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Coral reef fish association and behaviour on the fire coral *Millepora* spp. in north-east Brazil

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The branching structure of the coral colonies from the genus Millepora *provides substrate, shelter, and food resources for several reef organisms, such as fish and invertebrates. The present work analysed the association and behaviour of reef fish on the fire coral* Millepora alcicornis *and* M. brasiliensis *from September 2010 to February 2011, on the coastal reefs of Tamandaré, north-east Brazil. A total of 473 reef fish individuals of 27 species were sighted associated with the coral colonies, mainly composed of juveniles (65%). The most frequently observed behaviours were sheltered/stationary and swimming close to the coral; however, individuals were also observed foraging and breeding among* Millepora *spp. branching colonies. The agonistic behaviour performed by* Stegastes fuscus *individuals was highlighted in the present study, especially against* Chaetodon striatus, Diodon holacanthus *and* Ophioblennius trinitatis *individuals.* Millepora *spp. hydrocorals are ecologically important for juvenile and adult reef fish belonging to several trophic guilds. The complex structure of the coral colonies provides a wide variety of ecological functions on coral reefs (e.g. shelter, reproduction area, food and even territory). Nevertheless, the abundance of branching fire coral in Brazilian reefs have been declining over the past years; therefore, efforts must be made to protect this key habitat.*

Keywords: Hydrozoa, interactions, Pernambuco, habitat, substrate

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INTRODUCTION

The reef ecosystem holds a high diversity of species living associated (Pennings, 1997; Sale, 2002) and is known for their ecological, economic, and social importance (Bryant *et al.*, 1998). Reefs represent hard substrates colonized by diverse coral fauna and can take the form of banks or sandstones reefs (beach rocks), algal reefs, volcanic islands, ship wrecks or coral reefs (Amaral *et al.*, 2002, 2007).

Despite the fact that there is not a high diversity of corals in Brazilian waters, most of the species can be considered endemic (Leão & Dominguez, 2000). This fact characterizes Brazilian reef ecosystem as the one with higher rates of endemism in the world (Maida & Ferreira *et al.*, 1997). However, the structural complexity of reefs in the region is smaller compared to the Tropical Caribbean and Indo Pacific, except for the branched fire coral of the genus *Millepora* (Leão & Dominguez, 2000).

Species from the genus *Millepora* are colonial polypoid hydrocorals (Boschma, 1948) found on coastal reefs throughout the world and considered the second most important reef formers, being surpassed only by hermatypic corals (Lewis, 1989). Four species of the genus *Millepora* have been identified along the Brazilian coast: *Millepora alcicornis* (Linnaeus, 1758), *M. brasiliensis* (Verrill, 1868), *M. nitida* (Verrill, 1868) and *M. laboreli* (Amaral *et al.*, 2008). *Millepora alcicornis* and *M. braziliensis* are considered abundant in Brazilian waters, especially in the north-east. Both occur at the edges of reefs, forming colonies that can reach 2 m in diameter. The habitat they occupy can be compared to the one used by the species of the genus *Acropora*, such as *Acropora palmata* and *A. cervicornis* in the Caribbean (Leão *et al.*, 2003).

Millepora spp. form complex physical and biological systems, such as holes, crevices, and areas between branches that provide mutualism among species and offer refuge from predators. This structure increases the density, biomass and diversity of fish and invertebrates (Svane & Petersen, 2001; Garcia *et al.*, 2008; Rotjan & Lewis, 2008; Guichard *et al.*, 2001; Johnson *et al.*, 2011; Pereira *et al.*, 2012), consequently reducing the predation risk (Leão & Dominguez, 2000; Johnson *et al.*, 2011).

Reef fish families (e.g. Tetraodontidae, Pomacentridae, Blennidae, Chaetodontidae and Scaridae) are known to establish close relationships with coral structure. This association can range from corallivorous feeding behaviour (Ciardelli, 1967; Rotjan & Lewis, 2008; Berumen & Rotjan, 2010; Pereira *et al.*, 2012) by using the spaces created by these colonies for shelter/protection or breeding (Munday *et al.*, 1997; Gibran *et al.*, 2004). In addition, some cryptobenthic species

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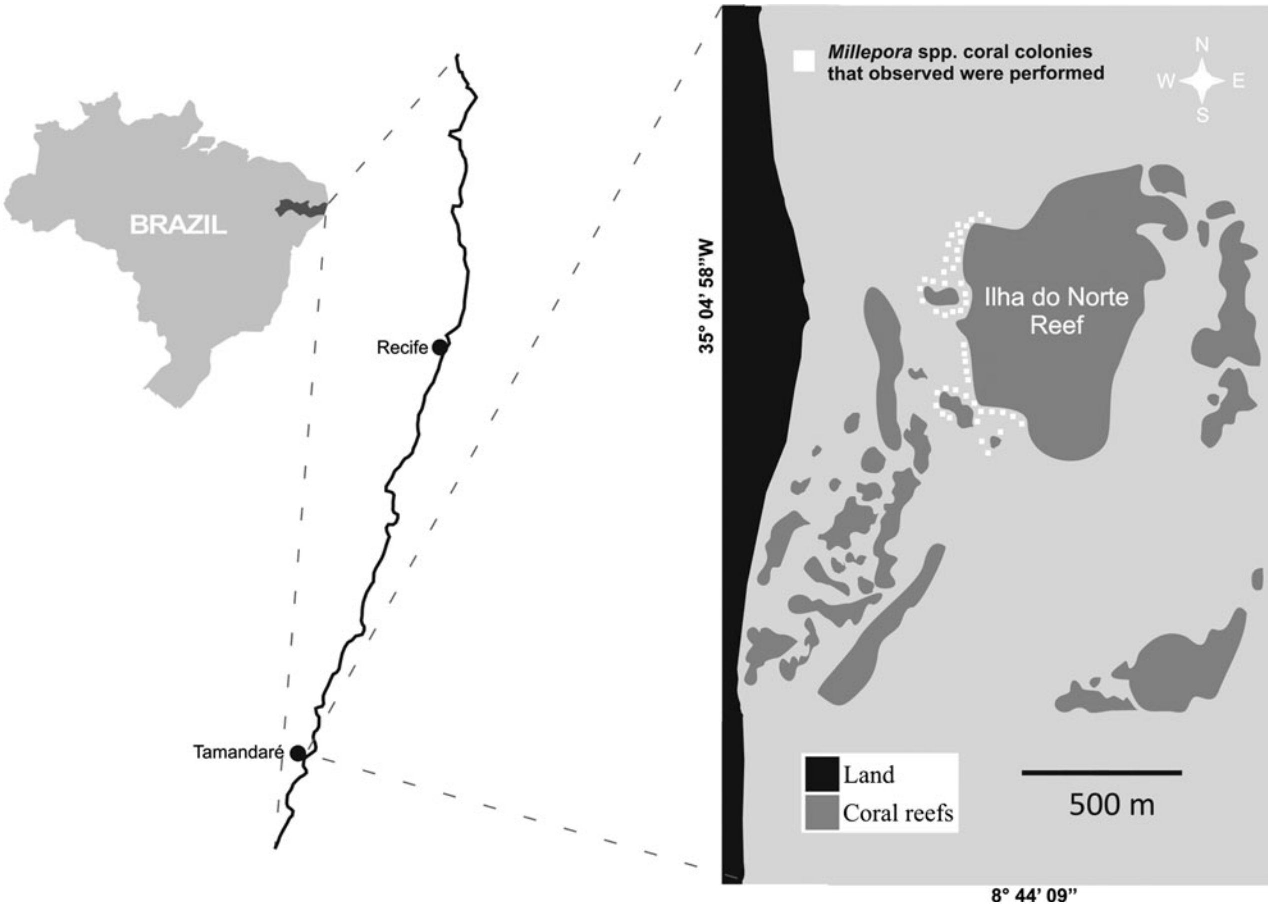

Fig. 1. Study area, Ilha do Norte reef in Tamandaré, indicating the *Millepora* spp. colonies that were examined.

from the genus *Gobiodon* are highly dependent on branching corals living their whole post-settlement life associating exclusively with corals from the genus *Acropora* (Munday *et al.*, 1999, 2004).

Although branching fire-corals were previously recognized as important microhabitats for newly settled and juvenile fish in the Caribbean (Victor, 1986; Nagelkerken & Nagelkerken, 2004), few studies (e.g. Coni *et al.*, 2012) have addressed the structure of the ichthyofauna associated with the fire corals (*Millepora* spp.) in the Brazilian reefs.

In this context, this is the first study to investigate the behaviour and ecological association between fish and coral structure, and the specific goals were: (1) determine the life phase that fish were associated with colonies of *Millepora* spp.; (2) analyse ecological and behavioural relationship between fish and coral colonies, as well as the habitat partitioning; and (3) determine reef fish foraging rates on the *Millepora* spp. coral colonies.

MATERIALS AND METHODS

Study area

The present study was conducted on coastal reefs located in the municipality of Tamandaré (8°44′54″S and 35°6′14″W), on the southern coast of Pernambuco state, north-east Brazil. The reef complex is located within the boundaries of the Coral Coast Marine Protect Area (Costa dos Corais MPA), that extends for 135 km just off the coast from Tamandaré to Paripueira up north of the Alagoas State. This MPA was the first federal conservation unit to include coastal reefs and is the largest marine protected area in Brazil (Ferreira *et al.*, 2001). The observations were conducted on the 'Ilha do Norte' reef, located about 300 m offshore; depth ranges from 0.5 to 6 m and the reef extends for approximately 1.5 km (Figure 1). Reef flats are covered with macroalgae species, hermatypic corals (*Favia gravida* (Verrill, 1868), *Montastrea cavernosa* (Linnaeus, 1766), *Mussismilia* spp. and *Porites astreoides*) (Lamarck, 1816), and large colonies of the fire corals *Millepora braziliensis* and *M. alcicornis* (Ferreira & Maida, 2006). *Millepora braziliensis* colonies are honeycombed, but can also be hemispheric, ramified, columnar, laminate, fan shaped, totally incrusting, or a mixture of these forms. However, *Millepora alcicornis* is normally ramified, but can also be incrusting, hemispheric, or a mixture of these forms (Amaral, 1997; Amaral *et al.,* 2002). According to Amaral (1997) the two species are so highly variable in shape that it is impossible to characterize them perfectly in this respect.

Censuses and behavioural observations

Underwater observations were made from September 2010 through to February 2011 during the regional dry season. In order to quantify the reef fish associated with the coral structure, as well as the agonistic integrations among fish, censuses

Table 1. The fish species associated with the hydrocoral *Millepora* spp. classified in decreasing order of the total numbers of individuals encountered, citing their common names, life stage, and relative frequency of occurrence.

Family	Species	Life stage	No. ind.	Rel. freq. occur. (%)
Holocentridae	*Holocentrus adscensionis* (Osbeck, 1765)	Juvenile	82	17.3
Pomacentridae	*Stegastes fuscus* (Cuvier, 1830)	Juvenile	79	16.7
Pomacentridae	*Stegastes fuscus* (Cuvier, 1830)	Adult	66	13.9
Epinephilidae	*Ephinephelus adscensionis* (Osbeck, 1765)	Juvenile	29	6.1
Holocentridae	*Holocentrus adscensionis* (Osbeck, 1765)	Adult	28	5.9
Labrisomidae	*Labrisomus nuchipinnis* (Quoy & Gaimard, 1824)	Adult	27	5.6
Epinephilidae	*Ephinephelus adscensionis* (Osbeck, 1765)	Adult	25	5.2
Pomacentridae	*Microspathodon chrysurus* (Cuvier, 1830)	Juvenile	19	4.0
Pomacentridae	*Abudefduf saxatilis* (Linnaeus, 1758)	Juvenile	18	3.8
Scaridae	*Sparisoma axillari* (Steindachner, 1878)	Juvenile	11	2.3
Scaridae	*Scarus zelindae* Moura, Figueiredo & Sazima, 2001	Juvenile	10	2.1
Blenniidae	*Ophioblenius trinitatis* (Miranda Ribeiro, 1919)	Adult	10	2.1
Chaetodontidae	*Chaetodon striatus* Linnaeus, 1758	Juvenile	7	1.4
Epinephelidae	*Cephalopholis fulva* (Linnaeus, 1758)	Juvenile	6	1.2
Labridae	*Halichoeres poyei* (Steindachner, 1867)	Juvenile	6	1.2
Scianidae	*Pareques acuminatus* (Bloch & Schneider, 1801)	Adult	6	1.2
Labrisomidae	*Labrisomus nuchipinnis* (Quoy & Gaimard, 1824)	Juvenile	5	1.0
Labrisomidae	*Labrisomus kalisherae* (Jordan, 1904)	Adult	5	1.0
Acanthuridae	*Acanthurus coeruleus* Bloch & Schneider, 1801	Adult	4	0.8
Pomacentridaee	*Chromis multilineata* (Guichenot, 1853)	Juvenile	4	0.8
Bleniidae	*Ophioblenius trinitatis* (Miranda Ribeiro, 1919)	Juvenile	3	0.6
Haemulidae	*Anisotremus moricandi* Ranzani, 1842	Adult	3	0.6
Haemulidae	*Haemulon squamipinna* Rocha & Rosa, 1999	Adult	3	0.6
Diodontidae	*Diodon holacanthus* Linnaeus, 1758	Adult	2	0.4
Labridae	*Halichoeres poyei* (Steindachner, 1867)	Adult	2	0.4
Sciaenidae	*Pareques acuminatus* (Bloch & Schneider, 1801)	Juvenile	2	0.4
Epinephelidae	*Rypitucus saponaceus* (Bloch & Schneider, 1801)	Adult	2	0.4
Pomacentridae	*Stegastes variabilis* (Castelnau, 1855)	Juvenile	2	0.4
Haemulidae	*Anisotremus virginicus* (Linnaeus, 1758)	Juvenile	1	0.2
Gobiidae	*Coryphopterus glaucofraenum* Gill, 1863	Juvenile	1	0.2
Chaenopsidae	*Emblemariopsis signifera* (Ginsburg, 1942)	Adult	1	0.2
Haemulidae	*Haemulon parra* (Desmarest, 1823)	Adult	1	0.2
Haemulidae	*Haemulon parra* (Desmarest, 1823)	Juvenile	1	0.2
Lutjanidae	*Lutjanus alexandrei* (Moura & Lindeman, 2007)	Adult	1	0.2
Holocentrida	*Myripristis jacobus* Cuvier, 1829	Adult	1	0.2

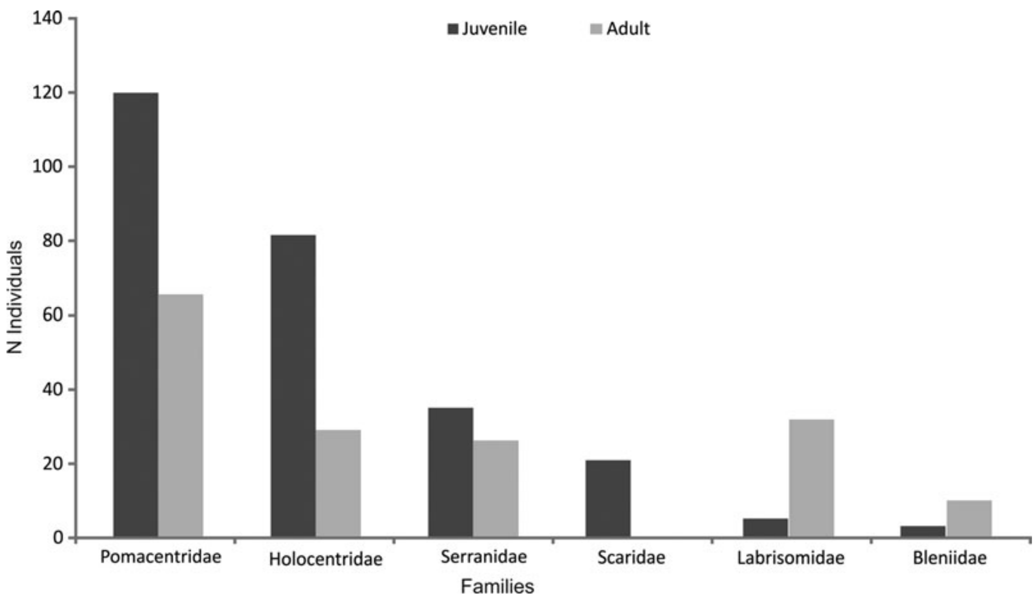

Fig. 2. The most representative fish families that occupy *Millepora* spp. colonies, classified according to their life phases.

Table 2. List of the fish species, classified in decreasing order of the total numbers of individuals encountered, and indicating their respective behaviours observed on the hydrocorals.

Behaviours	Species	Life stages	No. of ind.	Freq. occur. (%)
Sheltered/ stationary	*Holocentrus adscensionis*	Juvenile	56	30
(49.5%)	*Labrisomus nuchipinnis*	Adult	20	12
	Epinephelus adscensionis	Juvenile	19	11
	Holocentrus adscensionis	Adult	19	11
	Epinephelus adscensionis	Adult	18	11
	Ophioblennius trinitatis	Juvenile	8	5
	Pareques acuminatus	Adult	6	4
	Labrisomus kalisharae	Adult	5	3
	Anisotremus moricandi	Adult	4	2
	Labrisomus nuchipinnis	Juvenile	3	2
	Diodon holacanthus	Adult	2	1
	Pareques acuminatus	Adult	2	1
	Rypiticus saponaceus	Adult	2	1
	Ophioblennius trinitatis	Adult	2	1
	Emblemariopis signifera	Adult	1	0.6
Swimming	*Myripristis jacobus*	Adult	1	0.6
(36.8%)	*Stegastes fuscus*	Adult	26	20
	Stegastes fuscus	Juvenile	24	19
	Microspathodon chrysurus	Juvenile	13	10
	Adudefduf saxatilis	Juvenile	11	9
	Scarus zalindae	Juvenile	8	6
	Sparisoma axilare	Juvenile	7	5
	Cephalopholis fulva	Juvenile	6	5
	Halichoeres poyei	Juvenile	6	5
	Chaetodon striatus	Juvenile	5	4
	Acanthurus coeruleus	Adult	4	3
	Chromis multilineata	Juvenile	4	3
	Haemulon squamipinna	Adult	4	3
	Halichoeres poyei	Adult	2	2
	Stegastes variables	Juvenile	2	2
	Anisotremus virginicus	Juvenile	1	0.8
	Coryphopterusglaucofraenm	Juvenile	1	0.8
	Haemulon parra	Juvenile	1	0.8
	Haemulon parra	Adult	1	0.8
Foraging	*Lutjanus alexandrei*	Adult	1	0.8
(13.2%)	*Stegastes fuscus*	Juvenile	24	5.3
	Microspathodon chrysurus	Juvenile	9	2.0
	Ophioblennius trinitatis	Juvenile	4	0.9
	Sacarus zalindae	Juvenile	3	0.7
	Stegastes fuscus	Adult	3	0.7
	Chaetodon striatus	Juvenile	2	0.4
Breeding (0.002%)	*Labrisomus nuchipinnis*	Adult	1	100

were undertaken during free dives using the intensive search method. Censuses were carried out by searching for *Millepora* spp. colonies, where the researcher identified and quantified all fish species at the colony. In total, about 50 *Millepora* spp. coral colonies were surveyed during this research.

This methodology was chosen because it is more appropriate to measure quantitatively the fish communities, as well as being easy to apply and have low environmental interference (Bortone *et al.*, 1989). Behavioural observations were also performed, using the focal animal method (Altmann, 1974). Individuals were classified as juveniles or adults according to their sizes and colour patterns (Humann & Deloach, 2002) to determine which life phases were most closely associated with the hydrocorals. The observation sessions were standardized as five minutes, except when individuals escaped. The observed behaviour patterns were classified into four categories: (1) sheltered/stationary: when fish were observed inside holes, crevices, and open areas within the branches of *Millepora* spp. colonies; (2) foraging: reef fish were observed feeding on the coral structure. The numbers of bites and the time spent performing this activity was noted in order to estimate their foraging rates; (3) swimming: when fish were seen actively moving in or near coral structures; and (4) breeding: when fish were observed in courting postures.

RESULTS

A total of 473 coral reef fish individuals belonging to 15 families, 23 genera and 27 species were recorded in association with the *Millepora* spp. coral colonies. Pomacentridae (187), Holocentridae (111), Serranidae (61) and Scaridae (21) were the most representative families in regards to abundance (Table 1). Juveniles were more commonly observed associated with the coral colonies (65%), in opposition to adults (35%), with the exception of Labrisomidae and Bleniidae families, the ones with a greater presence of adult compared with juveniles (Figure 2).

A total of 285 behavioural observation sessions were performed (lasting 5 min each), with a total of 1425 min (23.54 h) of direct observations. Among the four considered behavioural categories (based on the total number of individuals), sheltered/stationary was the most well-represented, (49.5%), followed by swimming (36.8%) and foraging (13.2%). *Labrisomus nuchipinnis* (Quoy & Gaimard, 1824) was the only associated species observed in a courting posture. The couple of *Labrisomus nuchipinnis* was observed upside down in its courting, near the coral base (Table 2).

The highest foraging rate (bites/min) on the *Millepora* spp. coral colonies was observed for *Microspathodon chrysurus* (Cuvier, 1830) juveniles (1.16 ± 0.79 bites/min) followed by *Stegastes fuscus* juveniles (0.88/0.80 ± 0.36), *Ophioblennius trinitatis* (Miranda Ribeiro, 1919) juveniles had the juveniles (0.63 ± 0.07) and *Scarus zelindae* (Figueiredo & Sazima, 2001) juveniles (0.58 ± 0.21).

Stegastes fuscus individuals besides swimming and foraging on *Millepora* spp. colonies, were also observed performing agonistic behaviour. The highest number of recorded attacks was upon *Ophioblennius trinitatis* representing 40% of total number. Moreover, *Labrisomus nuchipinnis* (20%), *Chaetodon striatus* (20%), *Diodon holocanthus* (Linnaeus 1758) (13%) and *Abudefduf saxatilis* (Linnaeus 1765) (7%) were also targeted by the agonistic behaviour established by *S. fuscus*.

Habitat partitioning by some associated species with *Millepora* spp. colonies is illustrated in Figure 3. Species were observed at different locations in relation to the coral structure; whereas nocturnal and more cryptobenthic ones (e.g. *Holocentrus adscensionis* and *Labrisomus* spp.) were always recorded among the coral branches. In contrast, species with higher swimming capacity and active during the day were seen moving around the coral colonies (e.g. *Chromis multilineata* and *Sparisoma axillare*) (Figure 3).

Behavioural positions (foraging, swimming and sheltered/stationary) of some fish species, associated with the *Millepora* spp. coral colonies, were documented by unedited photography (Figure 4). This figure showed also the first record for *Labrisomus kalisharae* (Jordan, 1904) species in the State of Pernambuco.

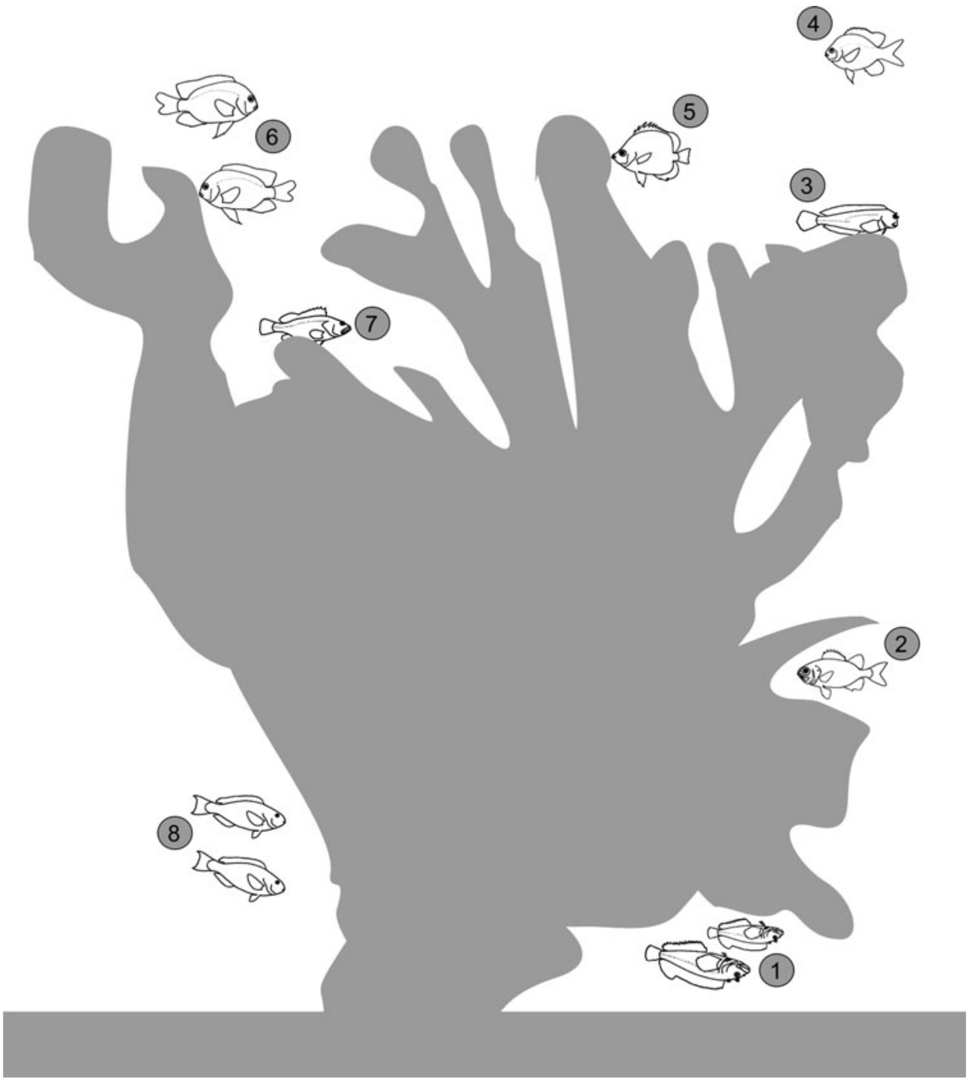

Fig. 3. Representative sketch of a *Millepora* spp. colony indicating the positions and behaviours of the fish species observed. Breeding: *Labrisomus nuchipinnis* (1). Sheltered/stationary: *Holocentrus adscensionis* (2), *Ophioblennius trinitatis* (3) and *Epinephelus adscensionis* (7). Foraging: *Chaetodon striatus* (5) and *Stegastes fuscus* (6). Swimming: *Chromis multilineata* (4) and *Sparisoma axillare* (8).

DISCUSSION

Reef fish are known to maintain direct relationship with coral colonies and many examples have been reported from the Pacific Ocean, which has the world's greatest diversity of corals (Patton, 1994; Precht et *al.*, 2010; Johnson *et al.*, 2011). Patton (1994) recorded a variety of fish in all analysed *Acropora* species on the Great Barrier Reef (Australia), and 85 species of fish belonging to 25 families were found associated with *Acropora pulchra* coral colonies (Brook, 1891) in French Polynesia (Johnson *et al.*, 2011). The present study described the reef fish community and their behaviour in association with *Millepora* spp. coral colonies, being that 27 fish species belonging to 15 families were identified. Branching corals are especially important by their capacity to provide structural complexity for a large number of reef fish (Holbrook *et al.,* 2002a). Microhabitats such as holes, crevices, and open interior areas between branches are important aspects of habitat structure and can account for much of the variation in species richness and total abundance (Holbrook *et al.*, 2002a, b; Brooks *et al.*, 2007). The living corals create a variety of habitats for a large number of species, giving support for sedentary organisms and food or shelter for mobile ones (Holbrook *et al.,* 2002a).

Among the four observed behaviour categories the most frequent was 'sheltered/stationary'. *Holocentrus adscensionis* and *Ephinephelus adscensionis* (Osbeck, 1765) were recorded sheltering on coral colonies during all the observation sessions. These species are carnivorous, feeding on small crustaceans, gastropods, sea stars and other fish (Randall, 1996; Greenfield, 2002). *Ephinephelus adscensionis* and *Labrisomus nuchipinnis* displayed 'sit and wait' feeding behaviour, resting in holes or cracks in the coral and would rapidly flee if disturbed (Sazima *et al.*, 2002). At night *H. adscensionis* feeds for crabs and other crustaceans living on sand and grass beds, hiding in reef crevices during the day (Greenfield, 2002).

The second most frequent behavioural category was 'swimming'. All registered species had direct contact with the *Millepora* spp. structure, except for *Abudefduf saxatilis* and *Chromis multilineata* (Guichenot, 1853). These two species were always observed swimming near the colonies' crest.

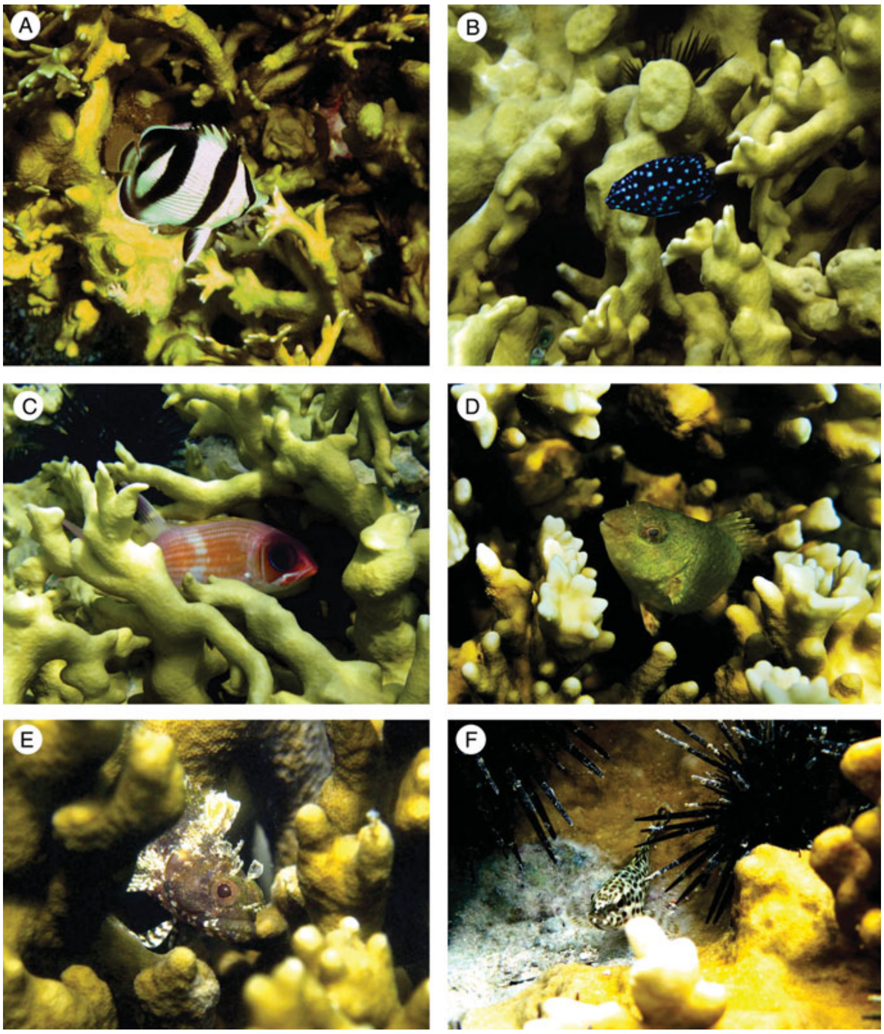

Fig. 4. Photographs of some of the fish observed on *Millepora alcicornis* colonies: (A) *Chaetodon striatus* (forraging); (B) *Microspathodon chrysurus* (swimming); (C) *Holocentrus adscensionis* (sheltered); (D) *Sparisoma axillare* (sheltered); (E) *Labrisomus kalisherae* (sheltered); (F) *Epinephelus adscensionis* (sheltered).

Chromis multilineata is a planktivore fish and several studies have found positive correlations between the abundance of planktivores and the water flow, a pattern explained by the higher influx of plankton in sites with higher water turbulence (e.g. Hobson & Chess, 1978; Hammer *et al.,* 1988; Floeter *et al.*, 2007). *Abudefdub saxatilis* is versatile forager that feed on a variety of food items (including algae) collected on water column (Randall, 1967).

Stegastes fuscus individuals were recorded exhibiting a large amount of agonistic interactions towards another reef fish species around the coral colonies. Furthermore, we are able to assume that some *S. fuscus* individuals include *Millepora* spp. colonies within their territories (authors, personal observations). Species of the genus *Stegastes* (damselfish) are known to be strongly territorial and to actively compete for food and habitat with other reef fish (Haley & Muller, 2002; Souza *et al.*, 2011; Pereira & Ferreira, 2012). Aggressive behaviour by farming damselfishes is often used toward corallivores, herbivores and potential egg predators and largely ignored other carnivores, planktivores and omnivores (Johnson *et al.*, 2011). Fish of genus *Stegastes* can decrease the recruitment of surgeon fish and butterfly fish (Shulman, 1984), and modify the structure of fish communities associated with hard corals by their territorialism (Johnson *et al.*, 2011). Intraspecific competition for food and nest sites as well as nest defence has been implicated as underlying causes for this behaviour (Ebersole, 1977; Haley & Muller, 2002). However, research related to the agonistic behaviour of fish associated with the structure of *Millepora* spp. has not been conducted on the Brazilian coast, nevertheless this is essential for assessing the reef fish ecology during association with coral colonies.

Four reef fish families (e.g. Pomacentridae, Scaridae, Blennidae and Chaetodontidae) were observed foraging on the coral colonies during the present study. Pratchett (2007) recorded fourteen species of the family Chaetodontidae consuming a total of 72 scleractinian corals on the Great Barrier Reef, Australia, and corallivorous fish of the families Tetradontidae and Labridae were reported foraging on *Acropora* spp. coral in the Red Sea (Berumen & Rotjan, 2010). During the present study, individuals of the Scaridae family were observed biting *Millepora* spp. colonies, often removing small pieces. Parrotfish are perhaps the best-known corallivorous group, consuming also the mucus that coats coral colonies, which can result in desiccation of the living surfaces (Rotjan & Lewis, 2008; Pereira *et al.,* 2012).

Parrotfish scrape or break off pieces of *Millepora* spp. colonies with their beaklike mouths (Lewis, 2006). Among all the analysed species foraging on the coral structure, juveniles of *Microspathodon chrysurus* and *Stegastes fuscus* showed the highest feeding frequency respectively. Feeding habits of *M. chrysurus* varies throughout its life; juveniles feed on copepods and other small crustaceans that live in *Millepora* spp. colonies and adults rely on green algae (cyanophytes) (Ciardelli, 1967). Ciardelli (1967) found coral fragments and other hard material in the oral cavity of those fish, but not in the gastrointestinal cavity, suggesting the existence of a sorting mechanism that eliminates hard particles from food (Ciardelli, 1967). These data corroborate with the results of this survey, where only juveniles of *Microspathadon chrysurus* were seen foraging on the hydrocoral structure.

Stegastes fuscus are known as one of the main herbivores species from the family Pomacentridae (Ferreira *et al.*, 1998); however, according to Feitosa *et al.* (2012) hydrozoans polyps were also found in their stomach contents. In the Indo-Pacific at least six damselfish species are recognized as coral specialized and several other species within this family rely mostly on corals for food (Wilson *et al.*, 2006, 2008). However, another Pomacentridae, *Plectroglyphidodon dickii* (Liénard, 1839), actively kills coral polyps without consuming them, thus increasing the area for algal growth inside their coral-dominated territories (Kaufman, 1977; Robertson *et al.*, 1981; Jones *et al.*, 2006). Damselfish cultivate and defend filamentous turfs of algae within territories (Mahoney, 1981; Robertson, 1984; Hata & Kato 2004; Precht *et al.,* 2010). The settlement and growth of algae can occur on damaged or broken branches of *Millepora* spp. (Lewis, 2006). Therefore, it is important to emphasize the strong association between the family Pomacentridae and *Millepora* spp. coral colonies which have been considered as part of its territory, as highlighted in this study.

Large number of invertebrates from micro and macrofauna are found associated with *Millepora* spp. corals colonies (e.g. Protozoa, Mollusca, Crustacea, and Annelida) (Lewis, 1989; Amaral *et al.*, 2008; Garcia *et al.*, 2008). The presence of these animals likewise stimulates the foraging activity of different fish species. Most of these feeding events occurred in the bodies of the colonies or near their extremities, areas with more crustaceans and echinoderms (Garcia *et al.*, 2008).

During the present study, a large number of juveniles were observed associated with the fire coral colonies. This same pattern was observed by Coni *et al.* (2012) in another reef complex on the Brazilian coast. This result indicates that the fire coral, the only conspicuous branching forms that occur in South-western Atlantic reefs, harbour a diverse fish assemblage (37% of the species pool known for the Abrolhos Bank (Coni *et al.,* 2012) and 27% of the ichthyofauna of Tamandaré region (Ferreira *et al.,* 1995)). Most of them are constituted by small-bodied fish (cryptobenthic) and juveniles of large-bodied fish. Juvenile reef fish have higher predation rates (Abdulla, 2004) and more intensive competitive interactions (Hobbs & Munday, 2004) than adults, thus they need to remain in close association with a protective substratum (Faunce & Serafy, 2007). In contrast, a predominance of adult individuals of the families Labrisomidae and Bleniidae was recorded in the present study. They represent small cryptobenthic fish that retain close associations with marine substratum throughout their entire life (Munday, 2002; Depczynski & Bellwood, 2004). It is likely that the smaller individuals of these taxa remained even more hidden than the adult, the ones which could have been underestimated during the present research.

Traditional models of competition (Diamond, 1978) propose that competing species coexist in the same area through resource partitioning. Habitat partitioning was observed for the *Millepora* spp. associated species, whereas more peripheral sites (around the colonies) were used by planktonic species and less habitat-specialized ones (Pratchett *et al.,* 2012). In contrast, species more associated with habitat, such as serranids and cryptobenthic species (Shpigel & Fishelson, 1989; Munday *et al.,* 1997) were always recorded inside the coral branches. Whenever a species decreases the common use of resources (Sale, 1977), thereby specializing on a specific part of an available resource, this should result in reduced levels of competition between species than within species.

Coral reefs are threatened nowadays by both local and global human impacts (Carpenter *et al.*, 2008; Hixon, 2011). On a local scale, pollution, eutrophication and overfishing represent the main cause of degradation; however, in an overall vision, ocean acidification and global warming are the major factors of habitat loss on reef ecosystems (Hixon, 2011). In addition, among a lot of coral taxa, the hydrocorals (*Millepora* spp.) was proved to be the most susceptible in regards to bleaching episodes in the Great Barrier Reef, Australia (Marshall & Baird, 2000). Biological effects of bleaching include reduced growth, reduced reproduction and increased mortality of corals (Gleason, 1993; Marshall & Baird, 2000). In Brazilian waters, the branching fire coral abundance has been declining over the past years (Amaral *et al.*, 2008). The species *M. alcicornis* has being exploited as a souvenir and ornamental feature in several areas of coast for at least two decades (Leão *et al.*, 1994). In Pernambuco State, there are records of intense trade of species from the genus *Millepora*, where the skeletons of their colonies and calcified hydroids are sold in markets and streets (Amaral *et al.*, 2008).

Millepora spp. hydrocorals are ecologically important species for both juvenile and adult reef fish belonging to various trophic guilds (Pereira *et al.*, 2012; Coni *et al.*, 2012). The complex structure of these coral colonies provide safe spaces for shelter, reproduction, many feeding opportunities due to the ample availability of associated micro and macrofauna, as well as important extensions of the territories of *Stegastes fuscus*. Therefore, the decline of this species can promote a reduction of abundance of associated organisms and also reduction of coral growth rates in Brazilian reefs (Oliveira *et al.*, 2008).

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