PROJECT REPORT

THE PATAGONIAN SQUID (DORYTEUTHIS GAHI) HAS SPAWNING PLASTICITY IN DEPTH AND SUBSTRATE USE

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Cover photo © SMSG. Photography by SMSG. A Patagonian squid attaches a squid egg mass to a giant kelp.

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1. ABSTRACT

The Patagonian longfin squid (*Doryteuthis gahi*) is an important squid around the Falkland Islands where it plays an influential role in the food web and supports an important fishery. *D. gahi* has an unusual loliginid spawning behaviour in that it attaches its egg masses to kelp, in contrast to usual loliginid behaviour of attaching egg masses to hard bedrock seafloor. However, cephalopod life history is characterized by its flexibility. It is possible that *D. gahi* uses bedrock for egg laying too, and potentially in deeper waters. However, mesophotic environments (20 - 150m) have not been studied well in the Falkland Islands as it is beyond standard scuba depth limits. Here, we report on a drop camera survey that characterizes the mesophotic inshore areas of the Falkland Islands and demonstrates that *D. gahi* indeed uses deeper, hard substrate areas to attach their egg masses to. Further, the survey indicated common appearances of slow-growing, frame-building bryozoans (*Microporella* sp.), indicating an area of potential scientific interest. These findings have management implications for the Falkland Islands inshore habitats.

2. INTRODUCTION

The cold-adapted Patagonian longfin squid (*Doryteuthis gahi*) is an important species in the Falkland Islands. *D. gahi* distribution ranges along the coast of Chile in the South Pacific Ocean, and along the coast of southern Argentina and around the Falkland Islands in the South Atlantic Ocean (Carrasco et al. 2021; Jones et al. 2019). In the Falkland Islands waters, *D. gahi* plays a crucial role in the marine food web by being a voracious predator on zooplankton communities, while also being an important prey for many fishes, pinnipeds, and seabirds (van der Grient et al. 2023). The influence and control of *D. gahi* on the food web makes it a candidate for the designation of a wasp-waist species (Bakun 2006). In addition, it is a species of commercial interest to the Falkland Islands, with yearly catches that can exceed 60,000 mt (FIG 2023). Further, *D. gahi* caught around the Falkland Islands support one of the most important loliginid fisheries in the world (Arkhipkin et al. 2006). Maintaining and sustainably managing this fishery is therefore important for the Falkland Islands. This requires an understanding of the life history of this species. Cephalopod life history is dependent on environmental conditions (Forsythe 1993, 2004; Moreno et al. 2007; Pecl & Jackson 2008). It is possible that changes in environmental conditions may affect *D. gahi* life history, which could impact commercial catches. Therefore, understanding whether there is plasticity in its life history is important for fisheries management.

The Falkland Islands inshore kelp forests are known spawning and nursery areas for *D. gahi,* where the squid lay egg masses on kelp stipes (*Macrocystis pyrifera* and *Lessonia* spp.), often 0.5-2.5 m off the bottom and at 8-20 m depth (Arkhipkin et al. 2000). It is unknown whether the Falkland population uses structures other than kelp styles, although incidental observations suggest that squid may lay egg masses on rocky substrate and in deeper waters, which is common laying behaviour in other loliginid species (Laptikhovsky 2008; *P. Brickle*, *personal communication*). Identifying such behaviour would allow for a more comprehensive understanding of recruitment opportunity to the population. If *D. gahi* also lays egg masses in deeper waters on the seafloor, this would suggest that there is plasticity in the population in terms of where they lay their eggs and their potential spawning areas.

The Falkland Islands inshore waters are known to host diverse communities, but these studies are often restricted to scuba-dive depth limits (Beaton et al. 2020; Goodwin et al. 2014; Figuerola et al. 2017). Limited knowledge is available for mesophotic habitat between 20-150 m (Bax et al. 2022). As this may, however, be an area that *D. gahi* uses for spawning, it would be useful to understand if and how *D. gahi* selects such an area for egg laying. For example, this could depend on the biological community present. Here, we investigate an area between 40-50 m depth on the east coast of the Falkland Islands to (i) characterise the biological community present, and (ii) determine whether *D. gahi* uses this deeper, hard substrate area for laying egg masses.

3. METHODS

Study area

Berkeley Sound is located on the east coast of East Falkland. The Sound varies in depth, ranging from 5 m on the west side, to 55 m depth on the east, and both hard and soft bottom areas have been recorded in the Sound. An area that was suspected to contain hard substrate at depths between 40-50 m was further investigated with a side-scan survey on the *RV Jack Sollis*. The side-scan data confirmed the presence of a hard substrate structure north of Kidney Island, located on the southside of Berkeley Sound entrance. This area was targeted for further biological investigation.

Transect design

A drop camera survey was conducted on 11 June 2023 on the *RV Jack Sollis*, using a semi-stratified sampling regime to cover a larger ground where hard and soft bottom areas are known occur (Figure 1). In total, 15 transects were conducted, using a Netview X camera (Table 1). The camera was lowered slowly to the seafloor until it touched the bottom, raised for 1-2 m and held there for 5 seconds, and then raised again for 1-2 m to avoid getting it entangled in unknown structures at could be present on the seafloor. The vessel, which did not possess a dynamic positioning system, was allowed to semi-drift with the current; the engines were used to ensure that the drift did not go faster than 0.3-0.4 knots as much as possible. The local current determined the direction of the transect. During each transect, the camera was lowered ten times to the seafloor, and between drops the ship was allowed to drift for roughly 1 minute. Note that transect 1 was conducted last as this station had to be repeated because the first attempt did not provide adequate imagery data.

Habitat and biological identification

The seabed composition was initially described from the imagery data and then classified according to common patterns (Table 2). Epibenthic organisms were identified in the video data obtained for each transect to the lowest taxonomic level as much as possible. The influence of the swell and drop meant that the camera was not at a consistent height, and therefore a qualitative presence/absence score for species was used within each transect. With each drop, the seafloor and its potential biological community was visible, but in many cases the seafloor was also visible between drops. These fragments allowed to determine clips, which were continuous imagery data of the seafloor and its epibenthic community and which could potentially contain one or more drops. Last, in each clip the presence or absence of squid egg masses was scored.

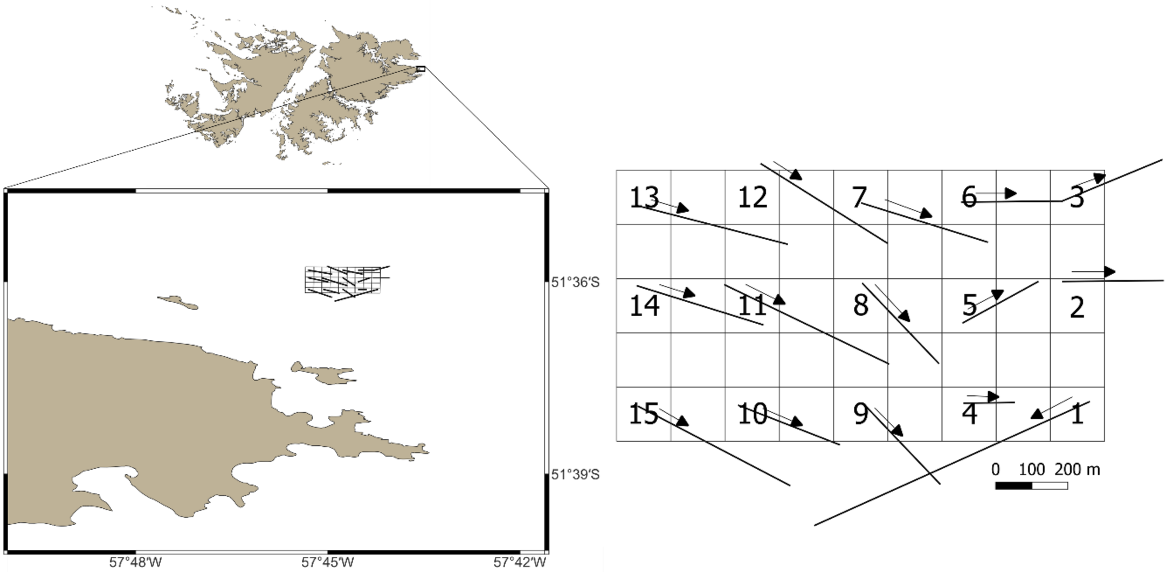

Figure 1. Location of the study area in Berkeley Sound, East Falklands, and length and direction (indicated by arrows) of transects as determined by local current regimes for the sampled stations. Transects are numbered according to the numbered grid it started from. Grid size is 150 by 150 m.

Table 1. Deployment and recovery information for each sampled transect. Note that transect 1 was sampled last as the first attempt did not provide adequate imaging data. Depth data obtained from shipboard data.

	Deployment				Recovery			
Transect	Latitude	Longitude	Depth	Time	Latitude	Longitude	Depth	Time
1	51°36.146	57°44.241	47.6	16:51	51°36.286	57°44.891	50.2	17:06
2	51°35.966	57°44.274	48.5	11:05	51°35.913	57°44.042	49.5	11:23
3	51°35.808	57°44.259	50.0	11:28	51°35.753	57°44.013	51.2	11:47
4	51°36.127	57°44.514	47.3	12:02	51°36.117	57°44.411	47.6	12:21
5	51°35.970	57°44.515	47.6	12:27	51°35.943	57°44.333	48.7	12:44
6	51°35.807	57°44.494	48.3	12:50	51°35.838	57°44.255	49.6	13:07
7	51°35.814	57°44.774	46.7	13:14	51°35.861	57°44.487	47.6	13:32
8	51°35.968	57°44.773	46.4	13:40	51°36.044	57°44.583	47.0	13:57
9	51°36.146	57°44.765	45.6	14:02	51°36.213	57°44.582	46.3	14:20
10	51°36.135	57°45.036	44.8	14:28	51°36.207	57°44.827	46.1	14:47
11	51°35.951	57°45.091	45.9	14:54	51°36.069	57°44.722	46.2	15:11
12	51°35.787	57°45.022	46.6	15:19	51°35.899	57°44.676	47.2	15:34
13	51°35.816	57°45.316	45.2	15:43	51°35.888	57°44.942	45.9	16:00
14	51°35.966	57°45.271	44.8	16:09	51°36.028	57°45.013	44.8	16:23
15	51°36.133	57°45.309	43.7	16:28	51°36.213	57°44.963	44.6	16:45

Statistical analyses

Biological community similarity was calculated for each clip using the Jaccard distance method for the presence/absence data. Differences in community composition based on the clip data were visualised via non-metric dimensional scaling, with ellipses indicating either station or habitat similarity. An ANOSIM test (permutations = 9999) was conducted to determine whether distances between groups were greater than within groups, where groups consisted of either transects or habitat classification. A PERMANOVA test (permutations = 9999) was conducted to test for differences in the distance or similarity between transects and habitat classification, with the initial model containing an interaction between these two factors.

Table 2. Habitat description and classification

Habitat description	Class
Hard substrate covered with sediment and shells, outcrops/3D formed by either hard substrate or parchment-worm tube aggregations	1
Mainly sediment with lots of shells, few small rocks present	2
Sediment	3
Hard substrate covered with sediment and shells; outcrops/3D structure formed by hard substrate present	4
Hard substrate covered with sediment and shells, no/not much 3D structure present	5
Mainly sediment, interspersed with 3D rock structures	6
Camera too high to tell	0

4. RESULTS

Drop and clip data

Across the 15 transects, video imagery data of the seafloor was obtained for a total length of 5855 s (~98 minutes) across 153 clips (Table 3). The number of drops observed in the transect videos did not always correspond to the number that was aimed for during the conduction of the transects. This was influenced by changes in the local bathymetry, with depth ranges within transects could varying between 6 and 13 m (Table 3). Median depth of the drops within a transect decreased from east to west, and, to a lesser extent, from north to south in the study area. Cumulative length of video imagery data (clips) per transect varied between 216 to 559 seconds, and mean length of each clip within a transect varied between 24 to 66 seconds. The number of clips per transect varied between 6 to 13 clips.

Table 3. Summary of drop and clip coverage per transect. Clips are continuous lengths of visible seafloor, with potentially one or more drops in a clip. No. = Number. Depth data obtained from the camera.

Transect	Drops			Clip		
	Aimed	Obtained	Depth range (median; m)	Cumulative length (s)	Number	Mean length (range; s)
1	10	7	35-48 (45)	216	8	27 (4-62)
2	10	11	39-47 (46)	559	10	56 (1-171)
3	10	10	42-48 (47)	244	10	24 (15-31)
4	10	10	37-46 (44.5)	458	12	38 (1-127)
5	10	10	40-46 (44.5)	529	8	66 (20-140)
6	10	10	40-47 (45)	502	12	42 (5-71)
7	10	10	36-46 (43)	431	13	33 (1-94)
8	10	12	35-45 (43)	378	11	34 (1-159)
9	10	10	31-44 (42)	457	10	46 (1-226)
10	10	8	31-43 (41)	481	9	53 (1-124)
11	10	10	31-41 (40.5)	336	12	28 (1-43)
12	10	10	35-45 (43)	333	10	33 (19-56)
13	10	11	34-43 (41)	356	12	30 (1-77)
14	10	7	33-42 (41)	273	6	46 (15-114)
15	10	8	31-43 (40)	302	10	30 (2-112)

Habitats in transects could be varied, ranging from sediment only, sediment with large rocks, to areas with hard substrate (62% of the clips contained hard substrate-dominated areas, while 38% of the clips contained soft sediment-dominated areas). There was a difference in the presence of 3D structure, and on occasion how this was created. If 3D structure was present, this always included large rocks or outcrops from the rocky substrate itself, but it could also include parchment worm tube aggregations (see station descriptions in Appendix A), which was reflected in the habitat classification. It could not be determined whether the parchment worm tubes were empty or not. Most clips contained only one type of habitat, but in some the clip contained a mixture of habitats. The percentage of habitat classes varied, with habitat class 4 the most common (23.9% of clips), followed by habitat class 3 and 5 (both 21.8%). The other habitat class types were far less common, with habitat class 6 occurring in 9.9% of the clips, habitat class 1 in 8.5%, and habitat class 2 in 2%. The remainder of the clips contained mixed habitats or the camera was too high to identify the habitat class.

In total, 44 (morpho) species of the epibenthic community were identified. Species number per transect varied between 2 and 35 species, and typically the low species numbers were observed in sediment-only habitats while high species numbers were observed as soon as the area contained hard substrate. A species that was present in almost all sediment-dominated clips include lobster krill (*Grimothea gregaria*). In these clips it was rare to see other species, although on occasion an individual of a different species (e.g., sun star (*Labidiaster radiasus*), purple-backed crab (*Peltarion spinulosum*), or a parchment worm (*Chaetopterus variopedatus*) tube) would be observed. As soon as hard substrate was present, the number of individuals and species increased. Species observed in half or more of the clips containing hard substrate include sponges (white and orange sponges, although the species identification is difficult from video data), sun stars, sea stars (as common (*Anastrerias antarctica*), beaded (*Cosmasterias lurida*) or rough-arm (*Ganeria falklandica*) sea stars can look similar, no further attempt was made to differentiate between them), parchment worm via the presence of their tubes (but note that it was not known whether they were empty or filled), brittle stars (ophiuroids; *Ophiomyxa vivipara*) and fur algae (*Desmarestia distans*), which all were present in 60% or more of the clips. Species that occurred in between 25-50% of the hard-substrate clips include purple encrusting coralline algae (*Corallina* sp.), small colonies of octocorals (*Alcyonium* sp), large white anemones (likely smooth anemones (*Actinostola chilensis*)), pencil urchins (*Austrocidaris canaliculata*), orange bubble tunicates (*Styela* sp.), painted shrimp (*Campylonotus vagans*), and larger rose-shaped, habitat forming bryozoans (*Microporella* sp.). Other species that were observed in in fewer clips ranged from yellow sponges, solitary tunicates (giant (*Paramolgula gregaria*) and possibly warty (*Asterocarpa humilis*) tunicates), lace tunicates (Didemnidae), basket stars (*Gorgonocephalus chilensis*), challenger sea stars (*Henricia obsea*), bat stars (possibly *Diplodontias singularis*), warty cushion stars (*Diplopteraster verrucosus*), and purple backed crabs. Noteworthy observations of singletons included a spider crab (*Eurypodius longirostris*), hermit crab (*Pagurus comptus*), an unidentified octopus (but likely a southern red octopus (*Enteroctopus megalocyathus*)) and a long-spired volutid (*Adelomelon ancilla*). Sunken drift algae was noted on several occasions.

In the end, two squid egg masses (*Doryteuthis gahi*), one in transect 2 and one in transect 6, were found attached to rocks in hard-substrate dominated areas (Figure 2).

Figure 2. Squid egg masses observed on hard bedrock in two transects.

Statistical analyses

Five clips were removed from the dataset for further analyses as no biological organism was observed in them. The clustering of the clip data does not show clear structure in the biological community in differentiation for either transect or habitat classification (Figure 3,4).

Based on an ANOSIM test, between and within group distance did not significantly differ for habitat classification (R = -0.016, p = 0.71). There was a small but significant group distance between transects (R = 0.096, p = 0.0004). The initial PERMANOVA model indicated a non-significant interaction term between transect and habitat classification (F = 1.11, p = 0.142), a non-significant effect of habitat (F = 1.75, p = 0.07), but a significant effect of transect (F = 1.90, p = 0.001). The model was simplified by removing non-significant factors, and the final model included only transect (F = 2.343, p = 0.001).

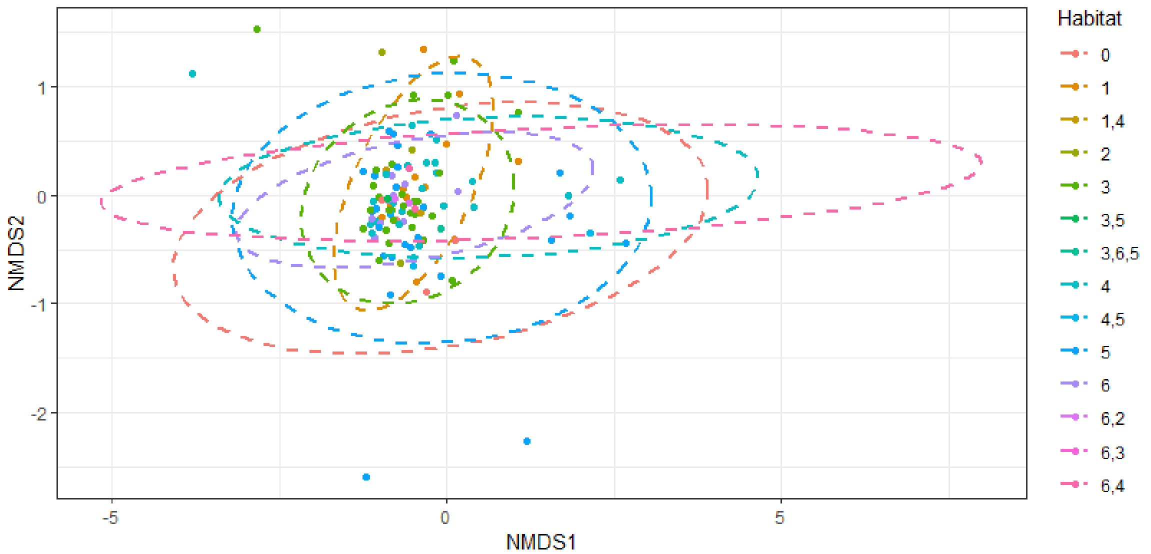

Figure 3. nMDS visualisation of the presence/absence epibenthic species identified in the different transects. Ellipses indicate the different habitat classification.

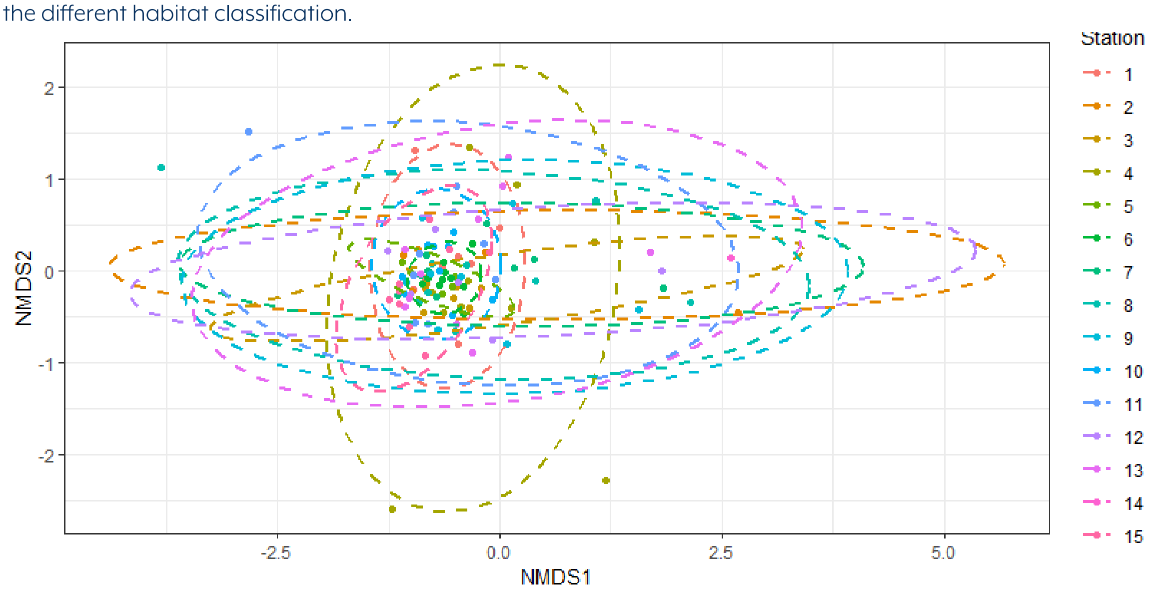

Figure 4. nMDS visualisation of the presence/absence epibenthic species identified in the different transects. Ellipses indicate the different transects.

5. DISCUSSION

The epibenthic community (determined by presence/absence data) at 40-50 m depth in the Falkland Islands inshore waters showed variation in space, with the most obvious differences between soft sediment areas (which mainly contained only lobster krill), and hard substrate areas. The presence of the latter could still be in areas dominated by sediment, yet the rocky hard substrates often contained multiple species. In a few cases, empty parchment worm tube aggregations were so dense that they themselves formed raised structures that were used by other organisms. The PERMANOVA results indicated that communities differ between transects. It is not clear which factors may result in these differences, as habitat class had been a suspected driver. Differences in habitat class may reflect differences in the number and availability of niches, yet this was not statistically supported here. Additional investigations using the presence or absence of soft or hard substrate, and the presence or absence of 3D structure did not show significant effects (results not shown). It is possible that the variation in habitat classes that some clips within a transect contained are resulting in the transect differences. Effects of habitat may be more apparent when abundances can be used in combination with species richness. This would require observing the biological community at consistent heights from the seafloor. Abundance differences in species between different areas can hint at habitat effects that analyses based on species richness alone cannot detect. Other environmental factors may be influential, too, such as current strength and direction, but this could not be measured in the current study.

The detection of relatively common *Microporella sp.* colonies is noteworthy. This bryozoan group is a fragile slow-growing, frame-building species and they and the habitat they create are poorly understood. In the UK, a similar species, *Pentapora foliacea*, has been identified in a Designated Special Area of Conservation (SAC). They have been reported from another area on the east coast of the Falkland Islands (Shag Rock, P. Brewin, *personal communication*). It is possible that these bryozoan colonies are relatively common around the Falkland Islands, which would imply that, following the UK, large areas may be designated as SAC. This would require further study to understand the true extent, and role of these frame-building organisms in the community. Last, it would suggest that inshore habitats may require special attention or protection if these organisms are present.

While only two squid egg masses were detected, these observations do demonstrate that *D. gahi* can use hard substrates for attaching its eggs as well. Not only that, but the observations also indicate that *D. gahi* can use deeper waters as spawning area. It will be important to further quantify the *D. gahi* uses of such alternative spawning grounds, if they select for specific areas, whether even deeper regions are used, and whether there exist differences in these factors between the different spawning cohorts of *D. gahi*. One observation of a *D. gahi* egg mass (attached to a parchment worm tube) trawled up from 68-71 m suggests that they may spawn quite deep (Laptikhovsky 2008). While these polychaete tubes were highly abundant in some of the transects, none had a squid egg mass attached to it. However, as observed in some of the sediment-dominated clips, empty polychaete tubes can move, and therefore they may end up in areas where these tubes provide hard substrate in an area that otherwise does not contain it. One other observation, from roughly 10 m depth, exist of an egg mass attached to bedrock (*P. Brickle, personal communication*), suggesting that hard substrate could be used in even shallower regions. These combined observations suggest that *D. gahi*, like other loliginid species, lay eggs on the seafloor, but that *D. gahi* may be much more flexible in their choice of where to attach their eggs to.

Cephalopod life history is characterised by its enormous flexibility which may be influenced by environmental conditions and especially temperature (Forsythe 1993, 2004; Moreno et al. 2007; Pecl &

Jackson 2008). For example, loliginid squid can vary in the number of spawning peaks and recruitment pulses in a spawning season, have an extended spawning time, vary in growth via which the population demonstrates asynchronous growth and maturation patterns, and which can result in changes between spawning cohorts (Boyle & Boletzky 1996; Moreno et al. 2005; Winter & Arkhipkin 2015). The use of spawning areas or substrates to attach their eggs too could also be considered as a life history adaptation. *D. gahi* in the Falkland Island waters has two spawning cohorts, the spring spawning and autumn spawning cohorts. The eggs these cohorts lay will face different environmental conditions (developing during summer or during winter). While both cohorts are known to spawn in the kelp forests, it is possible that they differ in their use of deeper waters. In addition, further investigation and monitoring of the use of deeper waters by both cohorts may give insight in how *D. gahi* may adapt to changing conditions via its flexible behaviour. For example, if inshore waters warm because of climate change, this can affect egg development via earlier hatching time, but smaller paralarvae, which can influence their ontogenetic migration success to the offshore feeding grounds (Agnew et al. 2000; Arkhipkin et al. 2004; Hatfield 2000). However, deeper waters will remain colder for longer, and if squid can select for these deeper colder waters, then then there may be no change in the migration success. This change in behaviour could possibly be observed first in the spring spawning cohort, although it is not known whether the two different cohorts have adapted to different temperature regimes. In any case, depending on how *D. gahi* uses deeper waters, and whether this will change in the future requires considerations to area management (e.g., establishing further marine management areas) to ensure that in the future there remains sufficient spawning area for the squid to support their population, important for the Falkland marine food web and the commercial fishery.

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7. APPENDIX

Transect description

Transect 1. Substrate was predominately made up of hard substrate covered with sediment and shells. 3D structure was created via outcrops of rock or parchment-worm tube aggregations. One clip showed predominately sediment with lots of shells, rubble, and a few small rocks present. The biological community was varied, with 24 morphospecies counted. Many parchment worm (*Chaetopterus variopedatus*) tubes were present, but most of these are likely empty. The number of the tubes could be high, forming aggregations in which debris accumulated, forming raised structures from the seafloor on which other organisms could be present. Several sun stars (*Labidiaster radiasus*) were present as well as other sea stars, but it is unclear which species (e.g., common (*Anasterias antarctica*), rough armed (*Ganeria falklandica*) or beaded sea stars (*Cosmasterias lurida*)). Many small patches (on occasion larger patches) of orange and white sponges were present, and on occasion small yellow sponges were observed. It is not possible from the video to determine their species. Patches of colonial tunicates, likely orange bubble tunicates (*Styela* sp.), are present, and several solitary tunicates were observed, including giant tunicates (*Paramolgula gegaria*) and possibly warty (*Asterocarpa humilis*) tunicates. Other commonly observed species included brittle stars (ophiuroids), and anemones (mostly large white ones, with potentially few smaller dark brown ones). Structure-forming bryozoans (*Microporella sp.*) were seen on various occasions. On many occasions small colonies of octocorals (*Alcyonium*) were present. Common algae include patches of dark-coloured algae. Purple encrusting coralline algae (*Corallina* sp.) were observed on occasion too. On two occasions, sunken drift algae were noticed. When the camera was close to the seafloor, smaller organisms such as pencil urchins (*Austrocidaris canaliculata*), painted shrimp (*Campylonotus vagans*), and snails were observed.

Transect 2. Substrate was predominately made up of hard substrate covered with sediment and shells. 3D structure was created on many occasions via outcrops of rock predominately, but on occasion aggregations of parchment worm tubes were present. On other occasions there is little to no 3D structure present and only hard substrate with some sediment cover. The biological community was varied with 35 morphospecies identified. Similar to station 1, sun stars, sea stars, ophiuroids, and white and red/orange sponges were observed many times in the video. Potentially different species of sponge, such as hourglass (*Siphonocholino fortis*), chalk (*Grantia* sp.) and potentially even knotted (*Mycale nodulosa*) and pen holder (*Haliclona* sp.) sponges were observed. Only few yellow sponges were observed. In two clips, challenger sea stars (*Henricia obesa*) were noted, and in three clips a warty cushion star (*Diplopteraster verrucosus*) was observed. Many more tunicates were present at this station, including giant and possibly warty tunicates and potentially other solitary tunicates. Colonial lace tunicates (Didemnidae) were common, while orange bubble tunicates were less present than in transect 1. The bryozoan *Microporella* sp. was frequently observed, as were small colonies of octocorals. In one clip, an adult long-spired volutid (*Adelomelon ancilla*) and an unidentified octopus was present. Several white anemones were present in the clips, while only one clip contained the small brown anemone. There were several patches of dark-coloured algae and purple encrusting coralline algae in the clips. When closer to the seafloor, on many occasions pencil urchins, scallops (*Zygochlamys patagonica*), painted shrimp, and snails. A squid (*Doryteuthis gahi*) egg mass attached to the hard substrate was present in one of the clips

Transect 3. The substrate contained soft sediment only. In all but one clip (in which no organisms were observed) lobster krill (*Grimothea gregaria*) were present, in varying numbers. One parchment worm tube was observed in one clip.

Transect 4. Substrate was predominately made up of hard substrate covered with sediment and shells, and no/not much 3D structure present. On a few occasions there were rock outcrops and parchment-worm tube aggregations that added 3D structure to the environment. The biological community was varied, with 30 morphospecies counted. Many ophiuroids were seen in the clips, as well as sea stars, but somewhat fewer sun stars than in transect 1 or 2. In one clip, warty cushion star, solitary bat star (*Diplodontias singularis*), and basket star (*Gorgonocephalus chilensis*) species were observed. Lace and orange bubble tunicate colonies were present, but fewer than in station 2, as were solitary tunicates such as giant and possibly warty tunicates. In many clips, the bryozoan *Microporella* sp. were present, and painted shrimps were observed in almost all clips, too. Many small colonies of octocorals were noted. One larger urchin was observed, but its species unknown. Orange or red sponges were frequently observed in clips, while white sponges less so. Yellow sponges were present, but less common. Possibly chalk or and popcorn (*Haliclona chilensis*) sponge species may have been present in the community. Dark coloured algae and purple encrusting coralline algae were seen in roughly half of the clips. Only a few anemones were noted, both the larger white and the smaller brown morphs. Closer to the seabed, many pencil urchins were observed, and sometimes snails.

Transect 5. The transect started off with mainly sediment interspersed with 3D rock structures, going into an area of soft sediment presence only. The transect finished with an area that was dominated by sediment but contained large rocks. In total, 15 morphospecies were identified. On the sediment-only areas, lobster krill (*Grimothea gregaria*) were observed (except for one clip which contained no observed animal), and one clip contained one sea star. In the area with sediment and larger rocks, sun stars, challenger sea star, parchment worm tubes, fish, octocorals, white and orange sponges, white and brown anemones, lace and orange bubble colonial tunicates, and giant tunicates were observed.

Transect 6. This station contained a mix of habitat. The transect started off with hard substrate covered with sediment and shells, outcrops/3D formed by either hard substrate or parchment-worm tube aggregations and went over into an area dominated by sediment with 3D rocky structures interspersed. This was followed by a fluctuating habitat of sediment only, back to hard substrate area covered with sediment and shells, were outcrops/3D structure were formed by hard substrate, although briefly there was an area with parchment-tube worm aggregations. In total, 34 morphospecies were identified in this area. In the sediment-only areas, many lobster krill (*Grimothea gregaria*) were present, although one parchment worm tube was observed. In the areas with 3D structure, but dominated by sediment lobster krill could be present, but more likely other organisms such as sun star, sea stars, sponges (orange, white (possibly hourglass), yellow sponges), and parchment worm tubes were common. Few solitary tunicates (giant, possibly warty tunicate) were present, as well as ophiuroids, painted shrimp and snails. Drift algae was observed in this area. Last, there were areas in this transect that contained hard substrate with rocky outcrops or parchment worm tube aggregations which created 3D structure. In these areas, parchment worm tubes were present in all clips, as were orange sponges and orange bubble tunicates. Sun stars, white sponges (possibly hourglass sponges), dark coloured algae, purple encrusting coralline algae, large white anemones, pencil urchins and snails were observed in almost all clips of this area. Sea stars, basket stars (observed in half of the clips of this type of area in the transect), yellow sponges, painted shrimp, scallops, and ophiuroids were relatively common. A challenger sea star and two bat stars were observed. Drift algae was noted in half of the clips of this type of area in the transect. Solitary tunicates (giant and possibly warty tunicate), lace tunicates, *Microporella* sp, octocorals, and a large urchin (unidentified species) were observed in only 1-2 clips. A squid (*Doryteuthis gahi*) egg mass was observed attached to small rocky, overgrown outcrop.

Transect 7. The transect started with an area of hard substrate covered with sediment and shells, outcrops/3D structure formed by hard substrate present, going to an area with less 3D structure, to an area of predominately sediment with 3D rock structures, and finished with an area of hard substrate covered with sediment and shells, outcrops/3D structure formed by hard substrate present. In total, 31 morphospecies were observed in this transect. In almost all clips, parchment worm tubes were present, as were sun and sea stars. Orange and white sponges (possibly including hourglass sponges), the bryozoan *Microporella* sp. and colonial bubble tunicates occurred in most clips. In roughly half of the clips ophiuroids, pencil urchins, dark-coloured algae, purple encrusting coralline algae, and painted shrimp were present. In few clips, snails, scallops, basket stars, large urchins, challenger sea and bat star, octocorals, an unidentified fish, drift algae, lace tunicates, white anemones, solitary tunicates (giant and possibly warty), and yellow sponges were present.

Transect 8. This transect contained a mix of hard substrate covered with sediment and shells, outcrops/3D structure formed by hard substrate present, and no/not much 3D structure present, and ended with an area that contained only sediment. In total, 29 morphospecies were identified. In many clips, orange sponges were present as well as parchment worm tubes although these did not form aggregations. Other common species in clips include ophiuroids, sun and sea stars, and white sponges and anemones. Many clips showed purple encrusting algae and dark-coloured algae. Several solitary tunicates were identified (possibly warty tunicate) and colonial lace tunicate. Only one clip contained *Microporella* sp. Few clips contained pencil urchins, snails, large urchin, basket star, painted shrimp, scallop, warty cushion and bat stars, brown smooth anemone, octocorals, and orange bubble tunicates. The sediment-only area contained lobster krill mostly, although one sun star and one pencil urchin were identified in one clip.

Transect 9. This transect started with an area of mainly sediment, with patches that contained more shells and some small rocks, going into an area with mainly sediment and some 3D rocky structures, to an area with hard substrate with sediment and shell cover but limited 3D structures present with patches of some 3D structures present. In total, 26 morphospecies were identified for this transect. The sediment-only area contained lobster krill, a tube of a parchment worm and a piece of drift algae. In areas that were dominated by sediment but that contained rocks lobster krill and other species were present including orange and white sponges, lace tunicates, parchment worm tubes, purple encrusting coralline algae, octocorals, large white anemones, and snails. Drift algae and a purple-backed crab were observed in this area, too. In the other areas many sun and sea stars, ophiuroids, and parchment worm tubes were observed. In half of the clips of this type of area, orange and white (possibly chalk) sponges, white anemones, pencil urchins, dark-coloured algae, purple encrusting coralline algae, orange bubble tunicates and octocorals were observed. In few clips, snails, warty cushion, basket and bat stars, *Microporella* sp., solitary tunicates (possibly warty), large urchins, and painted shrimp were observed. Some drift algae were observed, too.

Transect 10. This transect started with sediment-only, going over in an area with sediment containing few large rocks followed by an area of hard substrate with sediment cover with no or not much 3D structure, to a large area with hard substrate with 3D structure, ending with an area dominated by sediment that contained few small rocks. 28 morphospecies were identified. In the sediment-only region, lobster krill were always present in the clips, and on one occasion a sun star and a parchment worm tube were observed on the sediment. The clip that contained the transition from sediment-only to an area with more rocks, lobster krill was present, as well as sponges (orange and white), parchment worm tubes, sun star, large white anemone and ophiuroids. In the area containing hard substrate species such as orange, yellow and white (possibly hourglass, chalk and knotted) sponges were present. Sun and sea stars were frequently observed, as were small colonies of octocorals, orange bubble tunicates, parchment worm tubes. Many clips contained observations of large white anemones and *Microporella* sp. Snails, pencil urchins, brown smooth anemone, painted shrimps and scallops, solitary (giant and possibly warty) tunicates and possibly a spider and a hermit crab were observed in few clips. Ophiuroids, dark-coloured algae and purple encrusting coralline algae were present in half of the clips that contained this type of area.

Transect 11. The transect starting with hard substrate covered with sediment and shells, and at first little to no 3D structure, which went into an area with lots of 3D structure by rocky outcrops and rocks, back to an area that had little to no 3D structure but was still dominated by hard substrate and ending with a stretch of sediment-only area. In total, 27 morphospecies were identified. Observed in all clips containing hard substrate are orange sponges, parchment worm tubes (but they did not form aggregations) and dark-coloured algae, while almost all clips contained sun and sea stars, white sponges, white anemones, ophiuroids, and purple encrusting coralline algae. Less frequently observed were *Microporella* sp., pencil urchins, painted shrimp, snails, and octocorals. Only observed in one or two clips were giant, lace and orange bubble tunicates, yellow sponge, a large urchin, challenger sea and basket star, and an unidentified fish. Drift algae was observed in this area. The sediment-only area only contained lobster krill, if any.

Transect 12. This transect contained a fluctuating habitat classification between every clip, varying in amount of exposed hard substrate or sediment, and varying in the presence of rocky 3D structure present or not. This could also change within a clip. In total, 26 morphospecies were identified. Common to almost all clips were orange and white sponges (possibly chalk, knotted, or hourglass sponges), parchment worm tubes, sun and sea stars, ophiuroids, dark-coloured algae, purple encrusting coralline algae, and octocorals. *Microporella* sp. were observed in roughly half of the clips, as were white anemones, pencil urchins, large urchins, and snails. Less frequently observed were lace and orange bubble tunicates, yellow sponges, challenger sea and basket stars, painted shrimp, and purple-backed crabs.

Transect 13. The transect started with an area of sediment-only substrate, going into a mainly sediment-dominated area with some 3D rocky structure, to a mixed region of hard substrate covered with sediment and shells with 3D structure present, or no/not much 3D structure present. In total 23 morphospecies were identified. The sediment-only area predominately only contained lobster krill, although a parchment worm tube and a sun star were observed. The areas that were dominated by sediment but contained large rocks contained species such as orange, white and yellow sponges, sun and sea stars, lace and orange bubble tunicates, ophiuroids, dark-coloured algae, parchment worm (tubes), painted shrimps, large urchin, purple encrusting coralline algae, snails and small octocoral colonies. Drift algae was observed in one clip. The hard-substrate areas contained similar species to this, although no lace tunicates but lots more drift algae were observed. In addition, giant tunicates, large white anemones, pencil urchins, and a challenger sea star were observed in this area.

Transect 14. This transect started off with an area dominated by sediment and interspersed with larger rocks that gave 3D structure, going into an area which was dominated by hard substrate and rocky outcrops/3D structure. There was a moment where the hard substrate stopped and sediment is present, but it goes back into hard substrate with lots of 3D structure. 22 morphospecies were identified in this transect. *Microporella* sp., giant solitary tunicates, and small brown smooth anemones were identified in only one clip. Orange sponges, parchment worm tubes, dark-coloured algae, and purple encrusting coralline algae were observed in all clips, while ophiuroids, sun and sea stars, white sponges and octocorals were present in most clips. In few clips, snails, orange bubble tunicates, large white anemones, pencil urchins, and painted shrimp were present. Drift algae was noted in a few clips, too.

Transect 15. This transect started with a sediment-only area, going into a sediment-dominated area with some 3D rocky structure, to hard substrate covered with sediment and shells with 3D structure present, and ending with hard substrate area with limited 3D rocky structure. 29 morphospecies were identified. The sediment-only area in the beginning mainly consisted of lobster krill (one clip did not contain any visible organisms). One purple-backed crab was identified in this area, too. As soon as hard substrate was present, either in the form of larger rocks or the substrate itself, many species were present. Parchment worm tubes were present but did not form aggregations. In all or almost all clips, octocorals, orange sponges, sun and sea stars, ophiuroids, white sponges (possibly chalk, or hourglass sponges), large white anemones, and orange bubble tunicates were present. In half the clips of these habitats, small yellow sponges, dark-coloured algae, and basket stars were observed. In few clips solitary tunicates (giant or warty), *Microporella* sp., pencil urchins, painted shrimp, purple encrusting coralline algae, snails, an unidentified fish, and small brown smooth anemone were present. Drift algae were observed in two clips.

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