May 1995

CENTRE FOR RESEARCH ON INTRODUCED MARINE PESTS

TECHNICAL REPORT NUMBER 1

POTENTIAL FOR THE INTRODUCTION AND TRANSLOCATION OF EXOTIC SPECIES BY HULL FOULING: A PRELIMINARY ASSESSMENT

SEBASTIAN F. RAINER

CSIRO AUSTRALIA

DIVISION OF FISHERIES

Rainer, S. F. (Sebastian F.)
Potential for the introduction and translocation of exotic species by hull fouling: a preliminary assessment.

ISBN 0 643 05628 9.

1. Pest introduction - Australia. 2. Ships - fouling - Australia. 3. Exotic marine organisms - Australia. 4. Marine fouling organisms - Australia. I. Centre for Research on Introduced Marine Pests (Australia). II. Title. (Series: Technical report (Centre for Research on Introduced Marine Pests (Australia)); no 1).

574.9994

ISSN 1324 - 3543

CONTENTS

SUMMARY 5

INTRODUCTION 5

METHODS 5

RESULTS 6

DISCUSSION & CONCLUSIONS 9

ACKNOWLEDGEMENTS 10

FIGURES 11-18

SUMMARY

The extent and type of biological fouling was examined by diver inspection of the hulls of four overseas and four domestic vessels, in the ports of Fremantle and Hobart. Fouling species identified include sponges, hydroids, mussels, barnacles, bryozoans and ascidians. Mobile species found include gastropods, shrimps and fish. The amount of hull fouling was probably unimportant to the operation of most of the vessels. However, based on the vessels examined, hull fouling is likely to pose a significant risk of introducing new exotic species and of translocating those exotic species already in Australian ports.

INTRODUCTION

A recent review of data on introduced marine pests in Australian waters has found over 70 species of introduced algae, invertebrates and fish. About one third of the introduced species are thought to have been brought in as biofouling organisms on the hulls of overseas shipping, prior to be use of modern anti-fouling paints.

The increased use of large vessels in international shipping, discharging large amounts of ballast water in Australian ports, has focused attention on the role of ballast water as a vector for introducing marine pests. Although species such as the toxic dinoflagellate *Gymnodinium catenatum*, the northern Pacific seastar, *Asterias amurensis*, and the Japanese kelp *Undaria pinnatifida* were probably introduced by ballast water, preliminary investigations into the introduced giant fanworm, *Sabella spallanzanii*, indicate that the fanworm and a variety of other fouling species can grow abundantly on the hulls of small boats.

It has often been assumed, at least for commercial shipping, that the need to ensure efficient vessel operation coupled with the widespread use of effective anti-fouling paints had virtually eliminated hull fouling as an import vector for exotic species. A small-scale diver survey was carried out by The Centre for Research on Introduced Marine Pests (CRIMP) to determine the level of hull fouling on selected foreign and domestic vessels. This report gives the results of this survey and provides a preliminary risk assessment of hull fouling as a vector for the introduction and translocation of exotic species.

METHODS

The hulls of eight foreign and domestic vessels in the ports of Fremantle and Hobart (Table 1) were examined by scuba divers, who took still photographs and video footage of hulls with biofouling. Still photographs were taken with Nikonos V cameras, and video footage was taken with Sony underwater video cameras.

TABLE 1. VESSELS INSPECTED FOR BIOFOULING ORGANISMS.

Vessel	Type	Origin	Date (port) sampled
Vessel 1	Bulk carrier	Overseas	28/04/95 (F'mantle)
Vessel 2	Bulk carrier	Overseas	28/04/95 (F'mantle)
Vessel 3	Long-liner	Overseas	11/05/95 (Hobart)
Vessel 4	Long-liner	Overseas	11/05/95 (Hobart)
Vessel 5	Research vessel	Domestic	10/05/95 (Hobart)
Vessel 6	Ferry	Domestic	10/05/95 (Hobart)
Vessel 7	Harbour tug	Domestic	10/05/95 (Hobart)
Vessel 8	Trawler	Domestic	10/05/95 (Hobart)

RESULTS

VESSEL 1

Bulk carrier, registered in Panama. Unladen and inbound from Manila; intended cargo alumina. Length 187m, dead-weight 38,220 tonnes. Ship's agents - Hetherington Shipping Agency. Hull box-shaped with four bilge keels on each side, tapering forwards to a bulb bow and aft to the propeller housing.

The hull was generally very clean, with only patchy fouling on the bottom and sides, particularly in areas where paint had either been rubbed off or where docking blocks had prevented paint coverage during dockyard anti-fouling. The fouling organisms were typically small balanoid barnacles and bryzoans. On the outer edge and underneath the bilge keels a small horizontal shelf supported larger barnacles, probably a different species, and some hydroids (fig. 1). Towards the stern, fouling became more noticeable with larger barnacles and serpulid worm tubes growing on intake gratings and particularly around the collar of the propeller shaft housing (fig. 2). The propeller itself was clean apart from small balanoid barnacles. Above the water, but below the water-line, we observed some patches of calcareous worm tubes, probably from a serpulid polychaete.

In sheltered places such as recesses associated with the propeller and rudder post, large barnacles were again abundant. Two grated intake vents (one with round holes, one with horizontal bars) near the stern housed a rich assemblage of invertebrates, including at least two species of anemones, more barnacles, a pycnogonid, and dense colonies of hydroids (figs 3 & 4). The square vent was recessed for about half a metre behind the grating and appeared heavily fouled inside.

Several different types of mobile animals were found. A few small shrimps and a small sea-hare were seen in the recess created by the top of the rudder. Two small gobies were seen darting in and out of the bars of the two grated intake vents near the stern.

Small patches of filamentous green algae were present in several places on the sides of the hull.

VESSEL 2

Bulk carrier, registered in Piraeus; inbound from Kenai, Alaska and loading fertiliser. Length 187m, dead-weight 37,593 tonnes. Ship's agents - Maersk-Beaufort Shipping Agency. Hull shape as for vessel 1.

The initial impression of vessel 2 was again that it was generally very clean. However, filamentous algae, possibly of two different species, formed a thin "carpet" on the ship's sides from 2 m below the water line down to the side bilge keels (fig. 5). The absence of algal growth near the water line was probably the result of recent hull-cleaning. One small diameter outlet, presumably an effluent outlet, showed a distinct "plume" of green algae spreading out from its trailing edge along the hull.

The bottom of the hull was clean except for a few barnacles, mainly where paint was missing (fig. 6). The recessed shelves under the bilge keels were also relatively free of growth. The stern was again more fouled and many large barnacles, up to 5 cm base-width, occurred around the propeller collar (fig. 7) and shaft housing, intake gratings (fig. 8) and in the recesses associated with the rudder, propeller and vent pipes. Most of the large barnacles were dead, but some smaller ones (possibly a different species) were alive. No shrimps or other mobile invertebrates were seen.

VESSEL 3

Japanese long-liner, ca. 30 m long, V-shaped hull, single screw without propeller housing; a bilge keel and projecting echo-sounder housing on each side.

Anti-fouling in good condition, but with frequent stalked barnacles and occasional patches of balanoid barnacles. Stalked barnacles up to 5 cm long, occurred mainly in areas where hull welds (fig. 9) or protruding elements (fig. 10) cause reduced or turbulent flow, in and around hull intake points, and in the recess at the base of the rudder post (fig. 11). Balanoid barnacles up to 2–3 mm diameter, occurred on non-antifouling paint, such as on bow depth markings, and on nearby areas with an intact coat of antifouling. Filamentous green algae (1–2 cm long) was growing densely on depth markings and on the stainless steel nuts and bolts used to attach sacrificial anodes to the bilge keels. The keel area and the propeller seemed to be free of significant fouling although the propeller shaft had a 30 cm diameter bundle of long-line wound around it.

VESSEL 4

Japanese long-liner, ca. 30 m long, V-shaped hull, single screw with propeller housing; a bilge keel and projecting echo-sounder housing on each side.

Antifouling in good condition; adhering fouling species as on vessel 3, but generally smaller, presumably more recently settled. The keel area and the propeller again seemed to be free of significant fouling.

VESSEL 5

Fisheries research vessel, ca. 25 m long, V-shaped hull, single screw without propeller housing; a bilge keel and projecting echo-sounder housing on each side. Last slipped and cleaned July-August 1994.

Anti-fouling generally intact, but with moderate patchy growth of filamentous green algae, particularly near the bow. Bilge keels and keel with patchy growth of hydroids, bryozoans and serpulid worms. Propeller bases and shaft with a complete cover of balanoid barnacles (fig. 12). Hull and keel areas with broken or no antifouling had a partial cover of balanoid barnacles and serpulid worms. Intake gratings with holes were partially blocked by barnacles and hydroids (fig. 13); a mixed assemblage of fouling species was evident behind the gratings.

VESSEL 6

Sydney Harbour ferry, ca. 50 m long, used for occasional harbour cruises. V-shaped hull with propeller and rudder at each end.

Condition of anti-fouling poor; hull with heavy coating of filamentous algae and fouling animals. Filamentous algae abundant on bow/stern regions; green algae down to ca. 2 m below the waterline, replaced by red algae on deeper surfaces. Fouling up to 12 cm deep below vertical structures such as the keel and parts of the rudders (fig. 14); up to 5 cm deep elsewhere. Fouling species included abundant hydroids, serpulid worms and mussels, with moderate numbers of sponges, sea anemones, and simple ascidians and colonies of compound ascidians and bryozoans (fig. 15).

VESSEL 7

Tug, ca. 20 m long, V-shaped hull with bulb bow, single screw; one bilge keel and projecting echo-sounder housing on each side.

Anti-fouling in good condition; the vessel appeared to have been recently slipped and antifouled. A few patches of balanoid barnacles and serpulid worm tubes under the keel on areas lacking antifouling (fig. 16); a dense cover of dead barnacles (bases only) attached to the propeller hub and bases of the propeller blades.

VESSEL 8

Ocean-going trawler, ca. 25 m long, V-shaped hull with bow thruster, single screw with propeller housing; a bilge keel and projecting echo-sounder housing on each side. Slipped and antifouled five days before examination.

Recently slipped and repainted, this vessel served as a bench-mark for other vessels in the survey. There appeared to be no significant below-water hull areas that had not been cleaned and repainted, and no fouling was seen on the propeller, the propeller shaft or behind any gratings.

DISCUSSION AND CONCLUSIONS

The vessels examined in this study were of widely differing types and sizes. The antifouling on the hulls of the four overseas vessels appeared well-maintained, as was the antifouling of two of the domestic vessels examined. However, some algae, barnacles and polychaete worms are able to settle and grow on antifouling coatings, even on the exposed sections of a hull. Underwater areas without antifouling, such as the propeller and propeller shaft, and under slipping blocks, may have dense populations of barnacles and tube worms. More protected areas, such as behind gratings on intake vents, and particularly under bilge keels and near the stern, can support a much greater variety of sessile fouling species. Protected areas can also provide shelter for some mobile crustaceans, pycnogonids, molluscs and even small fish.

Older antifouling coatings are more likely to be overgrown by fouling plants and animals. The heavier fouling found on two of the domestic vessels is typical of inshore vessels whose antifouling has been damaged or is nearing the end of its effective life – as the antifouling loses its effectiveness, larger areas of a vessel will be covered by fouling species, in increasing variety.

The amount of biofouling present on the international vessels examined is unlikely to affect the economical operation of the vessels. However, even small numbers of colonial or aggregating species (i.e., most fouling species) may comprise sufficient individuals for successful reproduction and colonisation of new areas. The ecological risk posed by biofouling on ships' hulls is therefore not a simple function of the area of the hull that is fouled. Research to quantify this aspect of the risk of introduction /translocation is needed.

The variety of hull-fouling species present on the four international vessels examined suggests that modern antifouling paints have not eliminated hull fouling as a potential vector for the introduction of exotic species. The two bulk cargo ships examined had a greater range of fouling species than the long-liners, which were fouled mostly by barnacles characteristic of an open water habitat. The two bulk ships also had different fouling communities from each other, suggesting that the vessels' ports of lading play a role in determining which fouling species are present on a vessel.

The wide range of species growing on the hulls of domestic vessels suggests that hull fouling is likely to be a significant vector in the translocation of exotic species between Australian ports. However, a variety of considerations indicate that some types of vessels pose more risk than others:

- bulk carriers tend to be "stacked" more often in ports around the world awaiting loading which allows more time for hull-growth to accumulate (pers. comm. Bob Moore, Technical Manager, Stateships).

- live sheep carriers, particularly those of third-world origin, are reported to be noticeably fouled (pers. comm. Jim Phillips, commercial diver).

- slow-moving vessels, such as barges, floating cranes and oil rigs and tenders may be stationed in ports for long periods, and are not regularly cleaned. They are often towed at slow speed between ports, often from tropical to temperate regions and sometimes between Asia and Australia. There is anecdotal evidence that *Sabella spallanzanii*-infested barges have been towed north and south from Cockburn Sound.

- fishing boats and non-commercial vessels may spend days or weeks in ports that have pest species such as the Japanese kelp or the giant fanworm. Unconfirmed reports suggest that both species can grow vigorously on the hulls of small vessels.

- oil tankers and container ships are likely to be low risk vessels. Their storage arrangements allow for rapid loading and unloading leading to short turnaround times in port which give little opportunity for fouling species to settle.

ACKNOWLEDGEMENTS

Co-ordination, boat operations, diving and photography were carried out in Perth by Geordie Clapin, David Evans and Simon Braine, and in Hobart by Dianne Furlani, Richard Martin, Craig Proctor, Sebastian Rainer and Brian Wilson. David Evans provided a report on the survey in Perth. I thank them for their efforts in making the work successful. I also thank Captain Atkinson (Port Operations Manager, Fremantle Port Authority), Captain J.B.N. Hodgson (Marine Board of Hobart) and Mr A. Lee (Maritime Agencies of Tasmania), for their help in co-ordinating the diving operations with the masters of the foreign vessels.

Figure 1. Bilge keel fouling, vessel 1 (frame size 18 x 12.5 cm).

Figure 2. Propeller collar fouling, vessel 1 (frame size 18 x 12.5 cm).

Figure 3. Square intake near stern, vessel 1 (frame size 18 x 12.5 cm).

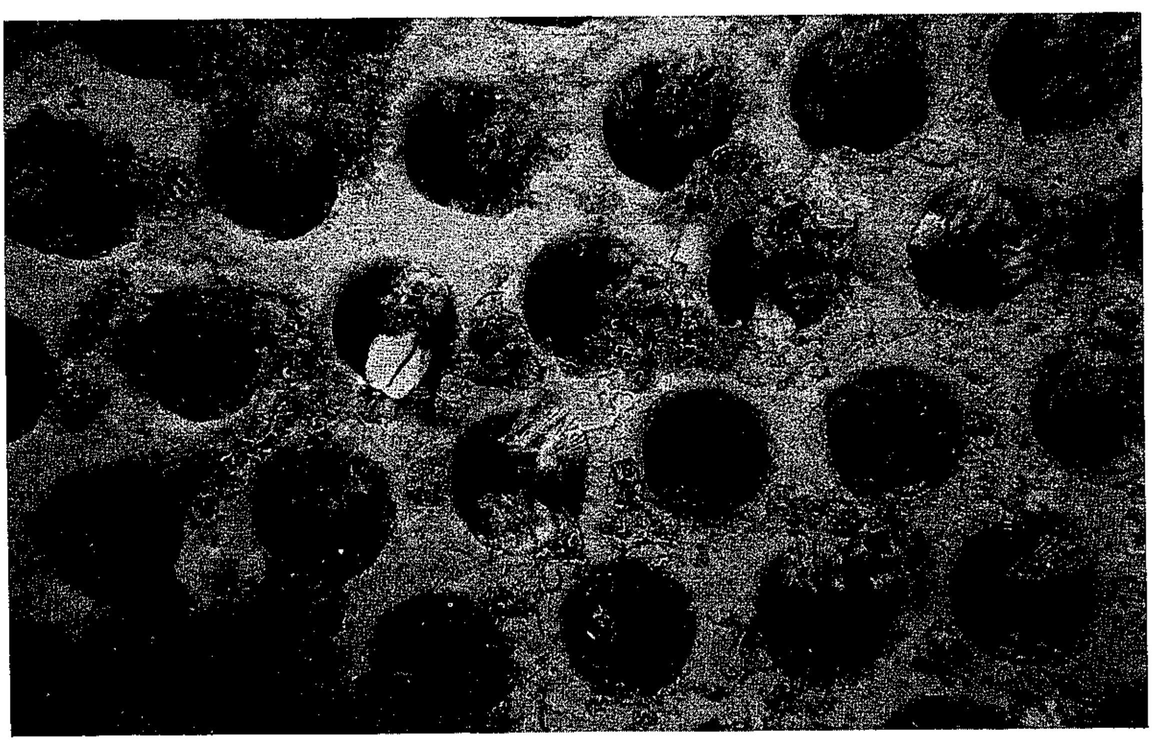

Figure 4. Round intake near stern, vessel 1 (frame size 18 x 12.5 cm).

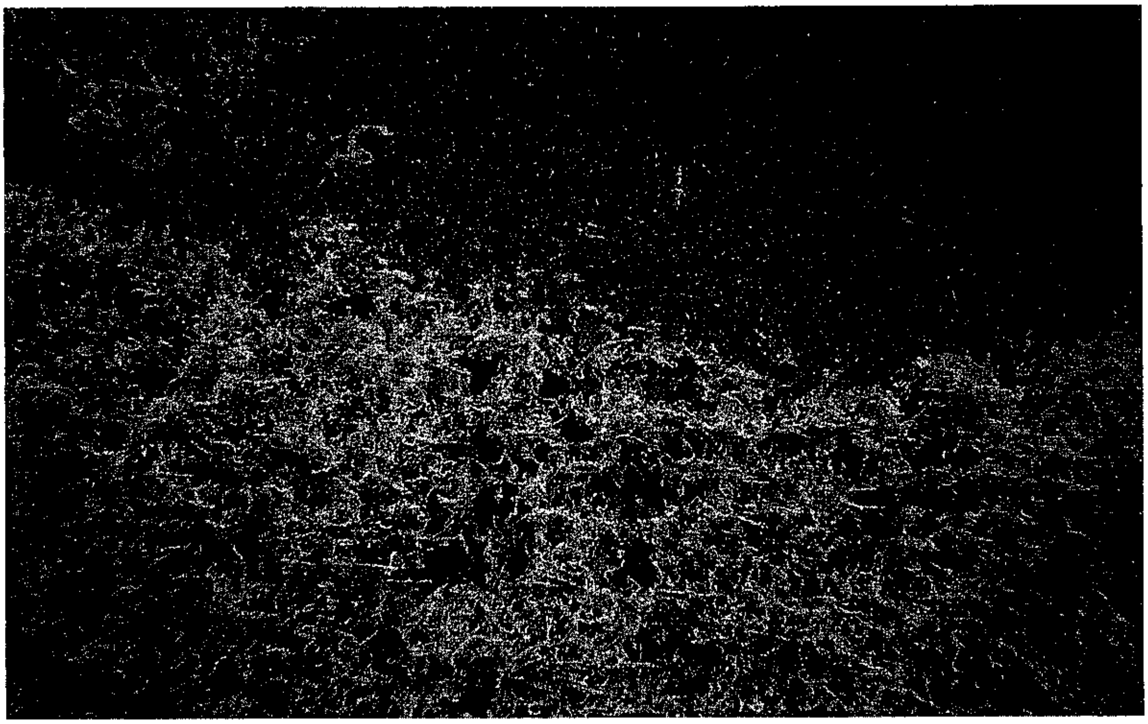

Figure 5. Filamentous green algae, hull side, vessel 2 (frame size 18 x 12.5 cm).

Figure 6. Damaged antifouling, hull bottom, vessel 2 (frame size 18 x 12.5 cm).

Figure 7. Propeller collar fouling, vessel 2 (frame size 18 x 12.5 cm).

Figure 8. Square intake near stern, vessel 2 (frame size 18 x 12.5 cm).

Figure 9. Stalked barnacles attached along hull welds, vessel 3.

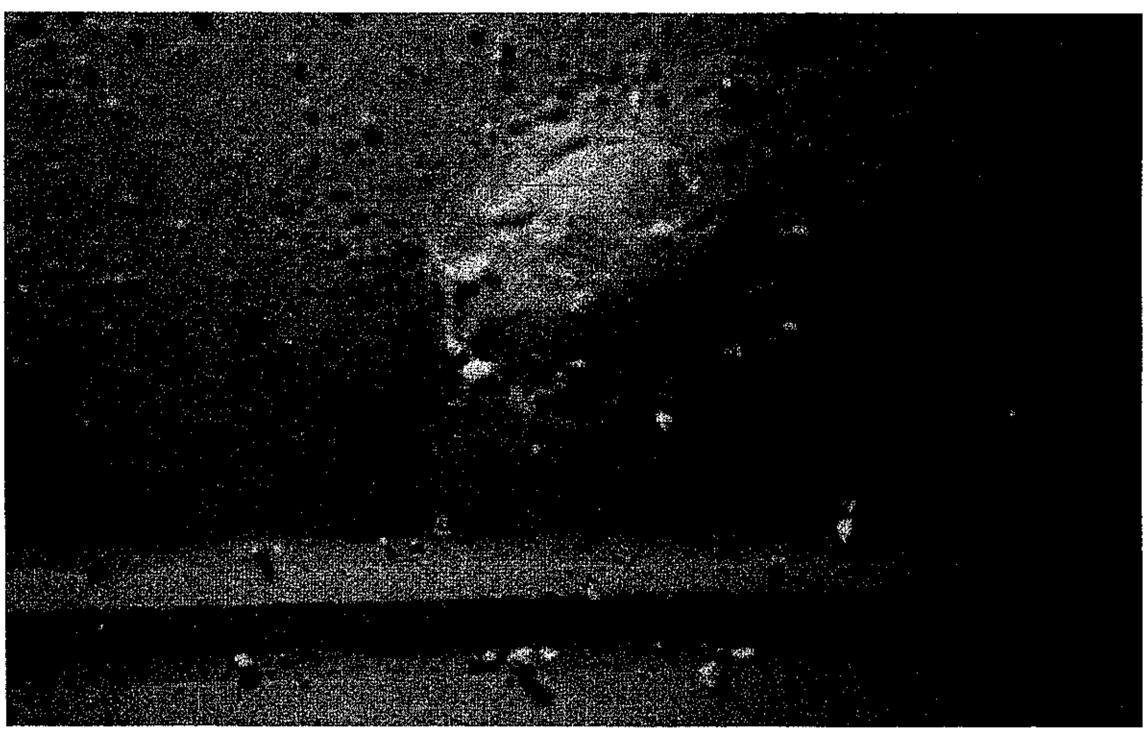

Figure 10. Stalked barnacles attached near raised hull features, vessel 3.

Figure 11. Fouling on the lower end of the rudder post, vessel 4.

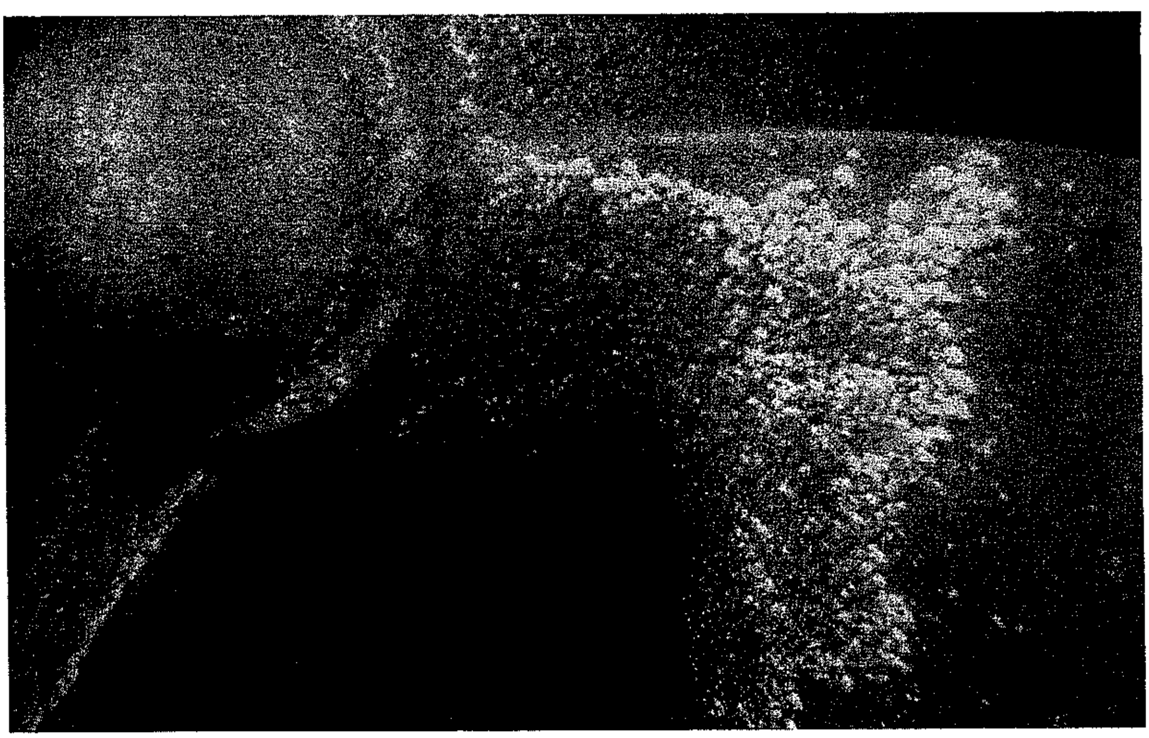

Figure 12. Propeller fouling, vessel 5.

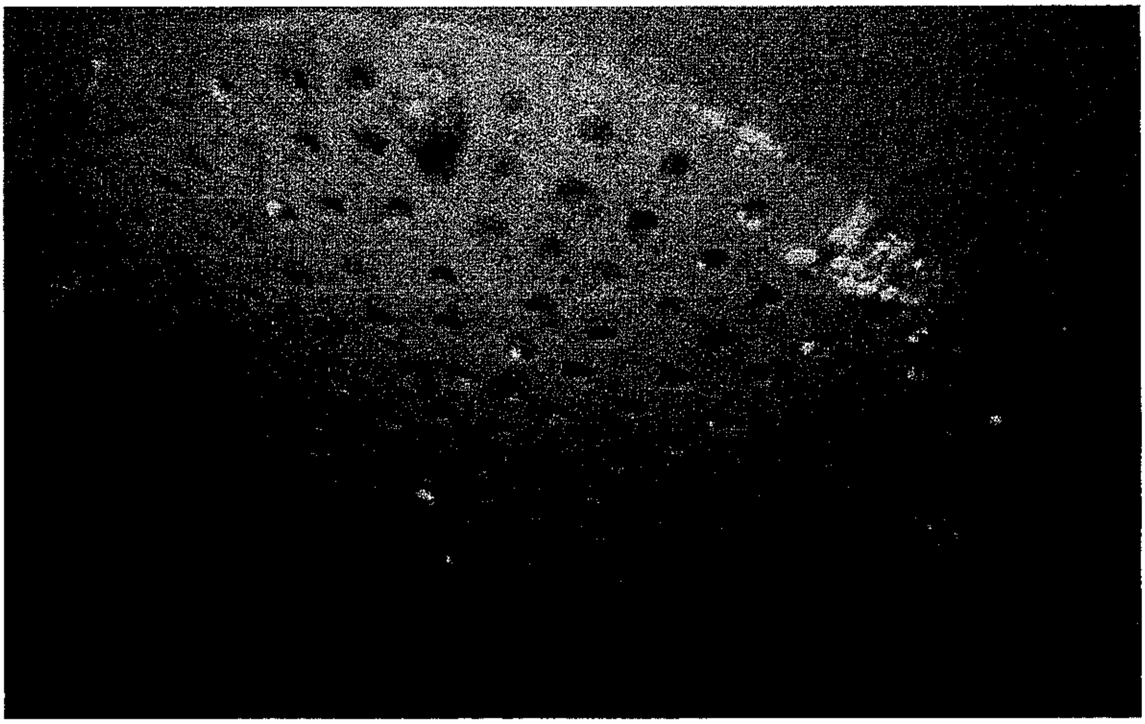

Figure 13. Fouling on and around intake cover plate, vessel 5.

Figure 14. Fouling around rudder area, vessel 6.

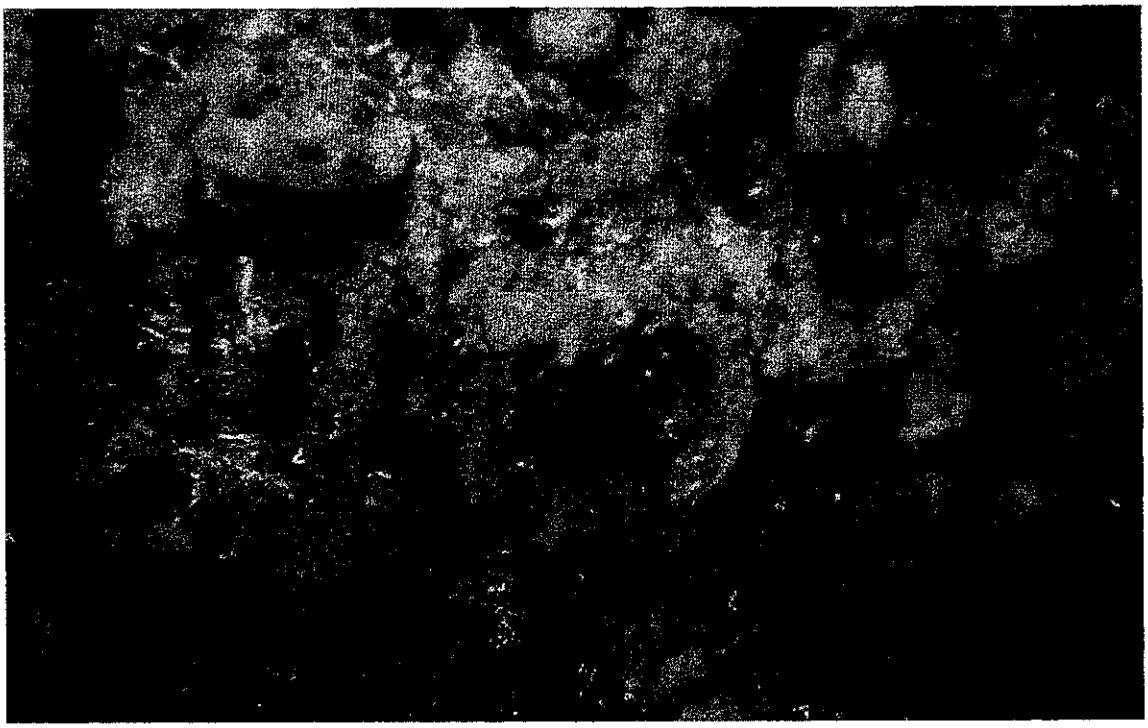

Figure 15. Hull fouling near stern, vessel 6.

Figure 16. Fouling on areas of the keel lacking antifouling, vessel 7.