2-3m at the 4m BMLW site.

3.1.4. TIOXIDE WEST

Composed of a quartzitic reef which sloped gently out into deeper water
with some rubble and outcropping. Some floc was evident on the rock surfaces. Visibility good at 4-5m.

3.1.5. TIOXIDE EAST

Composed of a quartzitic reef with extensive patches of rubble between outcrops. Floc was observed on the rocks and was particularly thick at the 4m site, filling in the gaps between the small bivalve molluscs to a depth of almost 1cm. Under calm conditions visibility was 4-5m but reduced rapidly when the floc was disturbed during sampling.

3.1.6. SULPHUR CREEK

Composed of a conglomerate reef, broken up and covered in boulder rubble. All surfaces were densely covered in silt/floc which was easily resuspended by passing divers. Visibility was very poor (i.e. approximately 20cm) at the 2m site when first surveyed but improved to 4-5m by the second visit.

3.1.7. PENGUIN

Composed of a conglomerate reef. While supporting a dense algal assemblage, most was lightly covered in floc below 2m depth. Visibility was 4-5m under calm conditions.

3.1.8. THREE SISTERS ROCKS

Composed of an angular, much folded and fractured quartzitic reef predominantly covered with boulder rubble. Visibility poor at just over a metre and less in patches due to rough weather conditions stirring up sediment and sand.
3.2. THE BIOTA

The species richness at the two set depths (2m and 4m) are noted for both algae (Figures 2 & 3) and animals (Transects - Figures 4 & 5; Quadrats - Figures 6 & 7). The main trend to be noted is the reduction in animal species numbers particularly at 2m at the Tioxide sites. Algal species richness reached a minimum at the Burnie and Tioxide West sites again at 2m. These patterns were repeated at 4m in the case of the animals but not the algae due to the replacement of the usually more diverse brown algae (Phaeophyta) by small red algae (Rhodophyta).

Percentage cover at each depth for the algae (Figures 8 & 9) and for some of the more significant algal species is illustrated in Figures 8 - 19. By contrast to the situation presented for species richness, the most marked reduction of algal cover was observed at the 4m depth at both Tioxide East and Sulphur Creek. The individual species from the common encrusting coralline algae (Rhodophyta - Figs 10 & 11) to the dominant brown algae (Phaeophyta) such as Acrocarpia (Figs 12 & 13), Ecklonia (Figs 14 & 15), Zonaria and Macrocystis (Figs 16 & 17) showed a general reduction in the Burnie to Sulphur Creek region but this was most evident at the 2m stations. The exception was a species of Halopteris (Phaeophyta - Figs 18 & 19) which was most abundant in the Tioxide region.

Inspection of the animal numbers per quadrat showed that the reduction in species richness at the Tioxide sites did not affect all groups equally. The most marked effect was the negative relationship between bivalve molluscs on the one hand and the gastropod molluscs and echinoderms on the other (Figures 20 - 25).

3.3. STATISTICAL ANALYSIS

The cluster analysis of sites based on similarity of percentage cover of algal species produced the dendrogram illustrated in Figure 26 and treated both sites and depths as separate data sets. The most significant
clusters divide the Tioxide - Sulphur Creek (and Penguin 4m) flora from those on either side.

The correlation matrix derived from the algal data set gives much the same picture (Table 1) but with different emphases due to the use of presence/absence data.

To attempt to reduce the "noise" in the animal data set due to the number of uncertain species represented by one record, the set was reduced to those species which were recorded from at least two sites. When analysed as a separate entity the animal data gave no significant correlations and had little effect when added to the algal data for a correlation analysis based on both plants and animals (e.g. at the 2m depth - Table 2).

4. DISCUSSION

4.1. A dip in the numbers of species of animals and plants in the Tioxide region is indicative of some environmental perturbation. The numbers are too low for any but the most elementary statistical treatment. Such a treatment, particularly for the animals, would be suspect until a number of taxonomic problems (e.g. the amphipods) have been sorted out and preferably more data obtained.

4.2. The cluster analysis based on the algae indicates that the algal assemblages of the Tioxide to Sulphur Creek region differ from those on either side of the region and this can be related back to both lower species richness and changes in species composition.

4.3. Particular groups show marked changes over the region, some of which can be related to variations in available substrate and others to intergroup interactions. An example is the likely effect of feeding by Echinoderms and Gastropods on the ability of Bivalves to colonise an area. Another likely interaction is the association of amphipods with particular algae.

4.4. The Bivalves show a considerable increase in density at the Burnie
and Tioxide sites at 2m and the Tioxide sites at 4m. These are inversely correlated with both Echinoderms and Gastropods, the latter being less obviously correlated. The Gastropod numbers were still low in the Burnie-Tioxide samples but the absence of other than presence/absence data for Boat Harbour (both depths) and any data for Doctors Rocks (4m) reduces the information value of this group.

Siltation is a likely cause of low numbers of grazing animals such as most Echinoderms (sea urchins and starfish) and herbivorous Gastropods, regardless of source. The absence of grazers is the most likely cause of massive colonisation by the Bivalves.

4.5. Turbidity, which included floc-sized particles, was very evident in all sites between Burnie and Penguin (Figures 27 & 28). This required very little increase in the swell for turbulence to stir up the bottom deposits and considerably increase the turbidity. This contrasted starkly with sites such as Boat Harbour, Doctors Rocks (Figure 29) and Three Sisters Rocks.

4.6. The casual observations of extensive froths on the beaches of Burnie indicated that Tioxide Australia is not the only source of effluents and that the local plants and animals may well be suffering from the effects of increased levels of organic materials and not just the combined effects of low light and high siltation from either silt or floc.

4.7. A more sensitive analysis probably could be obtained from carrying out observations on more quadrats in the affected region to determine the fine scale distributions of selected species which could be compared to unaffected sites such as at Boat Harbour in the west or the Three Sisters or similar sites further east. A careful analysis of algal distribution with depth is likely to provide a sensitive indicator of the effects of turbidity on light climate.

4.8. Floc build-up in sand may have marked effects upon the infauna and
provide an alternative strategy where rock substrates are not available for algal community studies.

5. CONCLUSIONS

There is definite evidence of environmental disturbance at the Tioxide sites with measurable effects extending to Burnie and Sulphur Creek. Species richness of both animals and plants is somewhat reduced and there is a clear indication of a change in community structure within this region. We suggest that the causes are primarily siltation and turbidity which reduce light levels.

6. REFERENCES

