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Behavioural observations on the scavenging fauna of the Patagonian slope

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The scavenging fauna of the Patagonian slope (900–1750 m), east of the Falkland Islands was investigated using the Aberdeen University Deep Ocean Submersible (AUDOS), an autonomous baited camera vehicle designed to photograph scavenging fish and invertebrates. The AUDOS was deployed on ten occasions in Falkland waters. Nine experiments were of 10–14 h duration and baited with 800 g of squid and one experiment lasted six days, baited with a 10 kg toothfish (*Dissostichus eleginoides*). Analysis of photographs revealed considerable patchiness in the composition of the scavenging fauna. Hagfish (*Myxine* cf. *fernholmi*) dominated three of the shallower experiments including the 6-d experiment, arriving quickly from down-current, holding station at the bait and consuming the soft tissues first, with consumption rates of up to 200 g h^{-1}. In the other experiments, stone crabs (Lithodidae), the blue-hake (*Antimora rostrata*) and amphipods were the primary consumers, but the rate of bait consumption was lower. Patagonian toothfish (*D. eleginoides*) were attracted to the bait at each experiment, but did not attempt to consume the bait. The patchiness in the fauna may be a result of depth, substratum and topography, but in general the rapid response of the scavenging fauna indicates that carrion is rapidly dispersed, with little impact on the local sediment community.

INTRODUCTION

The deep sea is characterized by low light levels, high pressure, low temperatures and relatively low food availability (Gage & Tyler, 1991). With the exception of hydrothermal vents and cold seeps the food supply to the deep sea is largely derived from fall-out from surface waters, although vertically migrating mesopelagic species may also be important (Mauchline & Gordon, 1991). Much of this fall-out comes in the form of marine snow, which in temperate latitudes arrives in a seasonal pulse following blooms in the plankton (Lampitt, 1985). Larger carrion, such as carcasses of fish, squid and marine mammals, although less predictable in timing, provide an important supplementary source of food, causing localized enrichment and changes in the benthic community (Isaacs & Schwartzlose, 1975; Jones et al., 1998; Smith, 1986; Stockton & Delacca, 1982). These larger carcasses are intercepted by mobile scavengers, that redistribute the material across the ocean floor making it available for less mobile and sedentary species (Collins et al., 1998; Jones et al., 1998). The dominant scavengers vary with depth; both Priede et al. (1994) and Desbruyeres et al. (1985) (cited in Britton & Morton, 1994) showed bathymetric zonation in scavenging fauna in the north-east Atlantic. At slope depths of 500–2000 m hagfish are among the most important scavengers (Isaacs & Schwartzlose, 1975; Smith, 1986) and where they are abundant may consume as much as 90% of the carcass (Smith, 1986).

The significance of food-falls to the benthic deep-sea community has been the subject of considerable debate (Jones et al., 1998; Smith, 1985; Stockton & Delacca, 1982), but in areas of fishing activity discards from fishing fleets are likely to be an important food source (Hill & Wassenberg, 1990; Jennings & Kaiser, 1998; Laptikovsky & Fetisov, 1999; Yamamura, 1997). The Patagonian slope is a productive area, supporting important fisheries for the squids *Illex argentinus* and *Loligo gahi* as well as teleost fish such as the hoki (*Macruronus magellanicus*), hake (*Merluccius australis* and *M. hubbsi*) and blue-whiting (*Micromesistius australis*) (Anon, 1997). In recent years fisheries have moved into deeper water with the establishment of a long-line fishery for the Patagonian toothfish *Dissostichus eleginoides* to the east of the Falklands (Des Clers et al., 1996) and these fishing activities are likely to influence the scavenging fauna, through the discarding of non-target species.

Little is known of the biology and ecology of the commercially important Patagonian toothfish or the other fauna of the Patagonian slope. Limited information is available from by-catch on long-liners and from a single experimental trawl survey (Coggan et al., 1996). The present study formed part of a programme to use arrival time at baits to estimate abundance of Patagonian toothfish using the Aberdeen University Deep Ocean Submersible (Yau et al., in press). Here we report on the composition and behaviour of the scavengers attracted to baits on the Patagonian slope.

MATERIALS AND METHODS

The Aberdeen University Deep Ocean Submersible (AUDOS) was deployed at ten stations to the east of the Falkland Islands in October 1997 (Figure 1; Table 1). The

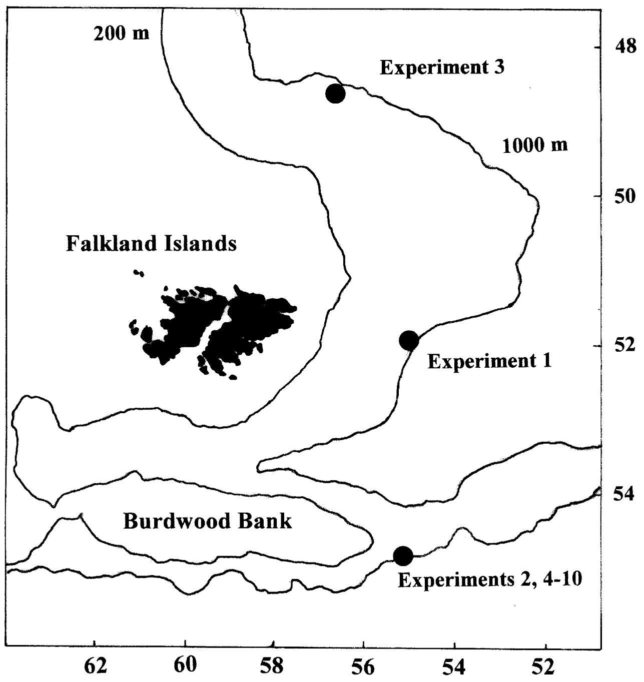

Figure 1. Map illustrating the location of the AUDOS experiments on the Patagonian slope to the east of the Falklands.

AUDOS is an autonomous lander vehicle designed to photograph and track scavenging fish and invertebrates on the sea-floor. It consists of an aluminium frame onto which are mounted a downward looking deep-sea camera (Ocean Instrumentation), a current meter (Sensortec), and twin acoustic releases (Mors) (Bagley & Priede, 1997; Collins & Bagley, 1999). The AUDOS is deployed by free-fall with 100 kg of ballast, which holds it in position on the sea-floor. The AUDOS frame is held 2 or 2.5 m above the ballast by a 100 m long mooring line, consisting of ten glass spheres (Benthos Inc. 17"). The AUDOS is released from the ballast by an acoustic signal from the ship at the end of the experiment and surfaces at a rate of 0.8 ms^{-1} under its own buoyancy. On the surface a marker buoy, attached to the end of the mooring, and incorporating a VHF radio beacon (Novatech), Argos satellite beacon (SIS) and large pink flag, aid in location and recovery. On the sea-floor an aluminium graduated cross, onto which the bait was mounted, was attached to the ballast in view of the camera. The cross and bait were thus approximately 50 cm above the sea-floor.

Experiment 1 was baited with a 10 kg toothfish and was deployed from the FV 'Argos Galicia' and retrieved ten days later by the MV 'Cordella' (Table 1). This experiment was designed to determine any patterns of succession in the scavenging fauna. Subsequent deployments and recoveries were made from the MV 'Cordella' and baited with four ×200 g squid (*Illex argentinus*). These experiments were intended to investigate the response of the mobile scavenging fauna to small food falls. In Experiment 1 the camera was mounted 2.5 m above the bait with a time-lapse interval of 10 minutes. For the shorter experiments the camera was 2.0 m above the bait and had a 1-min interval. Experiments 2–10 were conducted in areas targeted by the long-line toothfish fishery. The current meter failed to record current speed and direction, but did provide accurate data on temperature during each experiment. The strength of the current was estimated by the movement of ribbons attached to the cross and by the movement of the squid baits, hung from the cross (Table 1). If the ribbons were not moving the current was considered weak, moderate current caused the ribbons (but not the squid baits) to move and strong current forced the squid baits into a horizontal orientation (see Figure 2A).

Table 1. *Deployments of the AUDOS in Falkland waters in October 1997. Experiment 1 was baited with a 10 kg toothfish, with time-lapse interval of 10 mins and total duration of 144 hours. Experiments 2–10 were baited with four squid (*Illex argentinus*), with 1 min time-lapse and duration of 12–14 hours.*

Experiment	Date	Latitude	Longitude	Depth (m)	Bottom temperature (°C)	Current speed	Bait consumption and dominant scavengers
1	02/10/97	51 49.98 S	55 56.26 W	1100	2.4	Weak	Large numbers of hagfish. Bait consumed in 96 hours.
2	10/10/97	54 26.16 S	55 29.76 W	900	2.7	Very strong	AUDOS ballast dragged along sea-floor. Large numbers of hagfish. Bait consumed within five hours.
3	17/10/97	48 36.30 S	57 09.99 W	1047	2.6	Strong	Grenadiers and *Antimora rostrata*
4	14/10/97	54 25.94 S	55 24.56 W	1048	2.8	Moderate	Most of the bait consumed by hagfish.
5	11/10/97	54 35.35 S	55 10.14 W	1116	2.4	Very strong	Grenadiers, toothfish, little bait taken.
6	10/10/97	54 25.91 S	55 11.63 W	1148	2.65	Strong	Little bait consumed.
7	12/10/97	54 23.80 S	55 30.13 W	1179	2.3	Very strong	Crabs and grenadiers consumed much of the bait.
8	13/10/97	54 25.77 S	55 18.96 W	1212	2.5	Weak	Little bait consumed. Toothfish regularly seen.
9	10/10/97	54 41.65 S	55 19.29 W	1442	2.2	Moderate	Toothfish regularly seen. Bait mostly taken by crabs.
10	11/10/97	54 20.07 S	55 11.59 W	1735	2.1	Moderate	Little of the bait consumed.

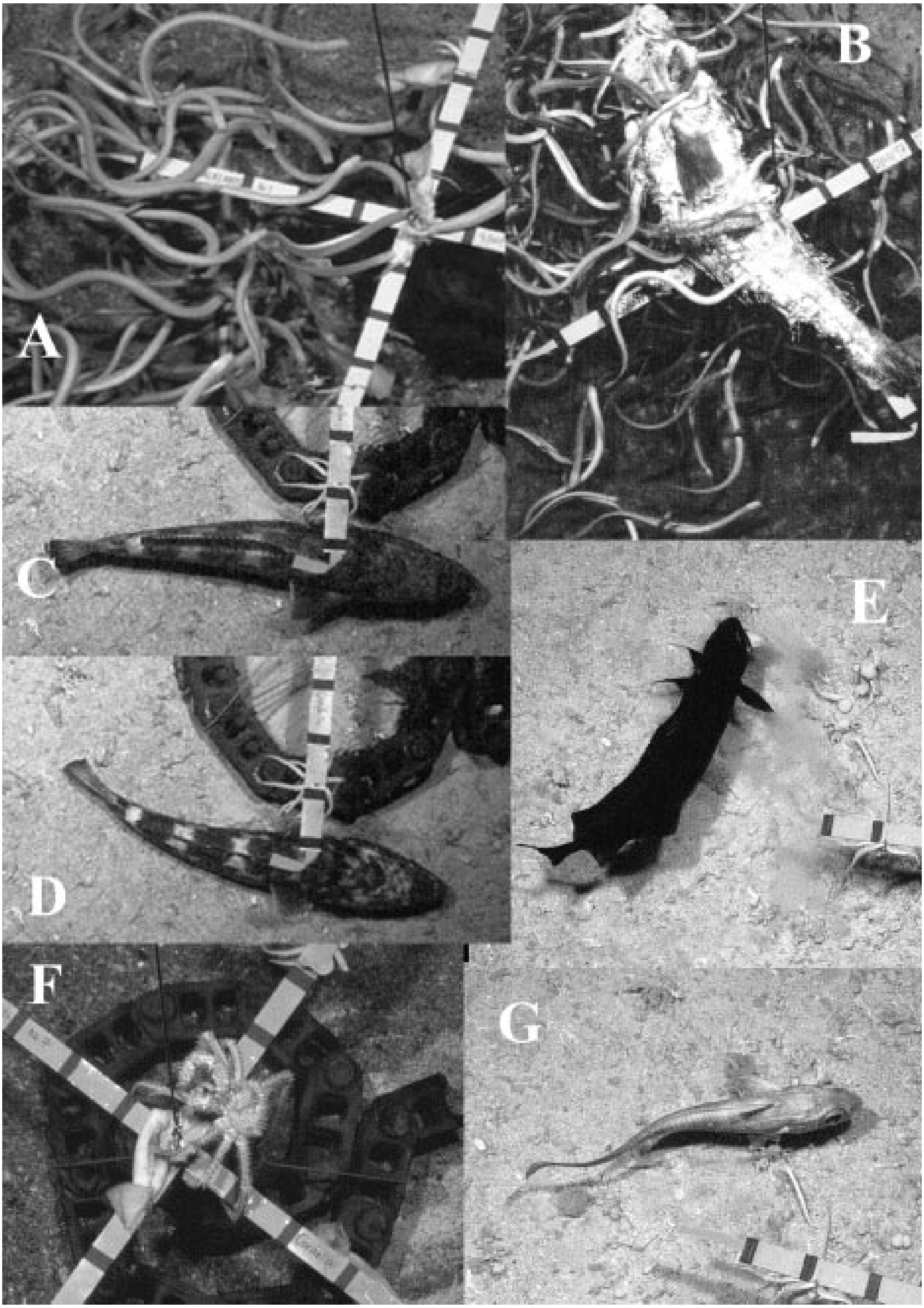

Figure 2. The principal scavenging species of the Patagonian slope (A) hagfish (*Myxine* cf. *fernholmi*) during Experiment 2; (B) hagfish (*Myxine* cf. *fernholmi*) during experiment 1, note hagfish entering the operculum and a toothfish in the background; (C,D) successive frames in Experiment 4, illustrating colour change in the Patagonian toothfish (*Dissostichus eleginoides*); (E) the blue-hake *Antimora rostrata* taking the mantle from the squid bait; (F) stone crab *Paralomis spinosissima*; (G) grenadier *Macrourus* sp.

The camera was loaded with Ektachrome 200 ASA colour positive film. Small strips of film were developed on board ship and the remainder was developed in the UK. Following processing the film was viewed on a microfilm viewer. Fish and invertebrates were identified using relevant texts (Gon & Heemstra, 1990; Macpherson, 1988; Norman, 1937) and from trawl caught specimens. Numbers of fish and invertebrates were counted in each frame and total lengths (TL) of fish were measured when they were level with the graduated cross or on the sea-floor (corrected for parallax).

RESULTS

The ten experiments covered a depth range of 900–1735 m (Table 1) and showed considerable variability in the scavenging fauna attracted and in the rate of bait consumption. At least nine species of fish, and three decapod crustacean species were attracted to the bait (Table 2).

Bait consumption

During Experiment 1 the camera took 800 frames of an area of sea-floor of approximately 4.5 m^2 during a period of 6 days. Hagfish (*Myxine* cf. *fernholmi*, see below; Figure 2A,B) were the dominant scavengers. The first hagfish did not arrive until three hours after the bait arrived on the sea-floor, but numbers subsequently accumulated to reach 150 in the field of view of the camera after 24 hours. The absolute number of hagfish was difficult to determine when they were at high density, but over 200 were visible in single frames (45 m^{-2}) (Figure 3). Numbers of hagfish in the field of view fluctuated, appearing to come in waves. Large numbers of amphipods were also visible around the eyes and head of the fish carcass but the absolute number and their role in consuming the bait could not be quantified.

Most of the bait was consumed within 90 h, with just the skin and bones remaining, equating to a consumption rate of approximately 100 g h^{-1}. The other fish that were regularly present around the bait were zoarcids, which were observed on the sea-floor close to the carcass, but did not appear to play a direct role in consuming it. There was a negative correlation ($r=-0.217$) between numbers of hagfish and numbers of zoarcids seen during Experiment 1 (see Figure 3). Toothfish, *Dissostichus eleginoides*, (Figure 2C,D), blue hake, *Antimora rostrata*, (Figure 2E) and grenadiers, *Macrourus* sp., (Figure 2G) were also photographed around the carcass.

During Experiments 2–10 the camera photographed an area of sea-floor of approximately 4 m^2. Here the rate of bait consumption and the scavengers responsible varied considerably (Table 2). The only scavenger seen in all experiments was the toothfish (*D. eleginoides*), but it was never seen directly consuming the bait. The main consumers of the bait were hagfish (*Myxine* cf. *fernholmi*) and stone crabs (Lithodidae). Two of the shallower experiments (2 and 4) were dominated by hagfish, with observed maxima of 135 and 18 individuals respectively, here the bait was consumed within four hours (200 g h^{-1}) after which the hagfish dispersed (Figure 4). Experiment 3, also at shallow depth, attracted only three hagfish but was in a different geographical location (Figure 1). During two of the deeper experiments (7 and 9) stone crabs of the genus *Paralomis* (Figure 2F) climbed onto and consumed much of the bait, but in the other deployments little of the bait was consumed within the experimental period (10–12 hours). During the deepest experiment (10) at 1735 m little of the bait was consumed, with *D. eleginoides* and *A. rostrata* the most common species.

Hagfish behaviour

Hagfish were seen during six of the experiments and were particularly abundant during Experiments 1 and 2. No hagfish were seen at the two deepest stations (9 and 10). Species identification of the hagfish was not possible, though it is likely that they were *M. fernholmi*, distinguished

Table 2. *Scavenging species identified from photographs taken by the AUDOS system in October 1997 east of the Falkland Islands on the Patagonian slope. Grenadiers* Macrourus holotrachys *and/or* M. carinatus.

Species	Common name	1	2	3	4	5	6	7	8	9	10
		Numbers of individuals/visits									
Dissostichus eleginoides	Toothfish	9	1	13	6	9	13	8	15	19	11
Macrourus spp.	Grenadier	8	3	4	4	3	—	7	3	1	—
Antimora rostrata	Blue hake	5	—	17	4	—	—	8	—	—	4
Somniosus microcehalus	Sleeper shark	1	—	—	—	—	—	—	—	—	—
Lycodapus cf. *australis*	Zoarcid	—	—	—	1	—	1	8	1	—	—
Unidentified zoarcids	Zoarcid	9	—	—	3	2	3	2	—	—	—
Graneledone sp.	Octopod	—	1	—	—	—	—	—	—	—	—
Mancopsetta/Paralichthys	Flatfish	—	—	—	—	—	1	—	—	—	—
		Maximum numbers in any frame									
Myxine cf. *fernholmi*	Hagfish	200*	131	3	19	—	—	1	3	—	—
Paralomis cf. *spinosissima*	Stone crab	—	—	—	—	—	2	—	—	—	—
Paralomis cf. *formosa*	Stone crab	—	—	—	—	1	—	2	1	5	1
Careproctus sp.	Liparid	—	—	—	—	—	—	—	1	2	
Thymops birsteini	Decapod prawn	3	1	—	—	2	2	2	—	—	5

*Approximate value (see text)

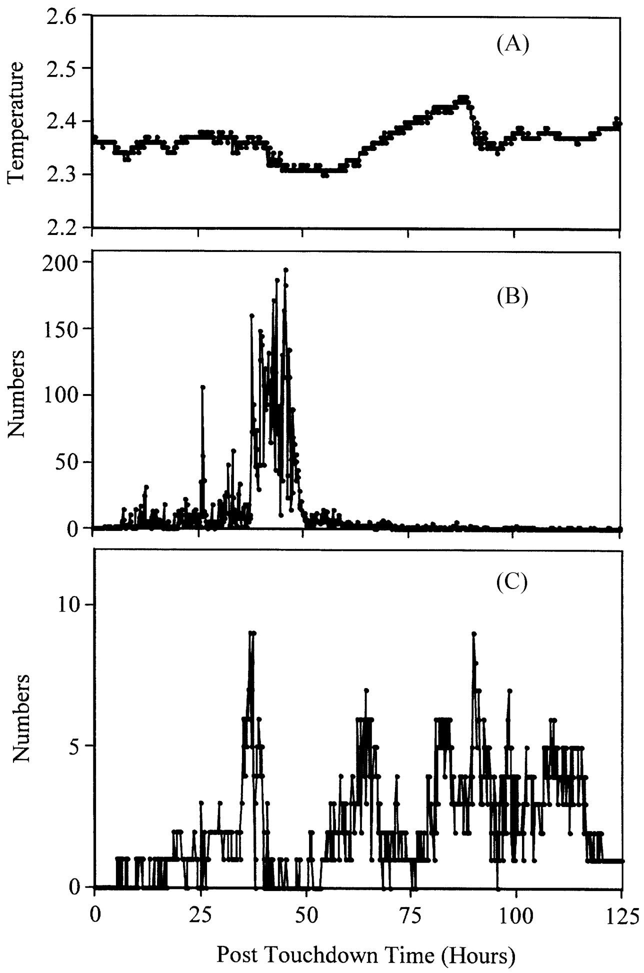

Figure 3. Temperature (A); numbers of hagfish (B); and numbers of zoarcids (C) at bait during Experiment 1, baited with 10 kg toothfish and with a time-lapse interval of ten minutes. Duration six days.

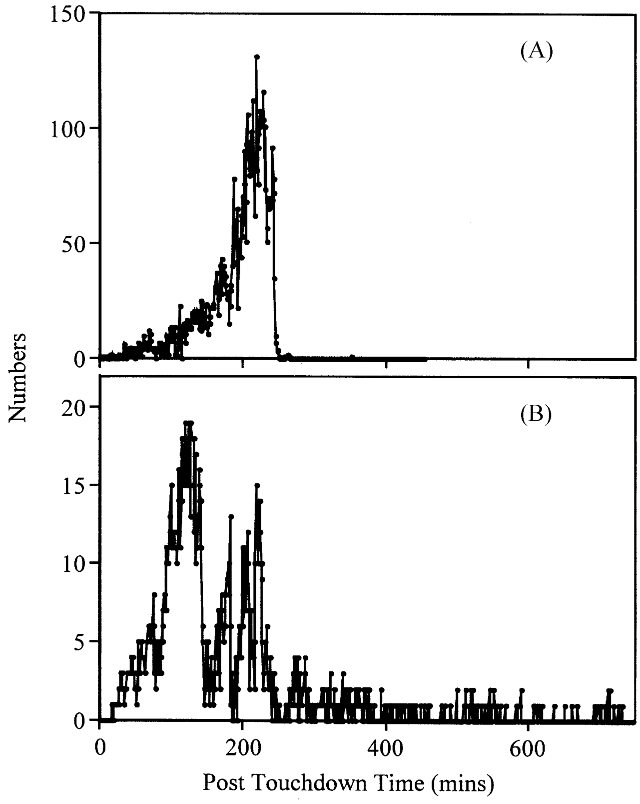

Figure 4. Numbers of hagfish at bait during two of the short-term experiments (A) Experiment 2; (B) Experiment 4.

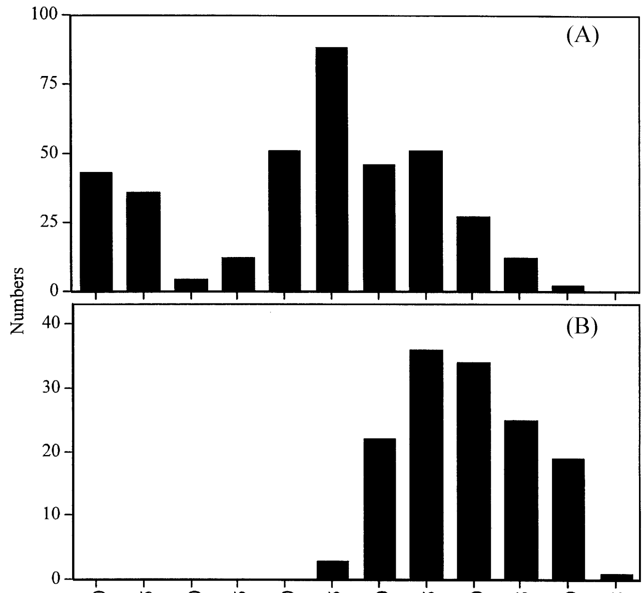

Figure 5. Length frequency of hagfish (*Myxine* cf. *fernholmi*) during Experiment 1 (A); and during Experiment 2 (B).

by a prominent ventral fin-fold that was clearly visible in the photographs (see Fernholm, 1998; Wisner & McMillan, 1995). *Myxine knappi* and *M. dorsum* are also described in Falkland Island waters, but have a very small ventral fin-fold and are not reported at depths greater than 650 m (Wisner & McMillan, 1995). It is, however, possible that more than one species was present, particularly during the long deployment when two size-classes of hagfish were present (see below).

Hagfish typically arrived at the bait from down-current a few minutes after the lander touched down on the sea-floor. In Experiments 2 and 4, the numbers of hagfish then increased rapidly as they appeared to take up residence at the bait (Figure 4). Hagfish consumed the soft parts of the bait first, entering the toothfish bait through the opercular opening (Figure 2B), the eyes, mouth and anus and entering the mantle cavities of the squid bait. During Experiment 1 three hagfish were seen with their heads buried in the operculum of the toothfish bait at the same time (Figure 2B). One hagfish remained with its head buried in the operculum for four consecutive frames (equivalent to 40 minutes). A single incident of knotting behaviour was seen during Experiment 1, with the hagfish tying itself in a knot, presumably to rip flesh from the carcass.

During Experiments 2 and 4 there was a single size mode of large hagfish present of mean total length (TL) ~500 mm (Figure 5). In the longer experiment, two size modes (110 and 370 mm TL) were present, but it was not clear if these represent different species or different size classes of the same species. The larger hagfish arrived first at the bait.

Toothfish (Dissostichus eleginoides)

Toothfish (Figure 2C,D) were seen during all experiments arriving, on average, after 59 minutes. The numbers of toothfish seen ranged from one (Experiment 2) to 19 (Experiment 9) (Table 2). The maximum number of toothfish in any frame was two. Toothfish were attracted to the bait, but did not appear to show much interest after arrival. Some individuals were observed circling around and swimming under the cross, but were never seen attempting to take the squid bait. When toothfish did appear, they frequently departed before the subsequent frame. Less commonly, an individual remained in the frame for a few minutes (maximum duration 13 min) and occasionally individual toothfish appeared, left the immediate area and returned repeatedly. The toothfish that stayed did not continue circling but usually settled onto the sea-floor and remained in one position for subsequent frames until their departure (e.g. for 12 min in Experiment 6).

Individual toothfish were sometimes identifiable from white scar lines, scratches or white spots on the dorsal surface of their heads. The 'normal' coloration of toothfish on first appearance at the bait was a more or less uniform olive-grey, though faint, paler bands may be visible. However, a sudden and at times quite dramatic increase in the contrast of the bands was sometimes observed if the toothfish remained in frame for more than a minute or two. Pale markings were also visible on the dorsal surface of the head after these colour changes. The increase in the banding contrast has been observed between consecutive frames (Figures 2C,D) and must therefore occur within a minute or less.

A total of 93 toothfish were seen in the photographs, but not all could be accurately measured since they were not fully in the frame or were not at the level of the graduated cross. The mean TL of fish was 780 mm, with a range of 520–1160 mm (Figure 6).

Lithodid crabs

Two species of stone crabs (Lithodidae), *Paralomis* cf. *spinosissima* and *P.* cf. *formosa* (Figure 2F) were seen during the experiments. *Paralomis* cf. *formosa* was common in the deeper experiments, with five seen together at the bait in Experiment 9. *Paralomis* cf. *spinosissima* was only seen during Experiment 6. The crabs arrived from down current and initially had difficulty gaining direct access to the bait, but eventually climbed up the ballast and were able to consume the bait. During Experiments 7 and 9 the *P.* cf. *formosa* were responsible for much of the bait consumption.

Other fauna identified from photographs

Grenadiers (*Macrourus holotrachys* and/or *M. carinatus*) (Figure 2G) appeared in all but two of the experiments (Table 2) and remained around the bait for many frames, often circling around the cross and investigating the bait. They did not appear to be affected by the camera flash. *Antimora rostrata* (Figure 2E) appeared in five experiments (Table 2), were regularly seen during Experiment 3 and like the grenadiers, they often remained in the vicinity of the bait for extended periods. The grenadiers and *A. rostrata* were photographed taking the squid bait.

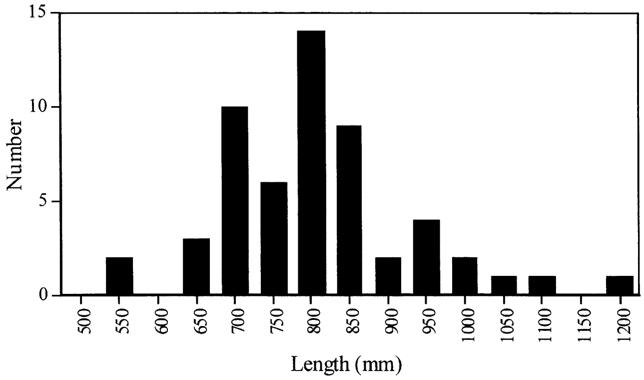

Figure 6. Length frequency of toothfish (*Dissostichus eleginoides*) measured during AUDOS deployments.

Other species identified included a sleeper shark (*Somniosus microcephalus*) with TL in excess of 2.5 m observed in one frame during Experiment 1. An octopod (*Graneledone* sp.) was seen in Experiment 2, and the prawn *Thymops birsteini* was photographed in seven of the experiments. Two species of zoarcids were seen, but could not be identified.

DISCUSSION

The scavenging fauna of the Patagonian slope showed considerable variability, even within limited geographic and bathymetric ranges. Hagfish were the dominant scavengers at the shallower locations (900–1100 m) but their distribution was patchy and they were absent from the two deepest stations. Stone crabs, grenadiers (*Macrourus* sp.) and the blue hake (*Antimora rostrata*) were the main consumers of the bait in deeper waters. The patchy distribution of the scavenging fauna may be a consequence of the complex topography of the area, depth, current strength, substratum type or temperature. The topography and current speed probably influence the spread of the odour from the bait, and if the odour plume leaves the sea-floor it is unlikely to attract the hagfish or crabs, which are exclusively benthic. Martini (1998) suggested that depth *per se*, does not limit hagfish distribution, but that temperature and substrate may be more important. Hagfish of the genus *Myxine* typically prefer soft sediments into which they can burrow easily and temperatures greater than 4°C (Martini et al., 1997; Martini, 1998). Temperature may be important here, since it was at the two warmer stations (see Table 1) that the hagfish arrived quickly, and it may be that this species prefers temperatures greater than 2.5°C. During 14 similar experiments around South Georgia, where bottom temperature was below 2°C, hagfish were not present (M.A.C., unpublished data). Other species of hagfish are, however, known to tolerate very low temperatures such as *M. glutinosa* in the Faroe–Shetland Channel (M.A.C., unpublished data).

In general the bait was consumed rapidly, suggesting that any carrion arriving on the sea-floor is rapidly dispersed. When hagfish were present the rate of bait consumption was particularly rapid, 200 g h^{-1} in Experiments 2 and 4 and 100 g h^{-1} in the Experiment 1. The slower consumption rate in Experiment 1 was due to the slow initial arrival of the hagfish. Rates of consumption by hagfish were similar to those observed by Smith (1985) for the hagfish *Eptatretus deani* at 1300 m the Pacific Ocean, whilst Jones et al. (1998) found similar consumption rates by grenadiers (*Coryphaenoides armatus*) and amphipods consuming cetacean carcasses at abyssal depths in the north-east Atlantic. In the absence of hagfish, consumption rates were considerably slower, with the bait appearing untouched after 12 h in Experiments 5, 8 and 10.

Large numbers of hagfish arrived at the 10 kg toothfish carcass in Experiment 1 and again around the squid bait in Experiment 2. The total number of hagfish attracted to the food-falls was difficult to quantify. Individuals may feed to satiation and then burrow locally, thus the large numbers seen in Experiment 1 may represent a 'conveyor belt' of hagfish, with departure rate equalling arrival rate. Alternatively the hagfish may display roosting, or topping up, behaviour in which the hagfish return regularly to the bait to keep their stomachs full, as Smith (1985) described in the hagfish *E. deani* in the Pacific.

The rapid arrival of the hagfish during Experiments 2 and 4 indicated high local abundance and strong swimming ability. Hagfish are reported to be weak swimmers (Adam, 1960; Davison et al., 1990; Martini, 1998) but during Experiment 2 the 100 kg AUDOS ballast was dragged across the sea-floor indicating a current speed in excess of $25\,\mathrm{cm\,s^{-1}}$ and probably closer to $50\,\mathrm{cm\,s^{-1}}$ (AUDOS has previously been deployed at current speeds up to $20\,\mathrm{cm\,s^{-1}}$, without being moved). Hagfish swam against this current to arrive at the bait, indicating that they were capable of swimming at speeds in excess of the current. It is likely that the hagfish take advantage of reduced current velocities close to the sea-floor, but nevertheless this study indicates they are capable swimmers. Martini (1998) suggested that the slow swimming speed of hagfish prevents their penetration into high current areas, but the evidence of this study indicates that some species of hagfish are capable of living in high current areas. The large hagfish seen during Experiments 2 and 4 were at the upper end of the size spectrum seen in Experiment 1 and the difference in size may be a consequence of current speed and the size of the carcass. In Experiments 2 and 4 the strong current may have prevented all but the largest hagfish from reaching the bait. In Experiment 1 the current was weak, and the bait remained longer, allowing small hagfish to reach it.

The slow initial arrival of the hagfish in Experiment 1 is probably indicative of low abundance in this area, whilst the large number of hagfish ultimately attracted to the bait is probably an indication of the area of influence of the odour plume. Abundance of scavenging fishes, such as hagfish, can be estimated from first arrival time at bait (Priede & Merrett, 1996) or from modelling the odour plume (Sainte-Marie & Hargrave, 1987), but both methods require a knowledge of current speed and fish swimming speed, which are lacking here.

The hagfish gained access to the soft parts through the operculum of the fish (Figure 2B) or the mantle aperture of the squid, there was only one detected incident of knotting behaviour during feeding by the hagfish. Knotting behaviour, where the hagfish attaches itself to prey with its toothplates and ties itself in a knot to rip part of the prey away, may only be used when the hagfish cannot get easy access to soft tissue (Martini, 1998). During Experiment 1 it appeared that the zoarcids avoided the bait when the hagfish were present in large numbers. The zoarcids may be affected by slime production from the hagfish, which is reported to block the gills of many teleost fishes (Isaacs & Schwartzlose, 1975; Smith, 1985). However other species were seen around the bait at the same time as the hagfish, including toothfish, grenadiers and blue-hake.

Toothfish (*Dissostichus eleginoides*) were the second most abundant species seen in the photographs, and were seen in every experiment indicating an extensive depth range (900–1735 m). Although toothfish were attracted to the bait, there was no evidence that they attempted to consume it. Long-liners operating in the same area use the same species of squid (*Illex argentinus*) as bait to catch toothfish, so there must be factors associated with the AUDOS experiments that prevent the toothfish from taking the bait. The fact that the toothfish change colour, possibly in response to the photographic flash, suggests that they are sensitive to the flashlight. It has recently been shown that hydrothermal vent shrimps may be blinded by flashlights from submersibles (Herring et al., 1999) and the same may be true for deep-sea fish. Future work on toothfish should utilize low light level video camera technology to negate possible effects of the flashlight.

The blue hake, *A. rostrata*, seen in four experiments here, has also been photographed at baits in the north-east Atlantic (Priede et al., 1994). Coggan et al. (1996) reported *A. rostrata* in trawls at depths greater than 736 m on the Patagonian slope, with the higher catches at deeper stations (~1000 m). The grenadiers *Macrourus holotrachys* and/or *M. carinatus* were regularly seen at bait, but could not be distinguished in the photographs. Coggan et al. (1996) found *M. carinatus* abundantly throughout the depth range surveyed (476–1018 m), but *M. holotrachys* was only abundant at the deeper stations. The single incidence of the sleeper shark (*Somniosus microcephalus*) is interesting, this species is rarely seen, but has occasionally been taken by long-liners operating in the area (C.P.N., personal observation).

The lithodid crabs (*Paralomis spinosissima* and *P. formosa*) were not seen during experiments where hagfish were common, which may be due to different substratum preferences. Macpherson (1988) reported that *P. spinosissima* occurred between 132 and 650 m around the Falklands, so if our identifications are correct it represents a considerable extension of the bathymetric range of this species. *Paralomis formosa* is known from depths of 400–1600 m on the Patagonian slope and around South Georgia and the South Orkneys (Macpherson, 1988). Around South Georgia the stone crabs *Paralomis* and *Paralithodes* were the dominant scavengers at 700–1400 m (M.A.C., unpublished data) Coggan et al. (1996) found the stone crab *Lithodes antarctica* at 476–1018 m on the Patagonian slope, but he did not record either species of *Paralomis*.

The results of this study indicate a diverse scavenging fauna on the Patagonian slope. The patchiness in the fauna may be attributable to differences in depth and sediment type. The response of the scavenging fauna to the arrival of carrion was usually rapid, particularly in areas of hagfish abundance and even in Experiment 1, when hagfish were slow to arrive, the 10 kg bait was consumed within 90 hours. This suggests that any carrion arriving on the sea-floor will be rapidly dispersed with little impact on the benthic sediment community.

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