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Habitat Use of Two Coral-Associated Cryptobenthic Gobiid Fishes (Family: Gobiidae) in the Southern Caribbean

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Abstract: Cryptobenthic fishes make up more than half of coral reef fish fauna and contribute greatly to coral reef trophodynamics and diversity. Because of their small size, they are easily overlooked and understudied. Some of them use corals as their habitat, but this association is not well understood. In the Caribbean, two common cryptobenthic gobies, *Elacatinus evelynae* and *Coryphopterus lipernes*, are usually observed residing on corals. In order to compare their habitat use, we investigated their distributions on a range of scleractinian host-coral species at three different depths (5, 10, and 15 m) at Curaçao, southern Caribbean. The numbers of both species were relatively low at 5 m. Furthermore, we investigated the relationship between fish size and depth and found that adult *E. evelynae* individuals were most common at 5 m depth and juveniles at 15 m depth. Novel host corals were found for both fish species. Taking host size into account, the gobies were most abundant on large coral colonies of two host species: *E. evelynae* on both *Colpophyllia natans* and *Montastraea cavernosa*, and *C. lipernes* only on *C. natans*. In summary, depth, host species, and host-colony size were found to be environmental factors that may determine the occurrence of both fish species.

Keywords: *Coryphopterus lipernes*; *Elacatinus evelynae*; depth range; fish size; host coral; coral-colony size

Key Contribution: The gobies *Elacatinus evelynae* and *Coryphopterus lipernes* use Caribbean corals as hosts. They show differences in their depth distribution, which is reflected by the choice of host corals available at different depths.

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Citation: Ziebell, A.-C.; Vogel, M.L.; Ratajczak, N.K.; Hoeksema, B.W. Habitat Use of Two Coral-Associated Cryptobenthic Gobiid Fishes (Family: Gobiidae) in the Southern Caribbean. *Fishes* **2023**, *8*, 531. https://doi.org/10.3390/fishes8100531

Academic Editor: Steven Saul

Received: 4 September 2023
Revised: 6 October 2023
Accepted: 19 October 2023
Published: 23 October 2023

1. Introduction

Corals contribute to coral reef biodiversity both by their own species numbers and by acting as hosts for a variety of associated animals [1–10]. They provide a habitat for various invertebrates, such as barnacles [11], copepods [12,13], crabs [11,14], shrimps [15–17], gastropods [18–22], bivalves [23], hydrozoans [24], acoel flatworms [25], and polycheate worms [26–28]. Additionally, they provide a habitat for various fishes, such as blennies [29,30], cardinalfishes [31], damselfishes [32,33], gobies [34–37], labrids [38], and pipefishes [39,40]. Many of these fishes are cryptobenthic species, which are defined by a length of less than 50 mm, cryptic morphology, hiding behaviour, and a close association with the benthos [41–43]. Many cryptobenthic species exhibit short life spans, rapid linear growth, high metabolic rates, fecundity, and mortality rates, resulting in a high productivity in relation to their biomass [43–49]. Additionally, cryptobenthic fishes occupy a low trophic level, making them responsible for transferring energy to higher trophic levels [41,48]. Co-occurring, closely related species may differ substantially in their diet, making them either generalist or specialist in their prey choice [49,50]. Some of them prey on coral-associated invertebrates, which may be harmful to corals as parasites [49], such as coral-gall crabs [11] and vermetid worm snails [51].

Initially, their small size led them to being overlooked in many visual censuses of coral reef biodiversity [52–56]. Adjusted methods make their immense densities noticeable, and they were shown to make up at least half of coral reef fish species [52,54–58]. Due to their high numbers, life history patterns and trophic level, cryptobenthic fishes play an essential role in coral reef trophodynamics and energy transfers [41]. Species that are habitat specialists are more threatened by specific environmental changes, such as the disappearance of certain host species [59], than habitat generalists, which can find alternative hosts [60]. Understanding the ecology and habitat use of cryptobenthic fishes will help to predict their responses to environmental changes caused by the various threats, which coral reefs are facing. Furthermore, this knowledge can aid in estimating future changes in coral reef fish populations because of the high importance of cryptobenthic fishes in coral reef dynamics.

The order Gobiiformes consists of 10 families, together comprising over 2000 species [61,62]. It includes the family Gobiidae, which is one of the most species-rich marine fish families [61]. Gobies make use of many different habitats, such as sand, seagrass and corals [34]. Studies from Australia, the Red Sea, and the Caribbean found that coral-associated gobies select for specific microhabitat traits and predominantly use certain host coral species [63–65]. Due to these habitat preferences, goby population dynamics are closely linked to the population dynamics of their host corals [66]. Furthermore, gobies may look for specific morphological traits in host corals, such as massive vs. branching colony shapes [36,67,68], which may help in determining their host association. In several studies from the Pacific, it was shown that the size of a coral positively correlates with its likelihood to be used as a host and the number of gobies that dwell on it [67,69,70].

In the Caribbean, associations of gobies with their host corals are not as well examined as in the Pacific. Our study thus focusses on the habitat traits of the two most common coral-dwelling gobies in Curaçao, southern Caribbean: *Elacatinus evelynae* (Böhlke & Robins, 1968) [71], commonly called the sharknose goby [72] and *Coryphopterus lipernes* Böhlke & Robins, 1962 [73], also known as the peppermint goby [74]. Although they are cryptic because of their small size, their motility, occasional occurrence in swarms, and exposed occurrence on top of corals make them easy to spot and to study by trained observers.

Elacatinus evelynae is recognizable by its bright yellow stripes that form a V-shape on its nose, which fades into blue stripes extending on the sides of its black body (Figure 1a). It is a common fish on coral reefs throughout all of the Caribbean and reaches a total length of around 4 cm [75]. *Elacatinus evelynae* has a depth range of 1–27 m [34]. Studies from Belize, Honduras, and St. Croix found the highest numbers at around depths of 4 m and 14–15 m [34,76]. It is a cleaner fish and maintains cleaning stations where it feeds on ectoparasites of bigger fish [77]. Moreover, *E. evelynae* feeds on coral polyps, sponges and copepods [78], some of which may perhaps occur in association with scleractinian corals [12,13]. It is regularly seen in pairs at their cleaning stations and is described to be monogamous [78–80]. It is also often observed in small groups of individuals varying in size (Figure 1b). It is possible to find pairs in and around a cavity, which could perhaps serve as a nest (Figure 1c,d). Various coral species have been recorded as hosts for *E. evelynae* before [81–83], but an extensive, systematic survey of its host-species range has not been conducted so far.

Coryphopterus lipernes is predominantly yellow with electric-blue markings above its eyes (Figure 2a). It is usually observed resting on coral heads, either solitarily or in groups [84] (Figure 2b). It is distributed all over the Caribbean [84], its range overlapping with that of *E. evelynae*. *Coryphopterus lipernes* can be seen year-round and is common at groove drop-offs [34,85,86]. Moreover, it has been found to move freely between several host corals, is diurnally active, and seems to be resting at night, adopting a duller colour [84].

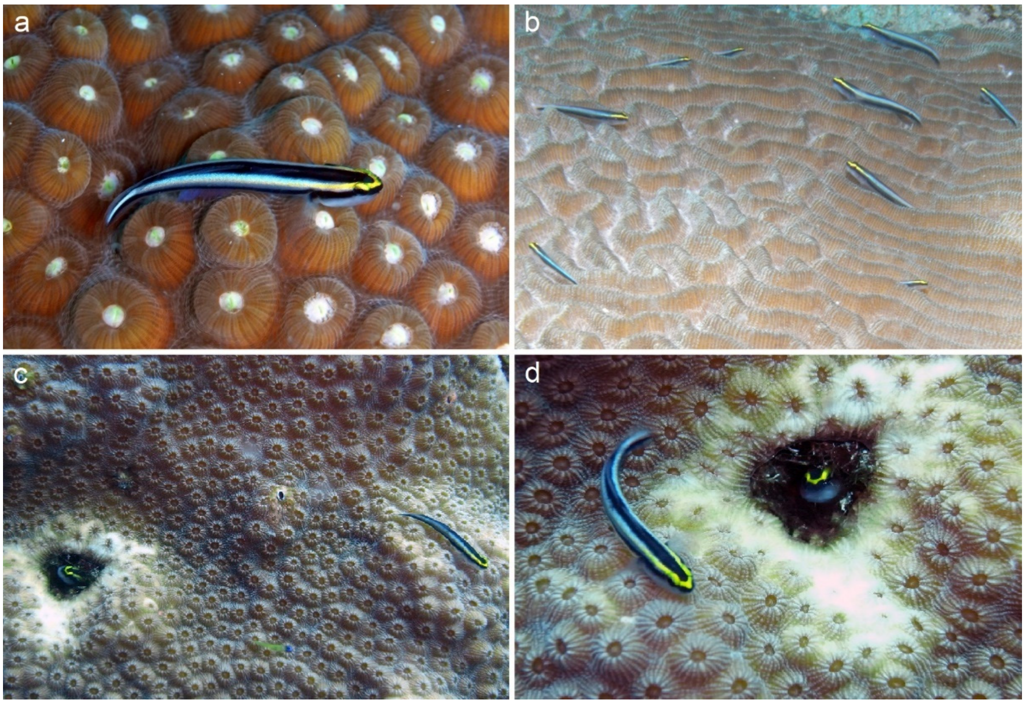

Figure 1. In situ photographs of *Elacatinus evelynae* at Curaçao. (**a**) An individual on *Montastraea cavernosa* (photo credit B.W.H.). (**b**) A group of nine individuals residing on *Colpophyllia natans* (photo credit M.L.V.). (**c**,**d**) A pair on *Orbicella franksi* with one individual inside a hole, which could be a nest, and another possibly guarding (photo credit B.W.H.).

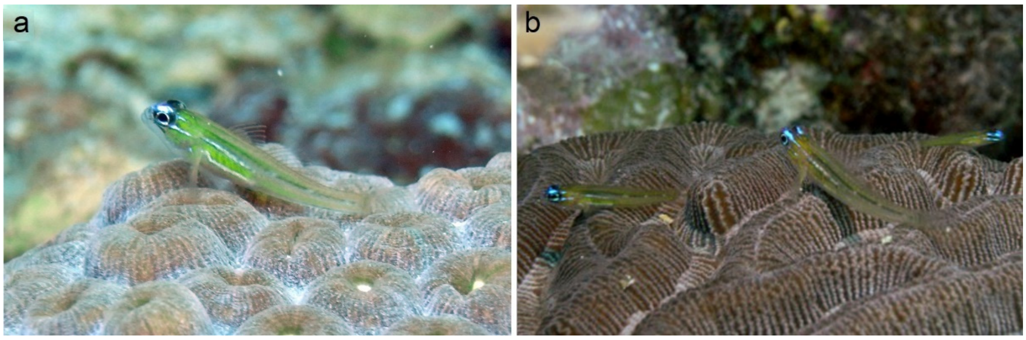

Figure 2. In situ photographs of *Coryphopterus lipernes* at Curaçao. (**a**) An individual on *Montastraea cavernosa* (photo credit B.W.H.). (**b**) A group of three individuals residing on *Colpophyllia natans* (photo credit A-C.Z.).

Unlike *E. evelynae*, *Coryphopterus lipernes* is not a cleaner fish and forages by chasing particles in the water column [84]. Its depth distribution appears to vary by location as its abundance peaks have been recorded at 25 m depth in Puerto Rico [86] and at depths of 12–15 m in Belize and Honduras [34]. Various scleractinian coral species have been described as hosts [84,87], but an extensive, systematic overview of its host-species range is lacking.

While the cleaning interactions of *E. evelynae* are subject of several studies, no ecological studies on *C. lipernes* have been conducted in the last two decades. The main record of numbers in relation to depth of both of these fishes in Curaçao is derived from a study in 1977 [85], which only focused on numbers of young recruits and did not tell how their entire populations were distributed.

The present study aims at evaluating the habitat utilization of both common fish species in Curaçao. We start by examining their depth distribution to fill the gap concerning their vertical distributions. Based on records from elsewhere [34,76] we hypothesise that both species show higher numbers at 15 m depth while *E. evelynae* could also be high in abundance at around 5 m depth. Furthermore, we test whether the size of the individuals is related to their most common depth range, as previous research has shown that young recruits of cryptobenthic fishes in Curaçao have abundance peaks at specific depths [85]. Moreover, we will investigate the hypothesis that both fishes make use of specific coral species and appear in higher numbers on larger coral colony sizes, as it has been shown for geographically distant populations of both fishes as well as related species [36,69,83]. By investigating the microhabitat use of *E. evelynae* and *C. lipernes*, we will contribute to a better understanding of the cryptobenthic fish fauna in the Caribbean to highlight their importance in coral reef ecosystems.

2. Materials and Methods

2.1. Study Locations

The fieldwork took place at Curaçao, an island in the southern Caribbean north of Venezuela. The island is surrounded by fringing reefs relatively close to the shoreline, with steep slopes that reach mesophotic depths down to over 80 m [88–91].

For this study we used eight locations at the leeward side of the island (Figure 3). To study the abundance of gobies per depth we took visual censuses at all eight locations. The gobies were perched on their host corals when they were detected by the observer. They did not move or made limited movements, while staying on top of their hosts. Their abundance, exposed positions, and mobility made them easy to notice and to study, probably more so than many other cryptobenthic fish species, making them ideal study objects. The data collected to investigate whether the size of gobies and depth are related to each other took place at seven dive sites (locations 1–5, 7, and 8). Data for analyses involving host-coral species were collected at five sites (locations 2, 4, 6, 7, and 8). Most sites were characterized by gently sloping reefs starting at depths of around 4–6 m. At Site 8 the reef slope was steeper than at the other sites and at Site 1 the rugosity of the reef was highest.

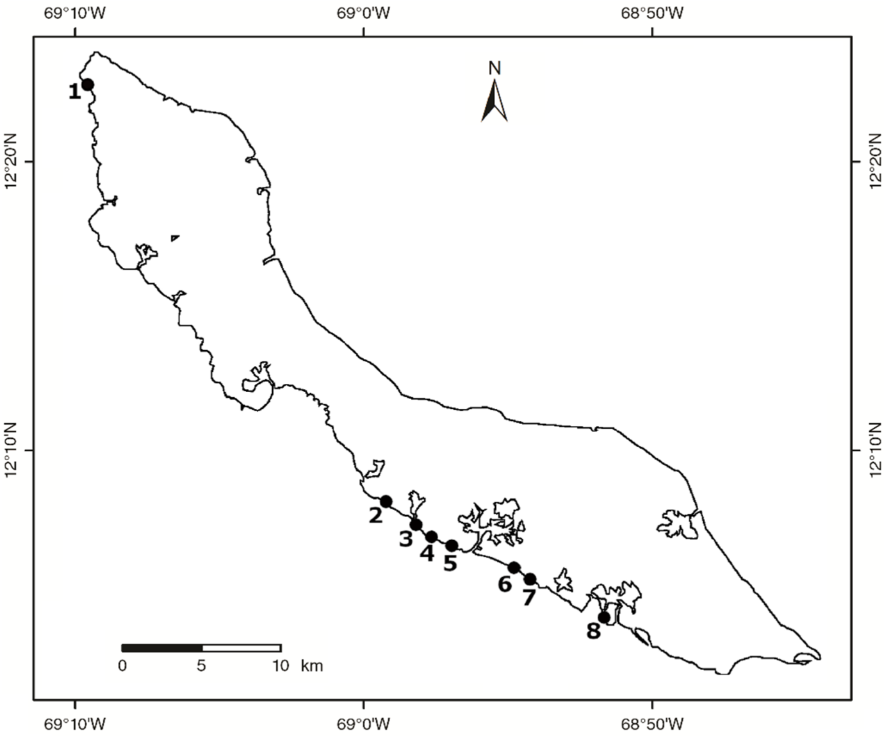

Figure 3. Map of Curacao showing survey sites: (1) Playa Kalki, (2) Blue Bay, (3) Parasasa Beach, (4) Water Factory, (5) Double Reef, (6) Marie Pampoen Sewage, (7) Marie Pampoen, and (8) Tugboat Beach.

2.2. Data Collecting

Data collecting took place in April and May 2022 by SCUBA diving. To analyse how their numbers depend on depth, the gobies were counted in a 50×1 m^2 belt transect at 5, 10, and 15 m depth. A 50-m tape measure was laid out at each depth, parallel to the shoreline, and visual census records of all visible gobies were taken while swimming along this line.

For the size analysis, all gobies found per depth ±1 m were sorted into two size classes (small and large). Due to their mobility when being approached too closely, exact size measurements were unfeasible. Thus, the size class of a fish was determined by its general morphology which differed evidently between juveniles and adults. Approximately, juveniles of *E. evelynae* were smaller than 2 cm and those of *C. lipernes* were smaller than 1.5 cm. The visual censuses were only taken by the first author to minimise perceptual bias.

To determine host use by both gobiid fishes, all the coral species that were present were inspected. We collected data as a team of three divers and each diver focussed on 2–3 coral species per dive and inspected each potential host coral colony at each depth for a dive time of around 20 min per depth. The numbers of both gobies per host coral were noted. In total, we monitored 16 scleractinian and two gorgonian coral species, *Gorgonia ventalina* and *Plexaura*/*Pseudoplexaura* spp. Approximate size measurements of the surface areas were taken for three commonly encountered, large host-coral species: *Montastraea cavernosa*, *Colpophyllia natans*, and *Pseudodiploria strigosa*. Additionally, a photograph of each inspected coral colony was taken to verify the species identity with the help of a field guide [92] and a recently published online photo album with updated nomenclature [93]. Our photos were taken with a Sea&Sea DX-1G (Nagasaki, Japan), a Sea&Sea DX-6G (Nagasaki, Japan) and a GoPro Hero 10 (San Mateo, CA, USA).

2.3. Statistical Analysis

The statistical analyses were carried out in R studio (R version 4.1.3) [94]. We set significance at an alpha level of 0.05 and a 95% confidence interval.

The depth distribution data of fish species were tested for normality with the Shapiro test of the 'stats' package by R Core Team [95]. The data were not normally distributed and we chose the Kruskal–Wallis test of the 'stats' package to investigate whether there were significant differences in the abundance of gobies per depth, as it is a nonparametric test for more than two groups [96]. After discovering the significant results, we used the 'FSA' package [97] to run a Dunn's multiple comparison test (post-hoc) with the Holm adjustment method to check between which depths the significant differences occurred.

To test whether there were significant differences in abundance between both species, we used a Wilcoxon test to compare their data for each depth. Since *C. lipernes* was uncommon at 5 m depth, we did not include these data for the following analyses. To examine whether the depth distribution of the two fish species depended on the size of the individuals, we used the Pearson's Chi-squared test for count data of the 'stats' package [85] with the variables 'depth' and 'size'. After finding a significant Chi-squared test result, we performed a pairwise comparison using the 'rcompanion' package to investigate the differences between the depths [98].

Per goby species, all scleractinian host species were compared regarding their proportions of corals that were occupied or not (prevalence). This comparison was performed by running a Fisher's exact test followed by a pairwise Fisher test to examine which coral species differed significantly from each other as hosts.

To gain insight into the microhabitat traits of both fishes, the coral size preferences were investigated. The three most dominant hosts were grouped into three size classes according to each host's maximum surface area: small, medium and large (Table 1). Five Fisher's exact tests and pairwise Fisher tests were conducted to investigate the relationship between coral size and goby occupancy for each fish and host species. Because *P. strigosa* mainly occurred at 5 m depth, there were not enough data points taken for *C. lipernes* to make an analysis for this host species feasible.

Table 1. Three size classes implemented for three large, common host corals of *Elacatinus evelynae* and *Coryphopterus lipernes*.

Coral Species	Small	Medium	Large
Montastraea cavernosa	$\leq$600 cm^2	$\leq$1200 cm^2	>1200 cm^2
Colpophyllia natans	$\leq$1200 cm^2	$\leq$2400 cm^2	>2400 cm^2
Pseudodiploria strigosa	$\leq$800 cm^2	$\leq$1600 cm^2	>1600 cm^2

Per fish species, we then analysed whether the sizes and depths of *M. cavernosa* and *C. natans* colonies influenced the numbers of individuals resting on them. As the data did not meet normality assumptions, we tested four different regression models created with the 'glmmTMB' package [99] for each combination of fish and coral species to decide which one would fit the data in the most optimal way. By using the 'DHARMa' package [100], we tested for overdispersion for each model and examined the residuals for the best-fitting model. The best-fitting model was determined by comparing the AIC values of the models using the 'bbmle' package [101]. To investigate the effect of coral size and depth on the number of *E. evelynae* per *M. cavernosa* colony, we used a negative binomial regression model with the location as a random effect. Despite using the best-fitting model, the residuals for the effect of coral size showed some problems, and thus the results should be interpreted with caution. Numbers of *E. evelynae* on *C. natans* and numbers of *C. lipernes* on both coral species were analysed by using a negative binomial regression model.

3. Results

3.1. Depth Distributions

Depth significantly influences the distribution of both gobies, *E. evelynae* (χ^2 = 6.7605, df = 2, p = 0.034) and *C. lipernes* (χ^2 = 11.511, df = 2, p = 0.003) (Figure 4). At 15 m depth, higher numbers of *E. evelynae* were present than at 5 m (p = 0.035), but no significant differences were detected between 5 and 10 m depth (p = 0.125), as well as between 10 and 15 m depth (p = 0.496) (Figure 4a). *Coryphopterus lipernes* showed a similar pattern, with higher numbers at 15 m compared to 5 m (p = 0.002) but not when compared to 10 m (p = 0.234). Although numbers of *C. lipernes* were higher at 10 than at 5 m depth, this difference was also not significant (p = 0.056; Figure 4b). We recorded 1.3 m and 4.8 m as the shallowest depths outside the transects for *E. evelynae* and *C. lipernes*, respectively.

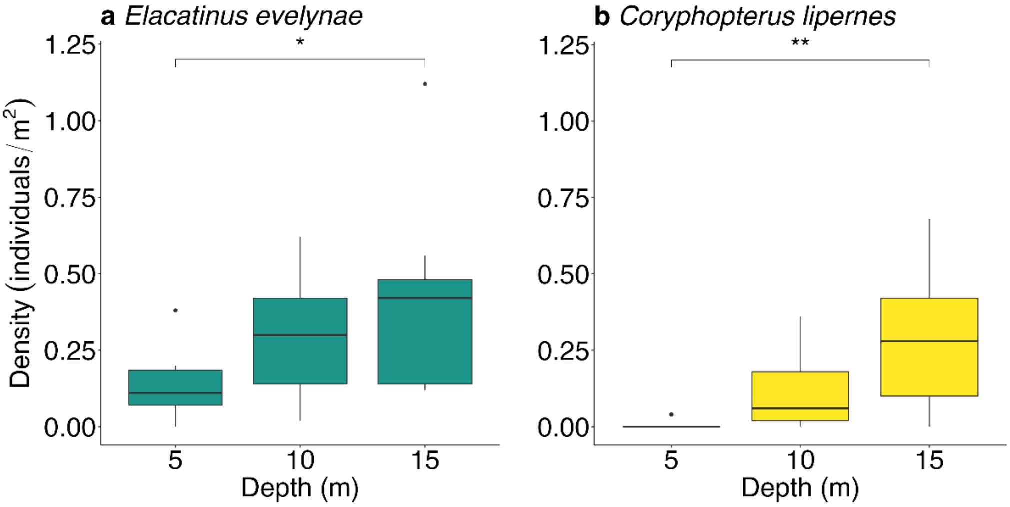

Figure 4. Boxplots comparing abundances of *E. evelynae* (**a**) and *C. lipernes* (**b**) across three different depths. Asterisks indicate significant p-values: * = $p < 0.05$, ** = $p < 0.01$. Dots (●) indicate outliers.

Furthermore, *E. evelynae* had a higher abundance than *C. lipernes* at 5 m depth (W = 59, $p = 0.003$) and at 10 m (W = 64.5, $p = 0.037$), but no significant difference between the two species was detected at 15 m (W = 50.5, $p = 0.400$; Figure 5).

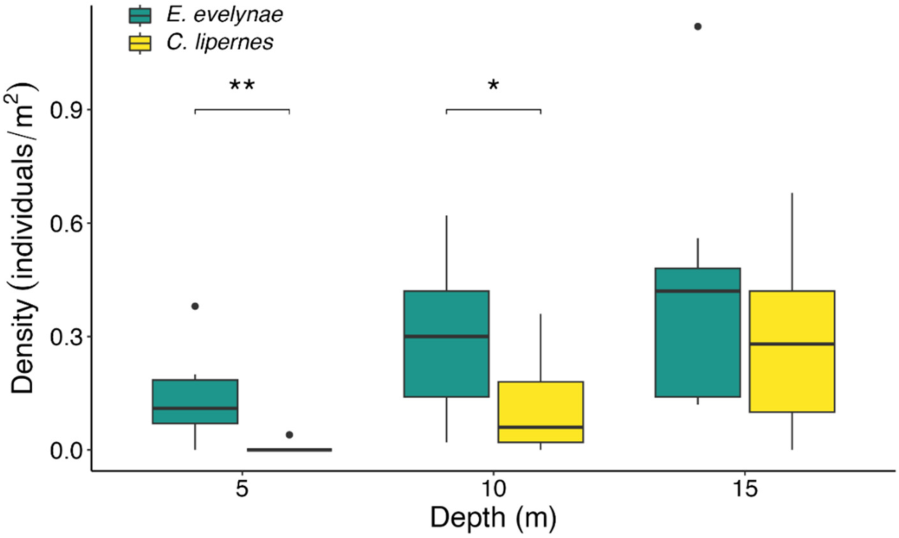

Figure 5. Boxplots comparing abundances of *Elacatinus evelynae* and *Coryphopterus lipernes* at three different depths. Asterisks indicate significant *p*-values: * = $p < 0.05$, ** = $p < 0.01$. Dots (●) indicate outliers.

3.2. Influence of Body Size on Depth Distribution

Elacatinus evelynae. The variables depth and size were dependent on each other ($\chi^2(2, n = 704) = 28.328$, $p < 0.001$; Figure 6a). The pairwise comparison indicated a significant difference in the proportion of the two size classes between 5 and 10 m depth ($p < 0.001$) and between 5 and 15 m depth ($p < 0.001$). Between 10 and 15 m depth no significant difference was found ($p = 0.889$).

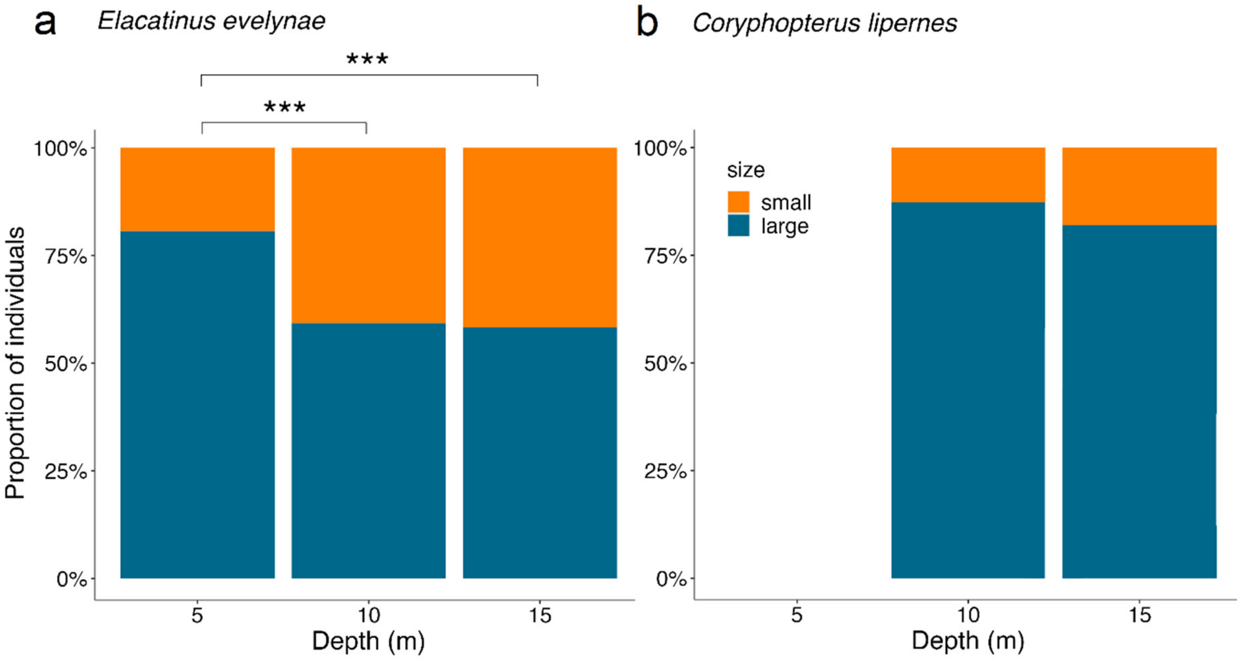

Figure 6. Proportions of small- and large-sized individuals in relation to depth of (**a**) *Elacatinus evelynae* and (**b**) *Coryphopterus lipernes*. Asterisks indicate significant *p*-values: *** = $p < 0.001$.

Coryphopterus lipernes. The Chi-square test on the size data of *C. lipernes* showed that the variables size and depth were independent of each other ($\chi^2(1, n = 324) = 0.81154$, $p = 0.3677$; Figure 6b). The number of individuals at 5 m depth was insufficient for statistical analysis.

3.3. Coral Habitat

Elacatinus evelynae inhabited 11 out of 16 observed scleractinian host species (Figure 7). The host species *C. natans*, *M. cavernosa* and *Orbicella faveolata* showed the highest proportion of corals with *E. evelynae* present (ESM Table S1). This fish was not observed on the coral species *Meandrina meandrites*, *Madracis auretenra*, *Eusmilia fastigiata*, *Dendrogyra cylindrus* and *Agaricia agaricites*. Neither was it represented on the octocorals *Gorgonia ventalina* and *Plexaura/Pseudoplexaura* spp.

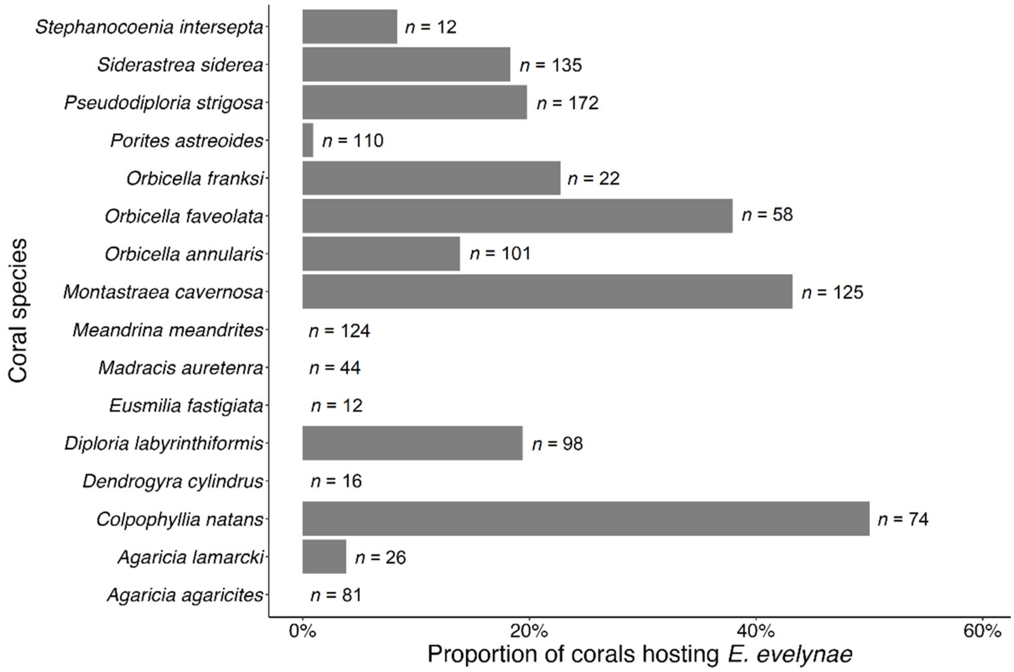

Figure 7. Overview of examined coral species with an indication of the proportion of corals hosting *Elacatinus evelynae*.

Based on coral size measurements and division in size classes (Table 1) of the host species *M. cavernosa*, *C. natans* and *P. strigosa*, an effect of size on the proportion of corals with *E. evelynae* present was observed (Figure 8). Medium and large-sized *Montastraea cavernosa* corals had significantly higher proportions of corals with *E. evelynae* than small-sized corals ($p = 0.020$ and $p < 0.001$, respectively; Figure 8a). No significant difference was found between medium and large corals of this species ($p = 0.825$). The same pattern was observed for *C. natans* corals (Figure 8), where significantly higher proportions of medium- and large-sized corals were used by *E. evelynae* than of small corals ($p = 0.003$ and $p < 0.001$, respectively), while no significant difference between medium- and large-sized corals occurred ($p = 0.078$). For *P. strigosa* (Figure 8c), large corals showed a significantly higher proportion of occupation than small ($p = 0.002$) and medium ones ($p = 0.044$).

The negative binomial regression model revealed that the number of gobies depended on the size of *M. cavernosa* colonies ($p < 0.001$; Figure 9a). The same result was found for *C. natans* hosts ($p < 0.001$; Figure 9b).

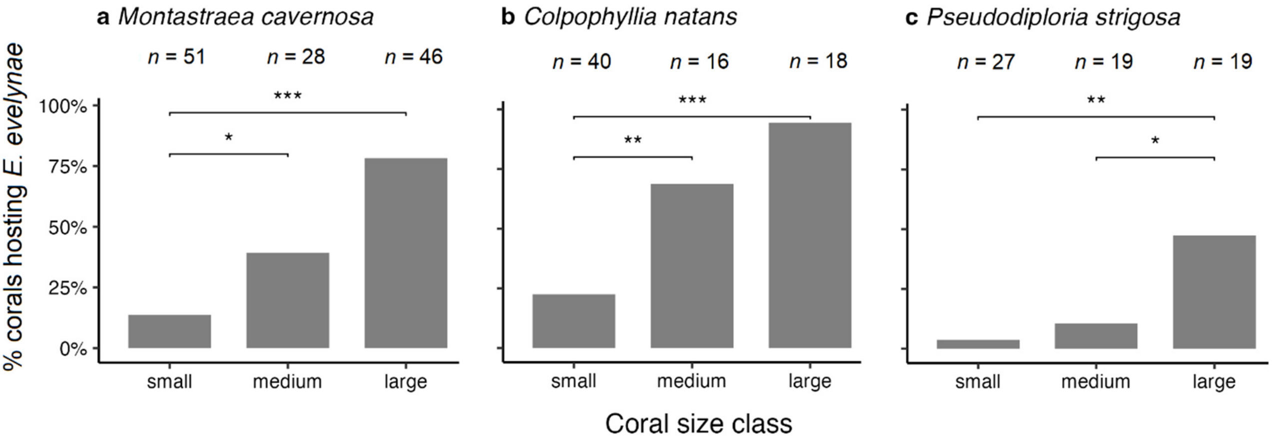

Figure 8. The proportions of all host coral species *Montastraea cavernosa* (**a**), *Colpophyllia natans* (**b**), and *Pseudodiploria strigosa* (**c**) with *Elacatinus evelynae* present in relation to the host's size class. Asterisks indicate significant p-values: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

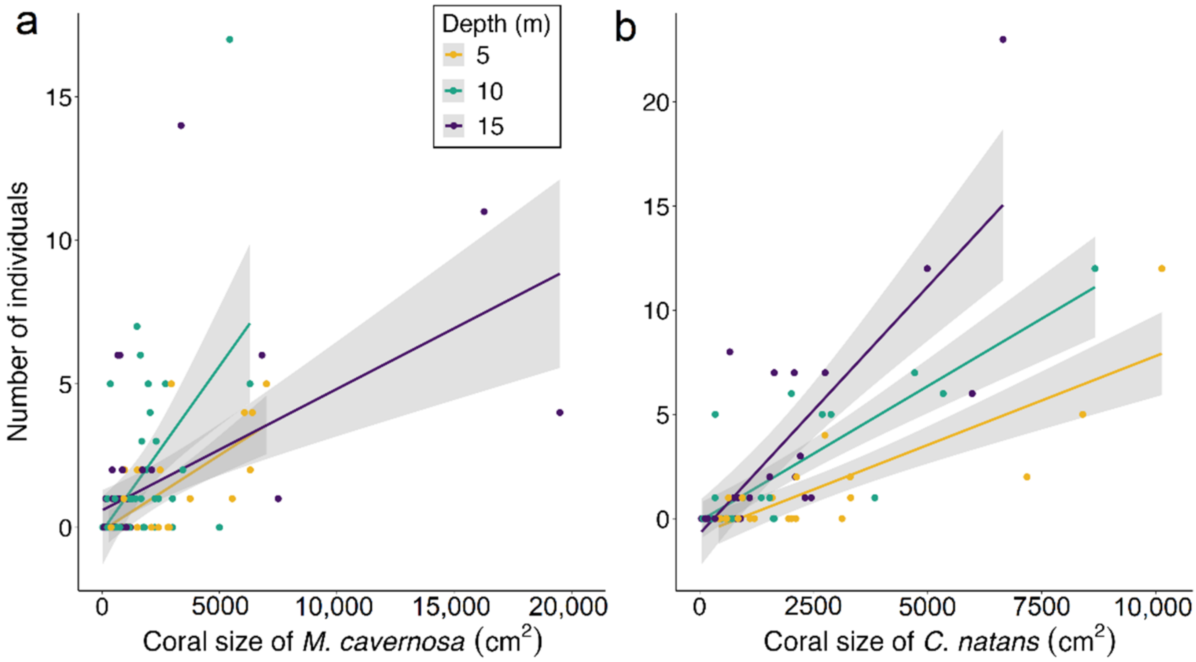

Figure 9. Numbers of *Elacatinus evelynae* individuals on different sizes of *Montastraea cavernosa* (**a**) and *Colpophyllia natans* (**b**). Shaded areas indicate 95% confidence interval.

Coryphopterus lipernes was found on 12 out of 16 observed coral species (Figure 10). The host species *Orbicella franksi*, *C. natans* and *Stephanocoenia intersepta* had the highest proportion of coral colonies occupied by *C. lipernes* (ESM Table S2). *Coryphopterus lipernes* was not observed on the coral species *M. auretenra*, *E. fastigiata*, *D. cylindrus*, *A. agaricites*, and gorgonians.

When investigating the effect of different size classes on the proportion of coral colonies with gobies, no significant differences between size classes could be found for *M. cavernosa* (p = 0.1134; Figure 11a). For *C. natans*, the Fisher's exact test was significant (p = 0.044) but the pairwise comparison did not show significant results. A comparison between only small and large corals, as extremes, also did not show a significant difference in the occupancy by *C. lipernes* (p = 0.087; Figure 11b).

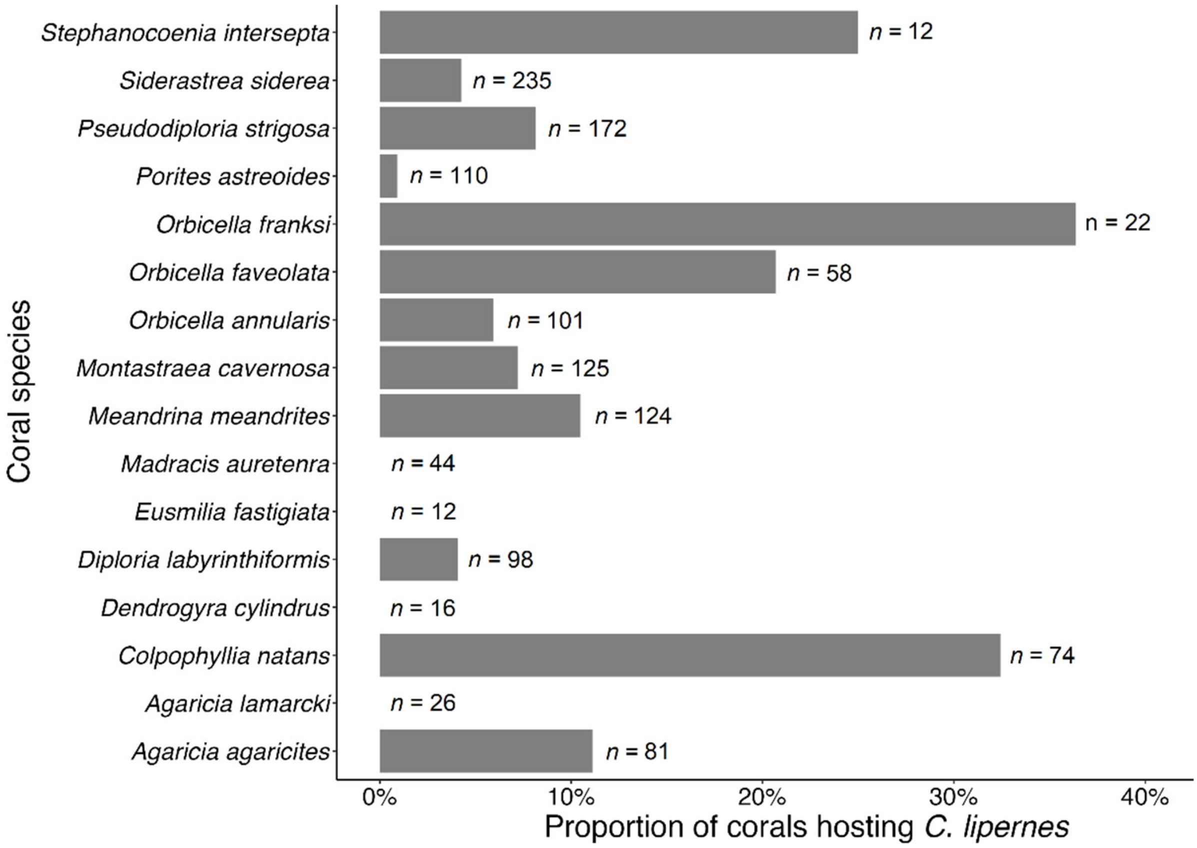

Figure 10. Overview of the coral species that were examined during this study with indication of the proportion of corals with *Coryphopterus lipernes*.

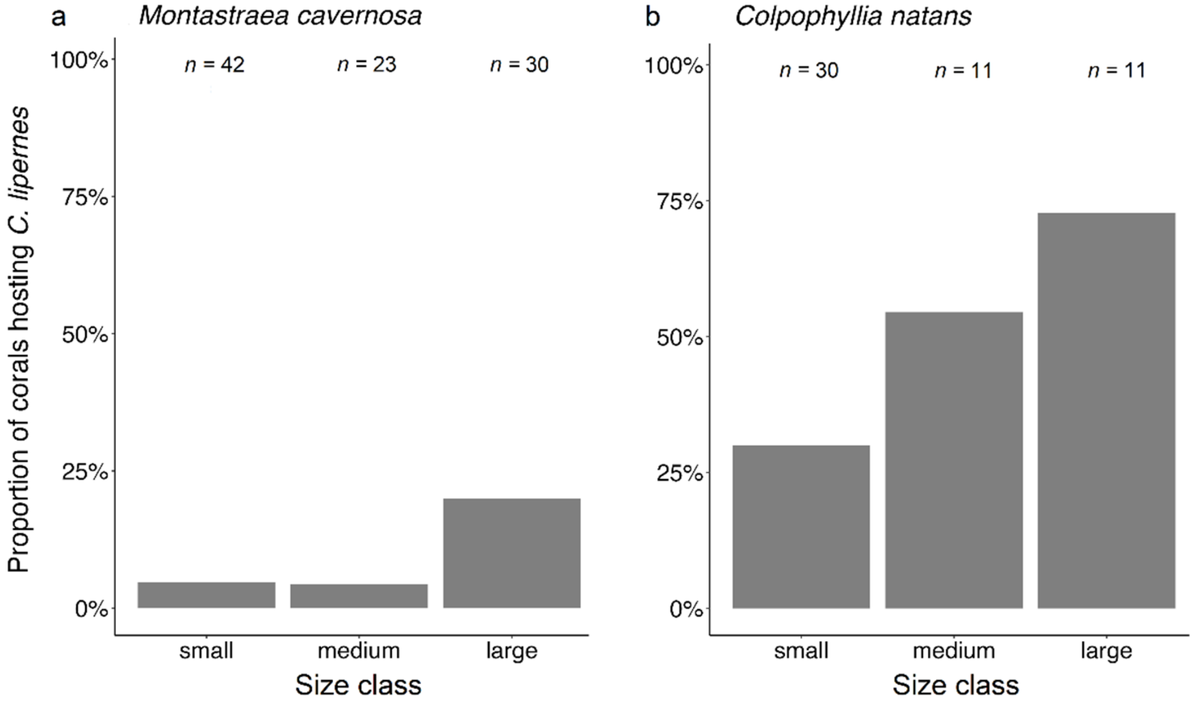

Figure 11. The proportions of all *Montastraea cavernosa* (**a**) and *Colpophyllia natans* (**b**) colonies with *Coryphopterus lipernes* present in relation to the host's size class.

According to the negative binomial regression, the number of *C. lipernes* was not related to the depth and size of *M. cavernosa* hosts ($p = 0.979$; Figure 12a). In contrast, the size of *C. natans* colonies did influence the numbers of associated *C. lipernes* ($p = 0.001$; Figure 12b). In addition, *C. natans* colonies at 15 m depth had significantly higher numbers of gobies than at 10 m ($p = 0.007$).

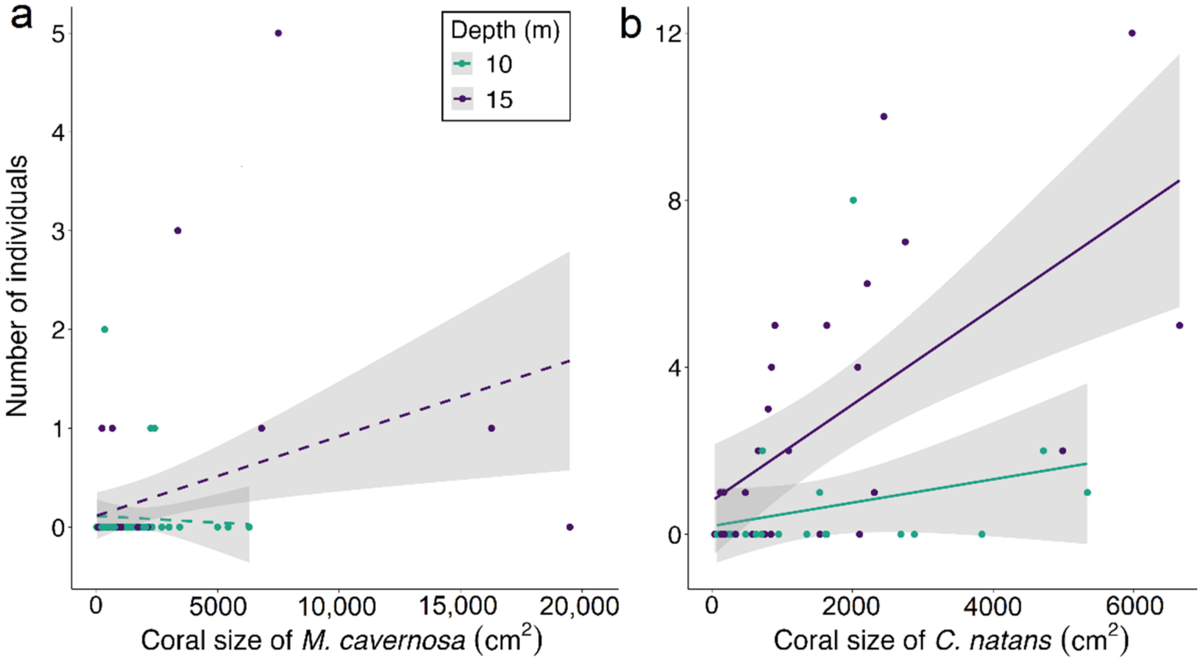

Figure 12. Number of *Coryphopterus lipernes* individuals on different sizes of *Montastraea cavernosa* (**a**) and *Colpophyllia natans* (**b**). The regressions for *Montastraea cavernosa* are not significant. Shaded areas indicate 95% confidence interval.

4. Discussion

4.1. Depth Distribution

The present study found differences in the bathymetric distribution and habitat use of two co-occurring cryptobenthic gobies in the southern Caribbean. It is not uncommon for reef–fish fauna compositions to vary with depth [102,103], and both goby species are known to show variation in densities along their depth ranges [34,76]. In accordance with the literature, our results illustrate that both fish species occur in different numbers at the three surveyed depths. A combination of different factors influences the depth ranges and most common depths of fish species, affecting both their larval recruitment and post-larval survival and growth. Larval settlement is often seen as playing a deciding role in the habitat distribution of fish, such as in damselfishes [104]. Furthermore, settlement could be a response to host preferences [105]. The coral species that were regular hosts for the two fishes are commonly found below 6 m depth [106]. Since the fishes are coral-associated and their most common hosts are abundant below 6 m depth, it is plausible that the associated fishes also show higher occurrences at these depths, in particular at 15 m as in the present study. We found that *E. evelynae* was significantly more abundant at 15 m than at 5 m depth, which is partly in accordance with the results of previous studies, which have reported peak numbers at a depth of 15 m [34,76]. A study in Honduras and Belize found a second peak at 3–6 m depth [34]. The bathymetrical distribution of *E. evelynae* thus seems to be location-specific as we did not find any hints on shallower peak numbers in the present study. Thus, we cannot make a general statement about depth distributions of all *E. evelynae* populations in the Caribbean.

Our study found that *C. lipernes* only rarely occurs at 5 m depth, which is consistent with an absence of *C. lipernes* records shallower than 6 m in Belize and Honduras [34].

In that study, the highest occurrence of *C. lipernes* was observed at depths of 12–15 m, which coincides with our highest recorded depth of around 15 m. Furthermore, we found significantly higher average numbers of *E. evelynae* than *C. lipernes* at 5 and 10 m depth, which is in accordance with the results of the previous study [34]. In contrast with our results, that study [34] also found that *C. lipernes* numbers dominated those of *E. evelynae* at 12–15 m depth and at deeper depths. That study did not statistically test these differences and only stated average numbers, making comparisons with our findings less reliable. We can thus assume that *E. evelynae* is generally more abundant than *C. lipernes* at depths up to 15 m, but there can be local differences. We expect *C. lipernes* to be more abundant in deeper waters than *E. evelynae*. Our study could have benefited from monitoring at greater depths, as well as more sampling stations along a depth gradient to give a clearer picture of the depth-related abundance patterns of both gobies at Curaçao.

4.2. Relation between Goby Body Size and Depth Distribution

The relationship between size class and depth distribution appeared to be significant for *E. evelynae*. There were fewer small individuals present at the shallowest depths than at both deeper depths and the proportion of the two size classes differed significantly at 5 m compared to 10 and 15 m depth. As no data are available on how size and depth distributions of *E. evelynae* might be related, we can only speculate about mechanisms that drive this size-related distribution. Generally, the larvae of fish show species-specific bathymetrical distributions [107]. Larvae of gobiids on an Australian reef were sampled at depths from 0 to 20 m and their numbers increased with depth [108]. Additionally, gobiid larvae in the Caribbean were caught more numerously in greater depths compared to just 1.5 m below the surface [109]. While we do not specifically know about the vertical distribution of *E. evelynae* larvae, we can assume that they show similar depth ranges as their gobiid relatives because of the higher abundance of smaller individuals at the deeper depths.

The higher numbers of large *E. evelynae* individuals at 5 m could be a result of decreased interspecific competition due to a relatively low number of *E. evelynae* here. This could provide them with more clients from which they feed, which in turn might help them to grow larger, as growth positively correlates with feeding success in many fish species [110]. Nevertheless, no studies are known concerning the relationship of feeding success and growth rate of *E. evelynae*, or regarding a depth-dependent foraging success. Neither did we find records of predatory species that feed on *E. evelynae*. We can thus not be certain which factors play a role in its size-dependent depth distribution.

For *C. lipernes*, there was no significant relationship between these two variables, which means that the two different size classes roughly showed the same proportions at each depth. We only tested two depths and *C. lipernes* has been shown to have greater abundances at around 20–25 m [86]. A previous study from Curaçao has shown that recruits of *C. lipernes* were the most abundant at 20 m depth [85]. To clarify whether size and age of *C. lipernes* varies with depth, it is, therefore, recommended to collect data on deeper transects.

4.3. Coral Habitat

When comparing host-corals between the two gobies based on the present results and records from other localities, it is relevant to know that nearly all reef coral species in the Caribbean have wide distributions [111] and that host utilization is not depending much on the presence and absence of potential hosts. We found 11 coral species as host of *E. evelynae*. Eight of these have been reported before [81,82], the new ones being *Agaricia lamarcki*, *Orbicella franksi*, and *O. faveolata* (ESM Table S3). Coral species previously recorded as hosts but not in the present study are *Pseudodiploria clivosa* and *Siderastrea radians* [81]. These two species usually occur shallower than our survey range, <5 m [93], whereas *E. evelynae* was not found at <10 m. It is possible that these earlier records were based on misidentifications of the hosts, since *P. clivosa* can easily be confused with *P. strigosa*, and *S radians* with

S. siderea [93]. Based on the literature and our own findings we can conclude that *E. evelynae* makes use of a small proportion of ca. 60 scleractinian reef-coral species reported from the southern Dutch Caribbean [88,112], and that it is most common on *M. cavernosa*, *Orbicella* spp., and *C. natans*.

Coryphopterus lipernes has previously been observed on several of the host corals also found by us [84,87]. To our knowledge, we provide new host records of *Stephanocoenia intercepta*, *Orbicella franksi*, *O. faveolata*, and *M. meandrites* (ESM Table S4). Coral species previously recorded as hosts but not in the present study are: *Manicina areolata* [87], *Mycetophyllia lamarckiana* [84], and *Pseudodiploria clivosa* [87]. The first one has a distribution that is usually deeper than our survey range [93,112], whereas the last one usually occurs at depths < 5 m [93], which is shallower than our survey. It is also possible that these two earlier host records are based on misidentifications, since *M. areolata* can easily be confused with *C. natans*, and *P. clivosa* with *P. strigosa* [93]. Both fish species, therefore, show a wide scleractinian host range, using some of them more than others. They can thus be seen as habitat generalists rather than specialists, as has been pointed out in an earlier study [34].

It is surprising that some common coral species were not observed to act as hosts. Both gobies were rarely seen on *Porites astreoides* (appearing as massive boulders) and not at all on *Madracis auretenra* (producing large patches of finely branching corals). Furthermore, the common massive coral *Meandrina meandrites* was not observed as host for *E. evelynae* and the foliaceous coral *Agaricia lamarcki* not for *C. lipernes*. Although the gobies acted as host generalists, they did not appear to associate with hosts at random because some coral species were avoided by them.

The two fish species showed much similarity in host choice, but there were also some differences (Figures 7 and 10), like *E. evelynae* occurring on *Agaricia lamarcki*, but *C. lipernes* not. On the other hand, *C. lipernes* was the only goby observed on *Agaricia agaricites* and *Meandrina meandrites*. The two fishes also showed differences in host dominance. *Colpophyllia natans*, *Montastraea cavernosa*, and *Orbicella faveolata* were the most used host corals of *E. evelynae*, whereas *Orbicella franksi*, *Colpophyllia natans*, and *Stephanocoenia intersepta* were the most used of *C. lipernes*. This difference in host dominance is related to the depth distribution of the hosts, with the deeper living *C. lipernes* occurring more abundantly on deeper coral species [93].

Research on the settlement behaviour of young *E. evelynae* showed that larger corals receive more settlers in comparison to small corals [81], which coincides with our findings. Furthermore, it is striking that the most popular host species that both gobiids visit generally offer a large surface area that is either a horizontal plate, a boulder, or a dome-shaped coral. *Madracis auretenra*, *E. fastigata* and *D. cylindrus* as well as *G. ventalina* and *Plexaura/Pseudoplexaura* spp. did not act as hosts. These corals differ from the host corals by being branching, by possessing small tentacles, or by having a surface area in a predominantly vertical orientation. This could be an indication that the coral morphology may also determine whether it is a suitable habitat for gobies. Other studies have investigated the link between the morphology of corals and their acceptance as hosts by *E. evelynae* and found that corals used as cleaning stations were taller and more structurally complex [83]. Moreover, their results indicated that cleaning stations had a lower surface to volume ratio than corals that were not used by *E. evelynae*. In another study it was found that only surface area and not height of corals influences their chance of *E. evelynae* recruits settling on them [81]. Thus, the current literature does not give a clear picture of how the characteristics of corals influence their probability of being goby hosts. Nevertheless, these combined results show that the size of corals influences their likelihood of being accepted as hosts by *E. evelynae* and *C. lipernes*. A larger coral size alone cannot be the only relevant factor in host choice, as some gobies were found on much smaller corals. Since *E. evelynae* is a cleaner fish, it seems obvious that it would select for corals that provide a visible and attractive cleaning station for the fish that it cleans. The position on the reef, height or limited intraspecific competition could be characteristics that make a cleaning station more visible despite a smaller size. *Coryphopterus lipernes*, however, is not a cleaner fish but also shows a trend of being most common on larger corals. The ecological drivers of this distribution remain poorly understood and further studies are needed to investigate which role other morphological traits apart from coral size play.

Furthermore, we show that the size of a coral does not only influence its likelihood to be a host but also the number of gobies that are resting on it. Often, the size of a host positively correlates with the number of organisms inhabiting it, as it was shown for fish as hosts for parasites [113] and for corals as hosts for various symbionts [1–9,114]. This is also the case for several goby–coral associations in the Pacific [67,69,70]. Additionally, the number of older fish present on a coral before a settlement event was positively correlated with the number of new settlers [81]. These findings suggest that *E. evelynae* settlers select for the same corals as earlier occupants. In temperate regions, shoaling behaviour of gobiid larvae has been reported for *Gobiosoma bosci* [115] and *Gobiusculus flavescens* [116]. Shoaling behaviour could be a reason why larvae settle on the same corals, but we do not know whether this behaviour can be seen in the larvae of *E. evelynae* and *C. lipernes*. A study of damselfish showed that larvae use dissolved chemical cues to settle on corals with resident older conspecifics [117]. Since older and younger gobies co-occurred on the same host corals, it is possible that the larvae of *E. evelynae* and *C. lipernes* also use resident older gobies as indicators of where to settle. This would benefit gobies which use corals as cleaning stations, such as *E. evelynae* [80]), since client fish that need to be serviced would benefit from the same host corals being used by generations of fish. Such site fidelity [74,76] implies that it would not be common for juvenile cleaner fish to start new cleaning stations and colonize corals by themselves, except when they are outcompeted [74] or older host corals die. Nevertheless, the settlement behaviour of these two fishes is too poorly understood to draw conclusions about the drivers of habitat selection in early life stages. Neither is information available about their dispersal behaviour and how they actively switch between hosts in post-juvenile stages. Observational studies could provide further insights into their microhabitat utilization.

5. Conclusions

This study provides evidence that two common coral-dwelling gobiid fishes in the southern Caribbean show selective behaviour in their host use. Not only do they appear in higher numbers at certain depths, but they also occur more abundantly on specific coral species and large coral sizes. Nevertheless, the mechanisms of how *E. evelynae* and *C. lipernes* select for or against corals are not well enough understood. Coral species with small maximum sizes and shallow depth ranges appear to be the least preferred as hosts.

Additional research on larvae and settlement behaviour is needed to understand what might drive larvae to settle on a specific coral and it should be investigated how environmental factors such as coral cover, feeding success and predation in relation to depth might affect goby mortality, growth and coral association after the larval stage.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/fishes8100531/s1, Table S1: Results of the pairwise comparison of all coral species for *Elacatinus evelynae;* Table S2: Results of the pairwise comparison of all coral species for *Coryphopterus lipernes*; Table S3: Comparison of present host-species records of *Elacatinus evelynae* to the literature findings; Table S4: Comparison of present host-species records of *Coryphopterus lipernes* to the literature findings.

Author Contributions: Conceptualization, A.-C.Z. and B.W.H.; methodology, A.-C.Z., M.L.V., N.K.R. and B.W.H.; investigation, A.-C.Z., data curation, A.-C.Z.; writing—original draft preparation, A.-C.Z. and B.W.H.; writing—review and editing, A.-C.Z., M.L.V., N.K.R. and B.W.H.; supervision, B.W.H.; project administration, B.W.H.; funding acquisition, A.-C.Z. and B.W.H. All authors have read and agreed to the published version of the manuscript.

Funding: Fieldwork at Curaçao was supported by the Jan Joost ter Pelkwijk Fund, A.M. Buitendijk Fund, and the Groningen University Fund.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Data are available online as Electronic Supplementary Materials.

Acknowledgments: We are grateful to the funding agencies mentioned above. We thank the staff of CARMABI and the Dive Shop for their assistance and hospitality. We are indebted to four anonymous reviewers for their constructive comments, which helped us to improve the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

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