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Evaluation of light traps for sampling lobster larvae in the German Bight, North Sea

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ABSTRACT

Biological monitoring of planktonic animals is greatly dependent on the deployment of traps. A variety of specialized traps have been designed for surface plankton and vertebrates. However, certain groups, such as planktonic larvae of benthic marine invertebrates remain underrepresented in sampling efforts. Catching them has proven to be more challenging because of their size, swimming ability, location, and abundance. In the present study a successful light trap for sampling American lobster larvae in New Brunswick, Canada, is evaluated on the island of Helgoland (German Bight, North Sea). Our results showed the traps were successful in catching larvae in laboratory experiments but were unable to catch European lobster larvae in the field. Traps deployed in the field were successful in capturing other benthic and pelagic zooplankton predominantly consisting of crustaceans from the orders: Cumacea, Amphipoda, Mysida and Isopoda. The low density of lobster larvae, the island's topography, and their unique photactic response possibly limited the success rate of the light traps. Future research is needed to construct a specialized trap to sample Helgoland's lobster larvae and provide information on the current larval fitness and population numbers.

1. Introduction

For many marine benthic species, the larval phase is the principal dispersal stage, as the planktonic larvae remain in the water column until equipped to settle and metamorphose. As a result, assessing reproductive effort requires determining larval densities, but selecting the correct method to sample them can be challenging. Sampling of larvae during this stage for the purpose of biological monitoring is predominantly done by net tows and/or passive collectors. Larval nets vary in mesh size and opening. Additionally, the direction of the cast which can be horizontal or vertical. Passive collectors principally lure larvae with light, and the traps used vary mostly in the intensity of the light and the shape of the opening. These commonly used methods have their advantages and disadvantages related to deployment, efficiency to catch certain taxa and the preservation of the caught organisms (McLeod and Costello, 2017). Net tows are weather-dependent (i.e. wind conditions) and difficult to deploy in shallow areas bordering rocky coastlines. Therefore, they involve more logistical planning and thus are more expensive if multiple locations are needed to be sampled. In contrast passive collectors such as light traps, are more economical to build and thus can be deployed for multiple days at different sites using smaller vessels (Øresland, 2007). Moreover, the selectivity between net tows and passive collectors is very different. Larval tows are efficient at sampling slow and abundant surface planktonic organisms (Øresland, 2007; Pineda et al., 2010; Sigurdsson et al., 2014), whereas passive collectors can be more efficient at sampling strong-swimming and scarce organisms, such as crustacean larvae (Sigurdsson et al., 2014; Escobar-Lux and Samuelsen, 2020; McElhany et al., 2022).

The distribution of larvae in the water column is dependent on various environmental factors such as water depth, currents, temperature, food abundance and the light-dark regime. These factors play an important role in providing cues on orientation and depth regulation of planktonic larvae (Forward, 1974, 1989). Accordingly, benthic and pelagic zooplankton (including larvae of invertebrates and fish) are often positively phototactic. The attraction to light has facilitated the capture of zooplankton by using light to lure animals into traps (Floyd et al., 1984; Chan et al., 2016; McLeod and Costello, 2017). Catching larvae in the field and monitoring serves as a method to assess current population numbers of a particular species and its vertical distribution (Lewis and Granek, 2021; Sponaugle et al., 2021). The number of

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competent larvae caught in larval tows or traps is key to correlate planktonic larvae supply, recruitment success and benthic community composition (Gaines et al., 1985). Due to high mortality rates during the larval stage, assessing stocks in the wild is crucial, especially for managing vulnerable species. Marine decapods like lobsters, which are heavily fished, are often in need of monitoring. Understanding whether bottlenecks occur at the larval stage, potentially hindering recruitment, is necessary due to their complex life cycles.

Larval tows have been used to quantify the abundance of different larval stages of the American lobster since the 1930s (Fogarty, 1983). This method captures relatively high numbers of stage I larvae, but lower numbers of stage II and III, and even fewer stage IV larvae (Wilder, 1953; Scarratt, 1973). One possible limitation of larval tows in catching larvae in more advance stages is that as larvae metamorphose, they become stronger swimmers and may avoid nets (Fleminger and Clutter, 1965). Furthermore, wave action and rain can cause larvae, typically found in surface layers, to move to deeper waters (Wilder, 1953; Øresland, 2007). In recent decades, several studies have demonstrated that light traps can complement larval tows (Doherty, 1987; Meekan et al., 2000; Mwaluma et al., 2009). Light traps have become an additional and successful tool for vertical sampling of larvae from the *Homarus* and *Nephrops* genera (Øresland, 2007; Sigurdsson et al., 2014; McGeady et al., 2022). The main argument for their usage and popularity as a sampling tool for pelagic larvae is that light traps require less working hours, and their catch rates are comparable to those of larval tows (Øresland, 2007). Additional advantages include that the animals caught are in good condition, and therefore can be used in experiments and morphological studies.

In Germany, European lobsters are restricted to the island of Helgoland (German Bight, North Sea) and the local lobster population remains at critically low levels due to overfishing and habitat destruction (Anger and Harms, 1994; Franke and Gutow, 2004). Annual landings are currently only a few hundred lobsters per year in comparison to a yield of 38 tons per year in the 1920s–30s (Klimpel, 1965; Schmalenbach and Buchholz, 2010). Another indication of very low adult densities is the scarcity of lobster larvae found in the field (Greve et al., 2004). As a result, to date, no sampling method has successfully caught lobster larvae around the island of Helgoland. Consequently, our understanding of the vertical and horizontal distribution of the European lobster larvae population on the island remains lacking. Lobster larvae are rarely found in the Alfred-Wegener-Institut Helmholtz-Zentrum für Polar-und Meeresforschung (AWI) long time-series plankton sampling (Helgoland Roads) CalCOFI net hauls. Indeed, lobster larvae were only found twice during the sampling period between 1975 (0.03 ind/m^3) to 2018 (0.02 ind/m^3). However, in Irish waters (Galway Bay and Lough Hyne), *Homarus gammarus* larvae of all stages have been caught using neuston nets (Minchin, 1984; Tully and Ó Céidigh, 1987). Therefore, it remains uncertain whether the low adult spawning densities make it numerically improbable to catch larvae, if spawning occurs farther away from the island of Helgoland, or if strong tidal currents and wind impacts carry the larvae into the open sea. Moreover, it could be a certain behavior (e.g. migrating immediately to the seabed) that prevents larvae from being caught with plankton hauls.

The sampling device we chose to evaluate was the "tube light trap" which has been successful in catching *H. americanus* in New-Brunswick (Canada), and *H. gammarus* and *Nephrops norvegicus* larvae in Sweden (Øresland, 2007; Sigurdsson et al., 2014). Furthermore, we selected this design because the trap meets the following criteria: (1) robust; (2) economical; (3) able to sample multiple locations simultaneously; (4) easy emptying without loss of animals; (5) allows sampling while drifting with the currents; (6) it permits sampling for up to 24 h without reduction in light intensity.

The present study assessed the efficiency of a modified light trap in both laboratory and field settings at different depths to gather more information on lobster larvae distribution. The main objective of our study was to evaluate the potential of using light traps on the island of Helgoland to support research on the European lobster in its natural habitat and conservation efforts. We were particularly interested in capturing larvae to assess their fitness, evaluate the current potential for settlement in the area, and explore the future use of light traps as a tool for studying connectivity and recruitment. Additionally, our experiments aimed to test and improve a low-cost, robust, and eco-friendly light trap for laboratory and field experiments involving crustacean larvae.

2. Materials and methods

2.1. Origin of animals

The study was carried out at the Alfred-Wegener-Institut Helmholtz-Zentrum für Polar-und Meeresforschung (Helgoland, Germany). European lobster larvae (*Homarus gammarus)* were obtained from the lobster-rearing facilities for lobster conservation, Reefauna. Larvae hatched from ovigerous female lobsters captured by local fishermen in the rocky subtidal zone around the island of Helgoland (German Bight, North Sea, 54°11:3′N, 7°54.0′E).

2.2. Design and construction of trap

We use a slightly modified version of Sigurdsson et al.'s (2014) light trap. Our version consists of a funnel shaped glass with a wider entrance and a narrower opening (1 cm diameter orifice), with the closed end sealed a removable plastic lid. The body of the trap is made of a red PVC pipe, 10 cm in diameter and 40 cm long. The plastic lid was fitted inside with a ring where chemical lights or LED lights could easily be secured and removed after use (Fig. 1). For deployment, two stainless steel rings were attached to the traps one at the closed end and the other one on the side. To prevent the loss of caught organisms through the entrance when traps were pulled vertically, a rope was passed through the top ring to lower the traps into the water column. For retrieval, the traps were

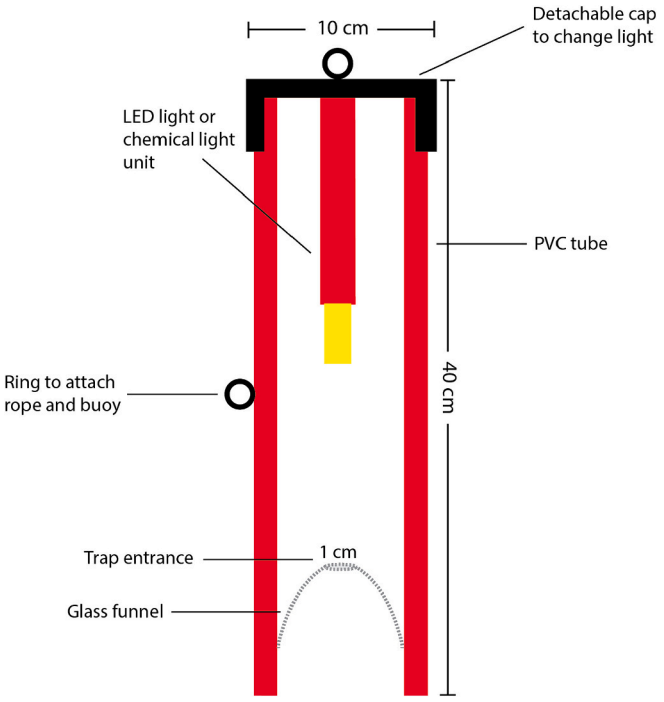

Fig. 1. Diagram of the light trap used in the study. The main body of the trap was made of a red PVC tube. The opening was made of glass and the trap was sealed with a plastic cap. Attached to the plastic cap was a fitting for the lights (shown in yellow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

pulled using a rope passing through the side rings. Yellow chemical lights (e.g glow sticks, [6 in., SnapLight Cyalume Technologies, USA]) or white LED lights (PotLight, Fishtek Marine, UK) were used to lure the lobster larvae into the traps. Light sources used in our light traps are in the range of wavelengths (380–750 nm) shown to provoke a phototactic response in other crustacean larvae (Forward, 1974; Schmalenbach and Buchholz, 2010). The yellow chemical lights have a wavelength of around 580 nm, and LED white light have wavelength of around 500 nm.

2.3. Laboratory experiment in small volume

To test if recently hatched larvae were lured into the light traps, two different light sources as lures were examined: (1) yellow chemical lights and (2) white LED lights. Traps were placed in plastic tanks (49 cm diameter, 72 cm high), containing ca. 100 L of seawater at a controlled temperature of 18 °C. The traps were placed approximately 50 cm from the bottom of the tanks. Seawater was gently bubbled with air throughout the experimental runs. The experiment was done in a controlled temperature and light room (12 h light/dark). Ten recently hatched lobster larvae (i.e. stage I larvae: 1–2 days after hatching) were randomly selected and released in each of the four tanks containing one light trap. For the purpose of our study, to evaluate light traps as a tool to catch lobster larvae, we only used stage I larvae as it is the most positive phototactic stage (Schmalenbach and Buchholz, 2010). Two of the tanks had traps with chemical lights while the other two had traps with LED lights. The experiment ran overnight, from 17:00 h to 9:00 h. At the end of experimental run; catchability was determined by how many larvae were inside of the trap. The experiment was repeated 28 times ($n = 280$). Furthermore, we conducted a control experiment ($n = 40$) to test whether traps were passively catching larvae. The traps were placed in the tank without light, and the results showed that only 1 of 40 larvae was found inside a trap.

2.4. Laboratory experiment in large volume

The second laboratory experiment was done in July 2020, in a lower larval density setting (10 ind/m^3), but in much larger experimental containers, comparing two different light sources as lures. We again used yellow chemical lights and white LED lights. The tanks used were located outside the facilities of the AWI Helgoland Marine Station. The tanks were made of black plastic and had a cover to prevent light from entering. Two traps, each with a different light source, were placed in each plastic tank (256 cm diameter, 110 cm high) containing ca. 5000 L of fresh seawater directly pumped from the North Sea at a temperature of 18.3 ± 0.14 °C. Traps were placed approximately 50 cm from the bottom of the tanks. Fifty recently hatched larvae were released in each tank and left overnight for 16 h (17:00–9:00 h). The following day larvae were counted and retrieved from the traps and tanks. The tanks were emptied and refilled with fresh seawater in between runs, a total of 8 runs were done ($n = 400$). After each experimental run, larvae removed from tanks and traps were returned to Reefauna.

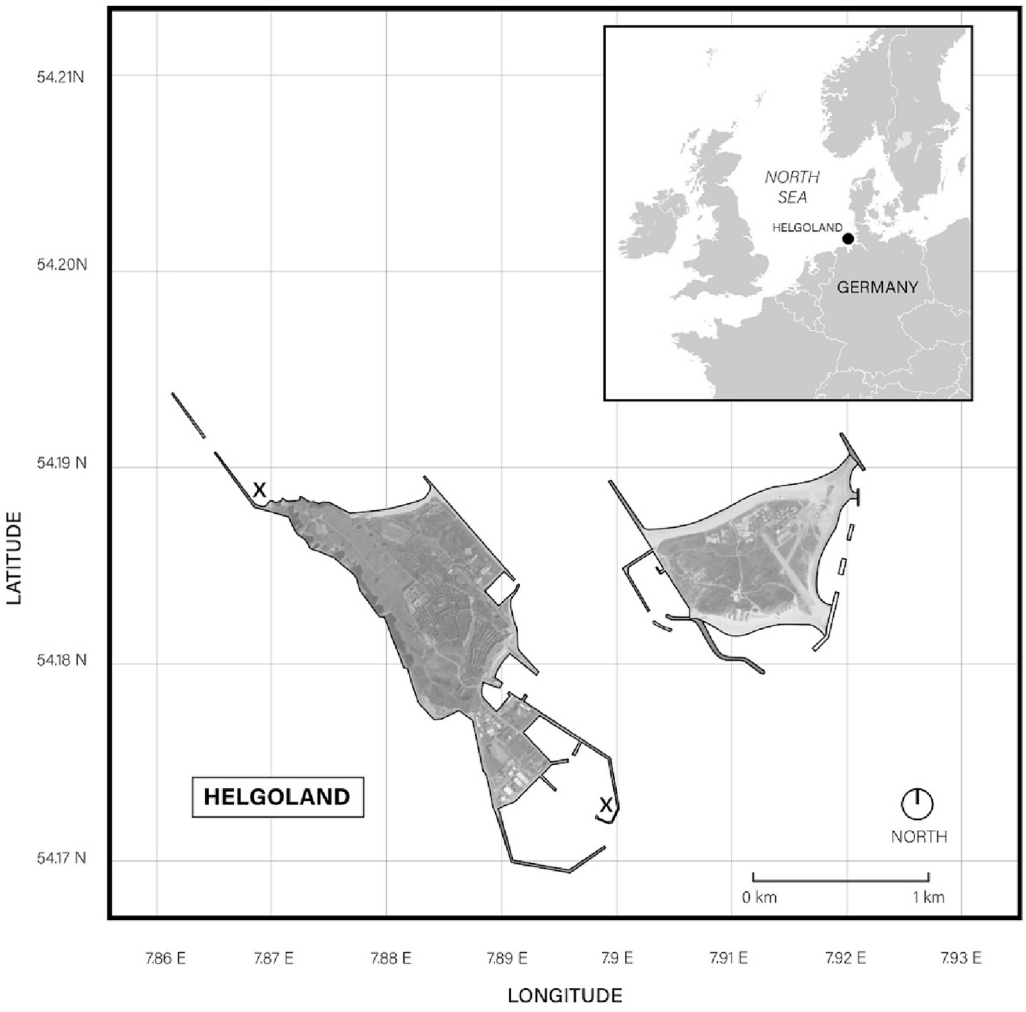

Fig. 2. Deployment trap locations on the island of Helgoland. Traps were deployed in the in the North at the Nordmole and in the South at Nebelhörn, sites are marked with an (X).

2.5. Field sampling

A total of six light traps were deployed in two different sites (Fig. 2) in the northern and southern part of the island of Helgoland: Nordmole (54°11:434′N, 7°52:493′E; depth: 3.2 m) and Nebelhörn (54°10:343′N, 7°53.949′E; depth 9.2 m) respectively. The areas were chosen based on high adult lobster densities as recommended by local fishermen and adequate lobster habitat areas which consist of a rocky subtidal zone. In each site, three traps were deployed on an anchored line, buoyed at the surface. At the Nordmole three traps anchored to a 10 m rope, were tied at 2 m, 4 m and 6 m from the seafloor. At Nebelhörn one trap was attached per rope at a depth of 1 m. The light traps were spread so they were approximately 1.5 m apart from each other. The differences in trap depth deployment are due to the sites seafloor depths, such that the distances to the sediment were similar. Traps were deployed once a week from May to August 2020. They were deployed at high tide during the daytime and left overnight for retrieval the next day during high tide. Traps were deployed for a shorter period than in Sigurdsson et al.'s (2014) study (deployed for ~8 days) to minimize predation risk within the traps. When the traps were retrieved, they were carefully pulled out of the water with the opening pointing up, to avoid loss of larvae. The traps were then immediately placed in individual buckets with seawater and transported to the laboratory for identification of the catch. Presence or absence of lobster larvae was recorded and additionally all other organisms captured by the traps were counted and grouped by order and identified to family or species level when possible.

2.6. Data analysis

Statistical analyses were performed in RStudio (2022). Data was tested for normality and variance homogeneity using the Shapiro- Wilk and Barlett's tests, respectively. Difference between light treatments was then tested using analysis of variance (two-way ANOVA). If criteria of a normal distribution or variance homogeneity were not met, non-parametric Wilcoxon signed rank tests were performed. For all the statistical tests, significant difference was set at $p < 0.05$. For the comparison of larvae caught by LED or chemical light traps, the chi-squared test was used in the analysis of contingency tables based on the counts of larvae entering traps with LED or chemical lights.

3. Results

3.1. Laboratory experiment in small volume

Traps using LED lights had a higher catch (mean ± SD, 60.0 ± 16.9%) in comparison to chemical lights (42.5 ± 15.6%), but this difference was not significant at p-value = 0.056 (Fig. 3).

3.2. Laboratory experiment in large volume

Light source had a significant effect on the number of larvae entering each trap (chi-square test, p-value<<0.001). Overall, 135 lobsters were captured by traps with LED light and 11 lobsters were caught by traps using chemical lights. The highest percentage of larvae caught during an experimental run was 46% by an LED light trap and 4% by chemical light trap. While the lowest capture percentage for LED light trap and chemical light trap was 24% and 0% respectively (Fig. 4).

3.3. Field sampling

In the whole season of deployments, no lobster larvae were caught. However, the traps were successful in catching a large variety of other small crustaceans. The results of our experiments show that the light traps caught a variety of organisms, and up to 1000 animals in one night (Table 1). Specimens from the following orders were captured: Cumacea, Amphipoda, Isopoda, Decapoda, Trochida, Mysida, Euphausiacea

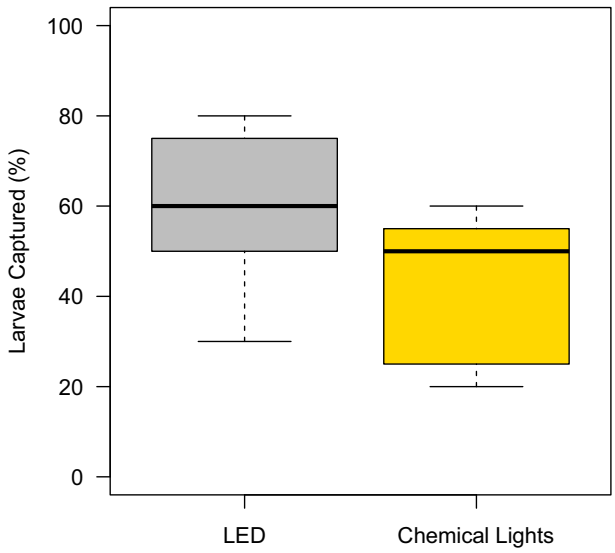

Fig. 3. Percentage of *Homarus gammarus* larvae captured by the different light sources after 24 h.

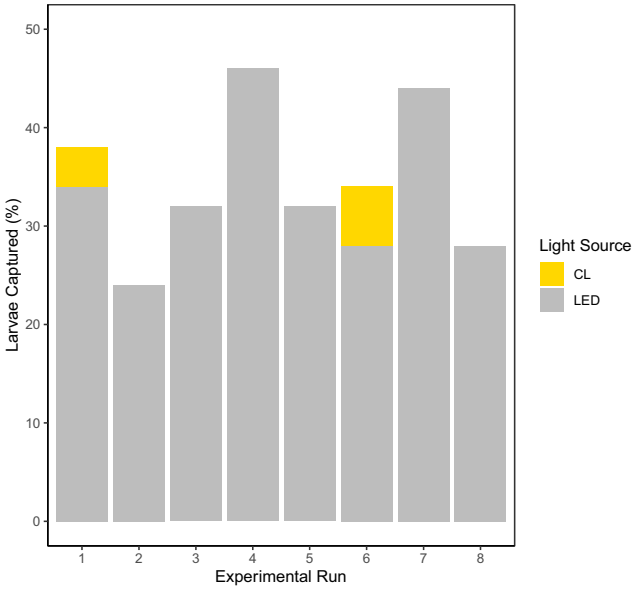

Fig. 4. Comparison of light sources efficiency in catching *Homarus gammarus* larvae. CL = chemical lights and LED = LED lights.

and Cydippida. By far, the largest part of the animals caught were Cumacea, followed by Amphipods and Isopods (i.e. family Idoteidae) (Fig. 5).

Several species from the Actinopterygii class (grouped and referred as fish throughout the study) were caught, which included two juvenile lumpsucker (*Cyclopterus lumpus*), one sea stickleback (*Spinachia spinachia*), two sand eels (order: Trachiniformes) and a goby larva (order: Gobiiformes). The Decapoda catch comprised shrimps and Brachyuran crabs (i.e. *Necora puber*; juvenile and megalopa). Decapod larvae made up 1% of the total organisms caught.

All animals caught were found alive and in good condition. The dominance of Cumacea was observed throughout the whole summer season (Fig. 6); and August was the month with the highest catch, coinciding with an increase in both Amphipods and Isopods.

Table 1
Identification and number of specimens collected in the field study (May–August 2020).

Location	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	Nordmole	
Date	06.05.20	13.05.20	10.06.20	17.06.20	24.06.20	01.07.20	08.07.20	15.07.20	22.07.20	29.07.20	05.08.20	19.08.20	Total
Amphipoda	3		210	8	13	9	35	18	20	25	100	190	631
Cumacea	1	3	2	710	24	25	120	115	400	29	30	900	2359
Decapoda:													
Shrimp	1		2				1				1	1	6
Crab				1			1			4			6
Euphausiacea		3											3
Gastropoda							2	2	11		3	1	19
Fish							1					2	3
Mysida					1	1		3		5		1	15
Isopoda									1	2	65	5	73
Cydipidda										2			2

Location	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	Nebelhörn	
Date	06.05.20	13.05.20	10.06.20	17.06.20	24.06.20	01.07.20	08.07.20	15.07.20	22.07.20	29.07.20	05.08.20	19.08.20	Total
Amphipoda		2	15	7	10	9	7	3	1	60	42	29	185
Cumacea			3	2	21	1	8	10	3	60	8	213	329
Decapoda:													
Shrimp										2			2
Crab			1	1			8						10
Euphausiacea													0
Gastropoda					6	1	1			2			10
Fish					1					1			2
Mysida										14			14
Isopoda										130	36		166
Cydipidda													0

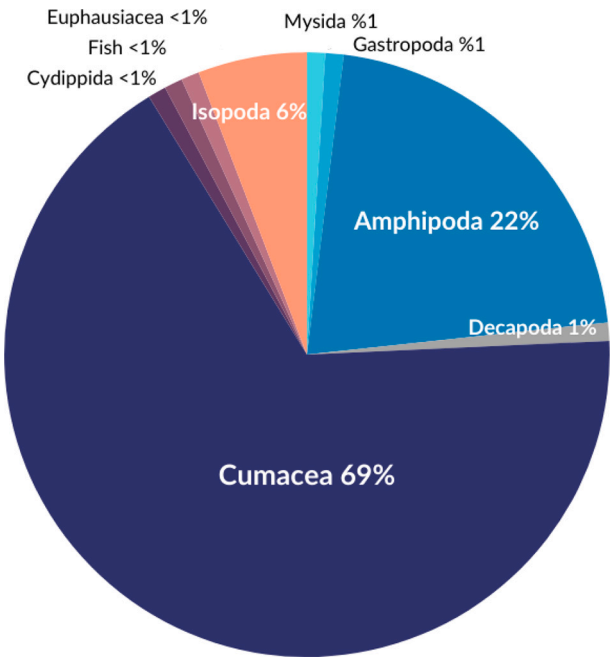

Fig. 5. Summary of catch in the traps between the months of May–August 2020.

4. Discussion

In this study, we evaluated the effectiveness of an inexpensive light trap for capturing European lobster larvae around Helgoland, North Sea. While our laboratory experiments demonstrated the trap's functionality, field deployments captured no lobster larvae. This suggests that larval densities in the sampled areas may be too low for effective capture. The discrepancy between laboratory and field results underscores the complexity of larval distribution dynamics in natural environments. The absence of lobster larvae in the field suggests either limited larval presence in the sampled areas or behavioral factors leading to their avoidance of the traps.

The lobster larvae population on the island of Helgoland has only been calculated based on the density of adult females. There is an estimate of about 15,000 animals around Helgoland on 30 km^2, at a mean water depth of 4 m (Schmalenbach et al., 2011), each producing 20,000 eggs (Coleman et al., 2019). This would mean there should be about 2.5 larvae per m^3 if the larvae were equally distributed and 100% of the eggs survived. However, this is not the case as egg loss in *H. gammarus* has been estimated to be as high as 44% from initial extrusion to hatching (Coleman et al., 2019). To date, only three lobster larvae have been caught throughout the Helgoland time-series plankton hauls in the years 1975, 2018 and 2020 at densities of 0.03 ind/m^3, 0.02 ind/m^3 and 0.04 ind/m^3, respectively. The lack of successful lobster larvae catches in the field make it challenging to have updated larval densities, and at the moment there is a mismatch between estimates and larvae catches.

Additionally, sampling location, times and duration are likely to affect catch compositions. Helgoland is exposed to strong tidal currents and wind impact, which may lead to variation in current speeds and water levels (Schmalenbach and Buchholz, 2010). The chosen deployment sites at the Nordmole and Nebelhörn are protected to a certain extent from strong current that may carry lobster larvae away. Our field experiments results showed traps deployed at both sites caught high numbers of epibenthic organisms, including decapod larvae of other species. However, a higher number of animals were caught at the northern part of the island at the Nordmole. Traps deployed at this site were approximately 1–2 m from the surface, the depth range at which European lobster larvae have typically been observed and captured (Dunn and Shelton, 1983; Nichols and Lovewell, 1987). Furthermore, the light tube trap design by Sigurdsson et al. (2014) from which our traps were based, successfully caught *H. americanus* larvae at a depth of 1 m from the surface. Sigurdsson et al. (2014) light traps caught 23 larvae (15 stage I larvae and 8 stage IV larvae) in 281 trap hauls. However, when comparing catch rates and human work hours, the light traps performed similarly to larval tows. Thus, light traps remain a tool that can complement larval tows, especially when aiming to sample and

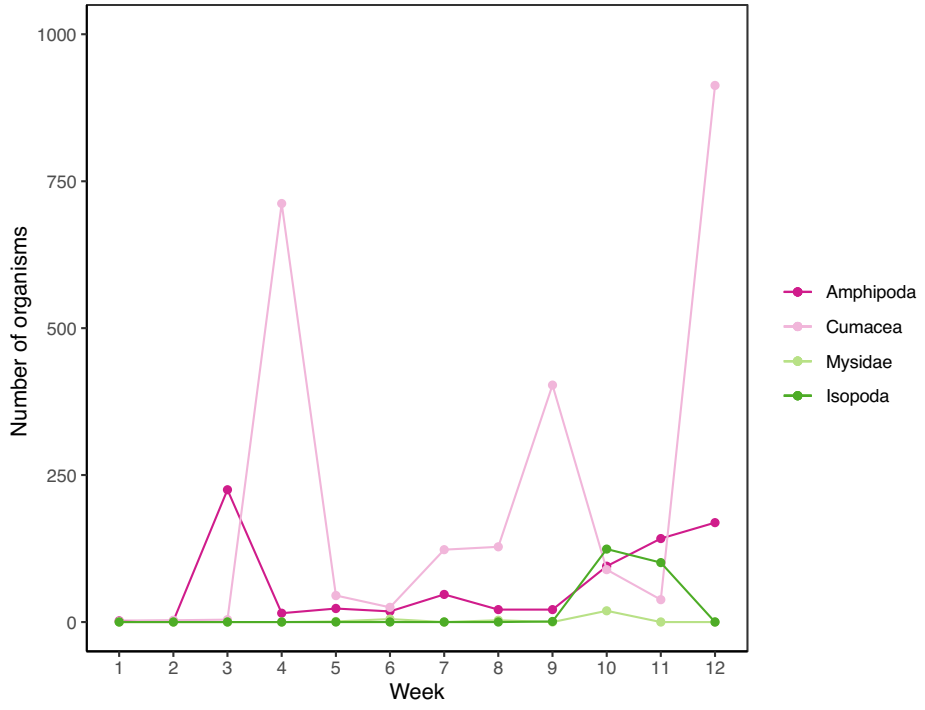

Fig. 6. Distribution of most frequently caught organisms in the field. Sampling took place during the months of May (week 1–2), June (week 3–5), July (week 6–8) and August (week 9–12).

monitor many areas over long periods.

Our traps were left overnight and possibly extending this time could have increased our chances of catching lobster larvae. However, leaving the traps for longer periods may also increase predation rates inside the traps. The risk of decapod larvae being eaten by predators in our traps is low, based on the few predators caught by our traps (e.g fish larvae). In a field study at the Bay of Fundy, Canada light traps were attended every 6–10 days and succeeded in catching *H. americanus* larvae (Sigurdsson et al., 2014). Leaving traps overnight (24 h) also successfully caught 32 stage I and 2 stage II *H. gammarus* larvae in Kåvra, Sweden (Øresland, 2007). Therefore, we suggest experiments should be conducted to compare the catch of the traps over 24 h to 10 days; to assess the optimal sampling duration. Our light trap was constructed and modified, based on the suggestions provided by Sigurdsson et al. (2014). We made the entry point (opening) of the traps smaller, by decreasing the size from 24 mm to 10 mm, since lobster postlarvae measure ca. 2–3 mm. Based on the low amount of known lobster larvae predators observed inside the traps (i.e fish), this modification can help prevent larger fish from entering the traps. Additionally, in our study we utilized a red PVC tube, but we recommend using a clear tube to enhance light dispersal and overall trap luminosity. Nonetheless, our traps did not catch any lobster larvae; but the trap's design proved to be adequate for capturing a variety of benthic and pelagic zooplankton.

Another possible explanation for why catching European lobster larvae around the island of Helgoland remains very difficult may be a distinctive negative phototactic response at early larval stages. A study carried out by Schmalenbach and Buchholz (2010) on the vertical positioning and swimming performance of lobster larvae at Helgoland showed that larvae had a marked positive response to light only at stage I. Moreover, with progressing larval age, the response to light decreases rapidly, in contrast to *H. americanus* larvae, which have been reported to be negatively phototactic in stage II and III, but again become positively phototactic shortly (~one day) before molting (Hadley, 1908). Another study on *H. americanus* reported early stage IV larvae to be highly photopositive, leading them to illuminated areas in the water column where planktonic food is expected to be more abundant (Botero and Atema, 1982). Observations of European lobster larvae' positive attraction to light throughout all larval stages are limited. However, a field study by Dunn and Shelton (1983) in Loch Ewe on the West Coast of Scotland noted that around dawn and dusk there was an aggregation of larval stages (I-III) in the upper three meters of the water column. Nevertheless, there is no confirmation that this vertical migration within the upper three meters was in response to light intensity or due to calmer conditions at dawn and dusk. Biological reasons for Helgoland's European lobster larvae' strong positive response to light in the first stage may be a way to promote dispersal throughout the rocky bottom around the island. Furthermore, the abrupt and early change in larval phototactic response to light may prevent larvae from drifting away from the suitable environment (Schmalenbach and Buchholz, 2010). This behavior combined with low lobster population numbers are potentially the reasons why catching lobster larvae around Helgoland remains a challenge.

Our laboratory experiment results showed our light traps were capable of luring and capturing larval lobster in different volumes and thus larval densities. Light traps were tested at different densities before conducting the field experiment. We started with a low volume and then increased it to a larger volume, aiming to reduce larval density and test the trap's efficiency threshold at the highest possible volume available in the laboratory facilities. These experiments focused solely on the first larval stage, since as mentioned this is the most positive phototactic stage. Therefore, our laboratory experiments have the limitation that the trap's efficiency could not be compared across larval stages. In the field, where a mixture of larvae between stage I to IV should be in the water column, we expected to catch a mix of larvae at different stages with the majority being in the early larval stages. The light sources used in our traps influenced the larvae capture rates and overall trap success. White LED lights captured more larvae than yellow chemical lights in the laboratory experiments overnight. Past light trap studies suggest that using a light source like LED appears to be the best option as they are robust, long-lasting, and more ecological (Sigurdsson et al., 2014; McLeod and Costello, 2017). The LED light we used had an intensity of 1.3 lm and was successful at catching larvae. Sigurdsson et al. (2014) compared capture rates between traps using different LED light intensities of 100 and 4 lm, and found no significant difference in capture rates between light intensities. The LED lights used in our experiments used re-chargeable AA batteries, and based on preliminary tests there was no reduction in light intensity after 72 h. Thus, we recommend using reusable white LED lights (PotLight, Fishtek Marine, UK) instead of single use chemical lights for light trap sampling.

To conclude, this study reports the first attempt to catch European lobster larvae around Helgoland, North Sea using an inexpensively constructed light trap. However, low number of adult lobsters around the island, combined with and early negative response to light, may be the major reasons why catching lobster larvae in the field remains challenging. Nevertheless, tube light traps from this study can be used for sampling of a variety of small crustaceans, especially cumaceans, amphipods, and isopods, which have a strong response to white LED light and can be easily captured by light traps during the summer season. Moreover, additional laboratory studies are needed to investigate the implications of the rapid decline in light response when testing lobster traps, as this study focused solely on the first larval stage.

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CRediT authorship contribution statement

Laura Leiva: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Luis Giménez:** Writing – review & editing, Supervision, Conceptualization. **Maarten Boersma:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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