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The shore fishes of Trindade Island, western South Atlantic

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Trindade Island (20°30′S, 29°20′W) is located approximately 620 nautical miles (1160 km) off the eastern Brazilian coast. Due to its geographical isolation, its ichthyofauna arouses great biogeographic interest. This work intends to provide the first comprehensive checklist for the shore fishes of Trindade Island. Six expeditions were undertaken (1995, 1997, two in 1998, 1999 and 2000—in total 86 days of fieldwork) to survey the ichthyofauna from tidal pools to reefs 30 m deep. A checklist of 97 species belonging to 44 families is presented, with information on the ecology and geographical distribution of each species. The most representative families were the Carangidae (nine species), Serranidae (nine), Labridae (seven), Pomacentridae (five) and Muraenidae (five). Trindade is zoogeographically related to the western Atlantic, since 32% of its species are also found in the continental margin and 12.3% are shared with the western and central Atlantic. Nearly thirty-five percent of the shore fish fauna of Trindade are widespread pan-Atlantic warm-water species. Another 14.6% are restricted to the Brazilian Province. At least six endemic species (6.2%) were found: *Malacoctenus* sp. (Labrisomidae), *Scartella* sp., *Entomacrodus* sp. (Blenniidae), *Arcos* sp. (Gobiesocidae), *Elacatinus* sp. and *Lythrypinus* sp. (Gobiidae). This endemism level is lower than that found on the tropical mid-Atlantic Ridge islands of St. Helena (13.9%), Ascension (15.7%) and St. Paul's Rocks (12.1%).

KEYWORDS: Trindade Island, oceanic islands, western South Atlantic, zoogeography, reef fish, feeding associations.

Introduction

Trindade Island is located at the eastern end of the Vitória-Trindade submarine Ridge (20°30′S, 29°20′W), 620 nautical miles (1160 km) off the coast of the State of Espõrito Santo, south-eastern Brazil. Together with the Martin Vaz Archipelago, which lies 48 km east of Trindade, it forms the most isolated insular group off the Brazilian coast (figures 1 and 2). The island is volcanic in origin and was uplifted approximately 3 to 3.5 million years ago (Almeida, 1961; Greenwood, 1998). It is

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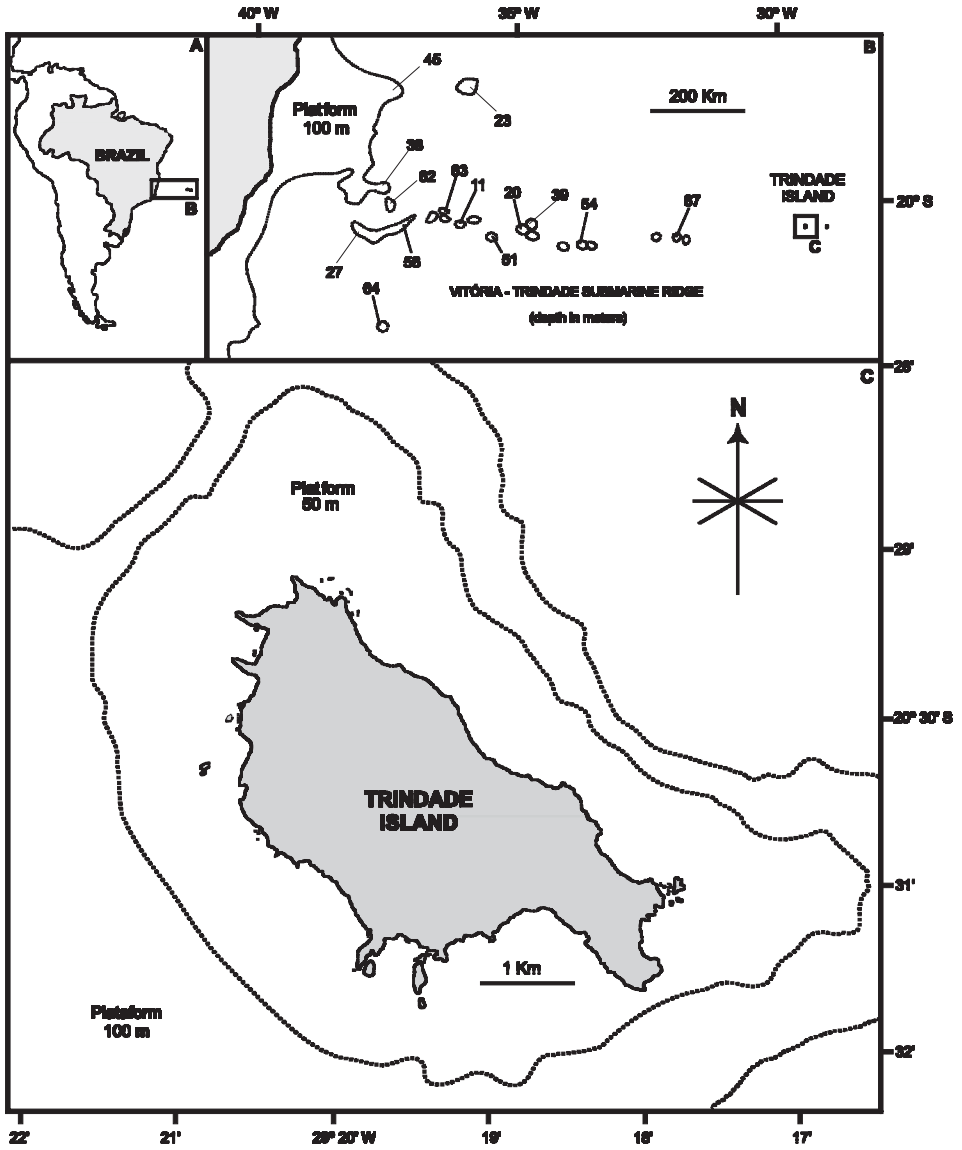

FIG. 1. (A) Map of the western South Atlantic; (B) Vitória-Trindade Submarine Ridge; (C) Trindade Island (20°30′S, 29°19′W), a volcanic formation about 1160 km off Brazil.

6 km long with an emergent landmass area of 9.28 km^2. The narrow shallow platform is approximately 32 km^2 (Leal and Bouchet, 1991).

The sea mounts of the Vitória-Trindade Chain have predominantly flattened tops, which are the result of alternating periods of growth (during periods of high sea level) and erosion (during periods of low sea level) of carbonate algal deposits over volcanic pedestals (Almeida, 1965). At present sea level, the flattened summits of the sea mounts are all situated in relatively shallow waters, their minimum depths ranging from 10 to 110 m (figure 1). The whole extension of the chain is under the influence of the southward flow of the warm Brazil Current (Miranda and Castro

FIG. 2. Volcanic reefs at Trindade Island (20°30′S, 29°20′W), off Brazil.

Filho, 1982). A tropical oceanic climate prevails, ameliorated by eastern and southern trade winds, with mean water temperatures of 27°C (DHN, 1968).

The island is surrounded by calcareous algal reefs, which are consistently present throughout the littoral zone. Occasional sandy patches are filled with lithothamnia cobbles. The substratum is also colonized by hermatypic corals *Siderastrea stellata* Verril, 1868, *Porites branneri* Rathbun, 1887, *Favia gravida* Verril, 1868; zoanthids *Palythoa* spp.; fire-coral *Millepora brasiliensis* Verril, 1868 and sponges (Leão, 1986). Algae develop only where the extremely abundant black durgon (*Melichthys niger*) can not penetrate nor feed readily due to water movement. The most common orders are Caulerpales (Chlorophyta), Dictyotales (Phaeophyta) and Ceramiales (Rhodophyta) (see Pedrini *et al.*, 1989; Nassar, 1994).

The fish fauna of Trindade is of particular interest because of the island's isolated position, between the mid-Atlantic Ridge and the Brazilian coast. Trindade lies approximately 2400 km from Ascension Island, 2500 km from St. Paul's Rocks, 2000 km from St. Helena and 4200 km from Africa.

Its ichthyofauna has remained largely unknown, in contrast to St. Paul's Rocks (Lubbock and Edwards, 1981), Ascension (Lubbock, 1980) and St. Helena (Edwards and Glass, 1987), the other isolated tropical Atlantic islands, where fish life is well documented. The first account of the fish fauna of Trindade Island was that of Murray (1902), who listed eight species collected by the HMS Discovery expedition to Antarctica in 1901. These fishes are deposited at the Natural History Museum London. The expedition of the American Museum of Natural History in 1912–1913 reported 16 species (Nichols and Murphy, 1914). The first significant collection of fishes was obtained by the 1916 expedition of the Museu Nacional do Rio de Janeiro, when 37 species were listed (Miranda-Ribeiro, 1919). Thirty-four years later, another expedition from the Instituto Paulista de Oceanografia collected 32 species (Carvalho, 1950). As a result of the French–Brazilian cruise MD-55 of

the research vessel *Marion-Dufresne*, three species (from relatively deep reefs—30 to 100 m) were added to these previous records (Andreata and Séret, 1995).

In summary, only 48 species had been previously reported in publications, mostly by Miranda-Ribeiro (1919). The present study offers the first comprehensive checklist for the shore fishes of Trindade Island. In addition, interspecific feeding associations, patterns of species distribution and zoogeographic affinities are discussed.

Material and methods

Six expeditions encompassing all seasons (August–October 1995, February 1997, April and August 1998, March 1999 and March 2000) provided 86 days of field work, and about 277 hours of underwater observation (snorkelling and scuba diving). The ichthyofauna was surveyed from tide pools to reefs down to 30–35 m depth. The specimens were collected with a combination of various fishing techniques such as: hand-nets, traps, hook and line, spearfishing and 30 small rotenone stations.

All species are listed in phylogenetic order following Nelson (1994). Within families the species are displayed in alphabetic order. We have included the following information for each species: (1) habitat—as observed in the field; (2) depth range; (3) trophic category—fishes were grouped in major categories, determined from direct behavioural observations, stomach contents analysis (Gasparini, unpublished data) and available literature (Randall, 1972, 1996); (4) geographical range; (5) record status; and (6) a rough indication of the relative abundance. We have also included an appendix with the necessary information for systematic workers of voucher specimens availability for study. Specimens are deposited in the fish collections of the following institutions: Museu de Biologia Professor Mello Leitão (MBML), Museu Nacional, Rio de Janeiro (MNRJ), Universidade Federal do Rio de Janeiro (UFRJ), Museu de História Natural da Universidade Estadual de Campinas (ZUEC), Coleção Ictiológica da Universidade Federal do Espõrito Santo (UFES), Coleção Ictiológica da Universidade Federal da Paraõba (UFPB), Museu de Zoologia, Universidade de São Paulo (MZUSP), and Coleção Ictiológica da Universidade Estadual de Feira de Santana (LIUEFS).

The species list is primarily based on the fishes observed and collected during the six expeditions (0 to 30 m deep). It also includes data from the literature (30 to 100 m), and from recreational fisheries run by Brazilian Navy sailors.

Results and discussion

The shorefish fauna

The Trindade Island ichthyofauna consists of 97 species belonging to 80 genera and 44 families (table 1).

The most speciose families were: Carangidae (nine species), Serranidae (nine), Labridae (seven), Pomacentridae (five) and Muraenidae (five). *Halichoeres*, *Sparisoma*, *Mycteroperca* and *Caranx* were the most speciose genera, each with three species. Six of the 97 species (*Coryphaena hippurus*, three carangids, one scombrid and one remora) are also found in offshore pelagic habitats. They occasionally visit the calcareous algal reef areas. Four other species (*Platybelone argalus*, *Hemiramphus brasiliensis*, *Elagatis bipinnulata* and *Selar crumenophthalmus*) are epipelagic forms that regularly associate with the reefs. Seventy-five species are mainly restricted to shore habitats. These include seven midwater forms such as carangids, sharks and

Table 1. Checklist, habitat, trophic category, geographical range and abundance of the shorefish fauna of Trindade Island.

Family and species	Habitat	Depth range (m)	Trophic category	Range	Record status	Abundance
GINGLYMOSTOMATIDAE						
Ginglymostoma cirratum (Bonnaterre, 1788)	B	5–35	B	PA	SR/P	CO
CARCARHINIDAE						
Carcharhinus perezi (Poey, 1876)	I, O–P	1–35	P	WA	VS	CO
MORINGUIDAE						
Moringua edwardsi (Jordan and Bollman, 1889)	B	3–?	?	WA	VS	?
MURAENIDAE						
Echidna catenata (Bloch, 1795)	B	0–2	B	CWA	VS	CO
Enchelycore nigricans (Bonnaterre, 1788)	B	0.5–35	P	PA	VS	CO
Gymnothorax miliaris (Kaup, 1856)	B	0.5–35	P	PA	VS	CO
Gymnothorax moringa (Cuvier, 1829)	B	0.5–35	P	CWA	VS	CO
Gymnothorax polygonius Poey, 1876	B	50–?	P	PA	VS	?
OPHICHTHIDAE						
Myrichthys breviceps (Richardson, 1848)	B	3–?	B	WA	SR/P	VA
Myrophis sp.	B		?	?	VS	?
Ophichthus ophis (Linnaeus, 1758)	B	10–?	P, B	WA	SR	UN
CLUPEIDAE						
Harengula cf. *jaguana*	I–MW	1–5	PL	WA	VS	VC
SYNODONTIDAE						
Synodus synodus (Linnaeus, 1758)	B	2–35	P	PA	VS	CO
Trachinocephalus myops (Forster, 1801)	B	10–35	P	PA	SR	UN
MUGILIDAE						
Mugil curvidens (Valenciennes, 1836)	I	0.5–2	H	CWA	VS	CO
BELONIDAE						
Platybelone argalus (LeSuer, 1846)	SW	0.5–2	P	PA	SR	RA
HEMIRAMPHIDAE						
Hemiramphus brasiliensis (Linnaeus, 1758)	SW	0.5–2	P	PA	VS	CO
HOLOCENTRIDAE						
Holocentrus ascensionis (Osbeck, 1765)	D	0.5–35	B	PA	VS	VC
Myripristis jacobus Cuvier, 1829	D	2–35	B	PA	VS	CO
SCORPAENIDAE						
Scorpaena plumieri Bloch, 1789	B	0.5–35	B, P	CWA	VS	UN

Table 1. (*Continued*).

Family and species	Habitat	Depth range (m)	Trophic category	Range	Record status	Abundance
SERRANIDAE						
Cephalopholis fulva (Linnaeus, 1758)	D–B	2–35	P	WA	VS	CO
Dermatolepis inermis (Cuvier and Valenciennes, 1833)	D	3–35	P	WA	SR/P	CO
Epinephelus adscensionis (Osbeck, 1771)	D	0.5–35	P, B	PA	VS	CO
Gonioplectrus hispanus (Cuvier and Valenciennes, 1828)	D	35–?	P	WA	VS	RA
Mycteroperca bonaci (Poey, 1861)	D	5–35	P	WA	SR	UN
Mycteroperca interstitialis (Poey, 1861)	D	2–35	P	WA	SR	UN
Mycteroperca venenosa (Linnaeus, 1758)	D	5–35	P	WA	SR	UN
Rypticus saponaceus (Bloch and Schneider, 1801)	B	2–35	P, B	PA	VS	CO
Serranus phoebe (Poey, 1851)	D–B	?–100	P, B	WA	VS	?
OPISTOGNATHIDAE						
Opistognathus aff. *aurifrons*	D	15–35	PL	Br	SR	UN
PRIACANTHIDAE						
Heteropriacanthus cruentatus (Lacépède, 1802)	D	3–35	P, B	PA	VS	CO
APOGONIDAE						
Apogon americanus Castelnau, 1855	D	0.5–35	PL	Br + ST	SR	CO
MALACANTHIDAE						
Malacanthus plumieri (Bloch, 1787)	D	5–35	B	CWA	SR	CO
ECHENEIDAE						
Echeneis naucrates Linnaeus, 1758	O–P	1–35	PL	PA	SR	CO
CORYPHAENIDAE						
Coryphaena hippurus Linnaeus, 1758	O–P	5–10	P	PA	SR	RA
CARANGIDAE						
Carangoides bartolomaei (Cuvier and Valenciennes, 1833)	I–MW	3–15	P	WA	SR	CO
Carangoides ruber (Bloch, 1793)	I–MW	3–35	P	WA	SR	CO
Caranx latus Agassiz, 1829	I–MW	0.5–20	P	WA	VS	CO
Caranx lugubris Poey, 1860	I–MW	0.5–35	P	PA	VS	CO
Decapterus macarellus (Valenciennes, 1833)	O–P	2–6	PL	PA	SR	?
Elagatis bipinnulata (Quoy and Gaimard, 1824)	I, O–P	2–10	P	PA	SR	UN
Selar crumenophthalmus Bloch, 1793	I, O–P	2–10	PL	PA	SR	CO
Seriola rivoliana (Cuvier and Valenciennes, 1833)	O–P	5–35	P	PA	SR	CO
Uraspis secunda (Poey, 1860)	O–P	2–15	P, PL	PA	SR	UN

Table 1. (*Continued*).

Family and species	Habitat	Depth range (m)	Trophic category	Range	Record status	Abundance
SCOMBRIDAE						
Scomberomorus cavalla Cuvier, 1829	O–P	5–15	P	WA	SR	UN
LUTJANIDAE						
Lutjanus cf. *vivanus* (Cuvier, 1828)	D	35–?	P, B	WA	SR	?
HAEMULIDAE						
Anisotremus surinamensis (Bloch, 1791)	D	0.5–35	B	WA	VS	CO
SPARIDAE						
Diplodus argenteus (Valenciennes, 1830)	D	0.5–15	O	WA	VS	CO
MULLIDAE						
Mulloidichthys martinicus (Cuvier and Valenciennes, 1829)	D	0.5–35	B	CWA	VS	CO
Pseudupeneus maculatus (Bloch, 1793)	D	0.5–35	B	WA	VS	CO
CHAETODONTIDAE						
Chaetodon striatus Linnaeus, 1758	D	2–35	B	CWA	VS	CO
Prognathodes brasiliensis Burgess, 2000	D	20–35	B	Br	SR	CO
POMACANTHIDAE						
Centropyge aurantanota Burgess, 1974	D	15–35	B	WA	VS	CO
Holacanthus tricolor (Bloch, 1795)	D	3–35	B	WA	VS	CO
KYPHOSIDAE						
Kyphosus sectatrix (Linnaeus, 1758)	D	1–10	H	PA	VS	VC
POMACENTRIDAE						
Abudefduf saxatilis (Linnaeus, 1758)	D–MW	0.5–15	O	PA	VS	VC
Chromis flavicauda (Gunther, 1880)	D–MW	?	PL	WA	L	RA
Chromis multilineata (Guichenot, 1853)	D–MW	3–30	PL	PA	VS	CO
Microsphatodon chrysurus (Cuvier, 1830)	B	3–20	H	WA	VS	CO
Stegastes fuscus trindadensis (Gasparini, Moura and Sazima, 1999)	B	0.5–15	H	Br	VS	CO
LABRIDAE						
Bodianus rufus (Linnaeus, 1758)	D	10–35	B	WA	VS	UN
Bodianus pulchellus (Poey, 1860)	D	10–35	B	WA	SR	UN
Halichoeres maculipinna (Linnaeus, 1758)	D	0.5–35	B	WA	VS	CO
Halichoeres brasiliensis (Bloch, 1791)	D	0.5–35	B	Br	VS	CO
Halichoeres poeyi (Steindachner, 1867)	D	0.5–35	B	WA	VS	CO
Thalassoma noronhanum (Boulenger, 1890)	D	0.5–35	B, C	Br + ST	VS	VC

Table 1. (*Continued*).

Family and species	Habitat	Depth range (m)	Trophic category	Range	Record status	Abundance
Xyrichtys novacula (Linnaeus, 1758)	D	15–35	B	WA	SR	UN
SCARIDAE						
Sparisoma aff. *atomarium*	D	15–?	H	Br	SR	RA
Sparisoma aff. *rubripinne*	D	2–35	H	Br	VS	CO
Sparisoma aff. *viride*	D	3–35	H	Br	VS	CO
TRIPTERYGIIDAE						
Enneanectes cf. *altivelis*	D	3–10	?	Br	SR	?
LABRISOMIDAE						
Labrisomus nuchipinnis (Quoy and Gaimard, 1824)	B	0.5–5	B	WA	VS	CO
Malacoctenus sp.	B	0.5–10	B	End	VS	CO
CLINIDAE						
Ribeiroclinus eigemanni (Jordan, 1888)	B	?–100–?	?	Br	L	?
BLENNIIDAE						
Entomacrodus sp.	B	0–1	H	End	VS	VC
Hypleurochilus fissicornis (Quoy and Gaimard, 1824)	B	0–5	B	PA	VS	VA
Ophioblennius sp.	B	0.5–10	H	Br	VS	VC
Scartella sp.	B (0–1 m)	0–1	H	End	VS	CO
GOBIESOCIDAE						
Arcos sp.	B	0–1	B	End	VS	UN
GOBIIDAE						
Elacatinus sp.	B	5–30	B, C	End	VS	CO
Lythrypinus sp.	B	2–10	B	End	VS	UN
Priolepis cf. *dawnsoni*	B (4–10 m)	4–10		Br	SR	CO
Gnatholepis thompsoni Jordan, 1902	B (1–12 m)	1–12	B	WA	VS	UN
ACANTHURIDAE						
Acanthurus bahianus Castelnau, 1855	D	0.5–20	H	CWA	VS	CO
Acanthurus coeruleus Bloch and Schneider, 1801	D	0.5–20	H	CWA	VS	CO
SPHYRAENIDAE						
Sphyraena barracuda (Walbaum, 1792)	I, O–SW	3–30	P	PA	SR/P	CO
BOTHIDAE						
Bothus lunatus (Linnaeus, 1758)	B	0.5–20	P	CWA	VS	CO
BALISTIDAE						
Balistes capriscus (Gmelin, 1788)	D	20–?	B, O	PA	SR	?
Balistes vetula (Linnaeus, 1758)	D	3–30	B	PA	SR/P	CO
Canthidermis sufflamen (Mitchill, 1815)	I, O–P	5–30	B, PL	CWA	SR/P	CO
Melichthys niger (Bloch, 1786)	D–MW	0.5–20	O	PA	VS	VC

Table 1. (*Continued*).

Family and species	Habitat	Depth range (m)	Trophic category	Range	Record status	Abundance
MONACANTHIDAE						
Aluterus scriptus (Osbeck, 1765)	D	3–20	O	PA	VS	CO
Cantherhines macrocerus (Hollard, 1854)	D	3–20	B	CWA	VS	CO
Cantherhines pullus (Ranzani, 1842)	D	3–20	B	PA	VS	CO
OSTRACIIDAE						
Acanthostracion quadricornis (Linnaeus, 1758)	D	10–30	B	WA	VS	UN
DIODONTIDAE						
Diodon holocanthus (Linnaeus, 1758)	D	2–35	B	PA	VS	UN
Diodon hystrix (Linnaeus, 1758)	D	3–20	B	PA	SR/P	CO

Habitat: B = Benthic; D = Demersal; I = Inshore; MW = Midwater; O = Oceanic; P = Pelagic; SW = Surface Water.

Depth Range: Range commonly seen on underwater observations (m).

Tropic Category: B = Benthic Invertebrate Feeder; C = Cleaner; H = Herbivore; P = Piscivore; PL = Planktonic; O = Omnivore; ? = Not known.

Range: PA = Pan Atlantic; WA = Western Atlantic and Trindade; C + WA = Central and Western Atlantic; Br + ST = Brazil + St. Paul's Rocks and Trindade; Br = Brazil; End = Endemic to Trindade.

Record Status: VS = Voucher Specimen, SR = Sight Record, P = Photography, L = Literature—Data from Andreata and Séret (1995).

Abundance: VC = Very common (observed in a variety of habitats, with more than 50 individuals per dive); CO = Common (at least one individual per dive); UN = Uncommon (localized and not observed on most dives); RA = Rare (fewer than 10 individuals seen during the five expeditions); RA^1 = Not found < 35 m deep; RA^2 = Rare nearshore; VA = Vagrant (possibly recruited from distant sites or extremely rare); ? = Not known.

a barracuda, nine demersal species that live in or feed primarily on unconsolidated bottoms such as sand and calcareous cobbles (*Moringua edwardsi*, *Myrichthys breviceps*, *Myrophis* sp., *Mulloidichthys martinicus*, *Pseudupeneus maculatus*, *Xyrichtys novacula*, *Opistognathus* aff. *aurifrons*, *Ophichthus ophis*, *Trachinocephalus myops* and *Bothus lunatus*), plus fifty-nine benthic species that live in the rocky-reef habitats. Additional cryptobiont species can be expected to occur at depths below 40 m.

The most abundant fish in Trindade, the black durgon (*Melichthys niger*) certainly accounts for the most important part of the fish biomass. Aggregations of more than 200 specimens are common. There are reports of the same abundance of this fish for Ascension Island (Lubbock, 1980; Price and John, 1980) and Clipperton Atoll (Robertson and Allen, 1996).

Concerning the trophic structure of the assemblage, the benthic invertebrate feeders (B) sum up 38.2% of the shorefish fauna; the piscivores (P) = 33%; the herbivores (H) = 12.4%; the planktivores (PL) = 8.2%; and omnivores (O) = 4.1%. It was not possible to access the feeding behaviour of four species (= 4.1%).

Interspecific feeding associations

Reef fishes interact in complex feeding associations (Eibl-Eibesfeldt, 1955). A common interaction involves fossorial fishes (or invertebrates) and their followers

in which a 'nuclear' species is the focus of a heterospecific group that opportunistically feeds on the residual or escaping benthic invertebrates (Smith and Tyler, 1972; Hobson, 1974; Fishelson, 1977; Diamant and Shpigel, 1985). Another frequently observed association is the cleaning symbiosis (Hobson 1971; Losey, 1987) in which a cleaner fish feeds on ectoparasites and other material from the body surface of co-operating hosts, or clients. Interspecific feeding interactions were poorly known in oceanic localities of the South Atlantic. Both feeding association types were observed and photographed in Trindade.

Interspecific foraging tactics involved three 'nuclear' species—the spotted goatfish, *Pseudupeneus maculatus*, one sharptail eel, *Myrichthys breviceps* and one octopus, *Octopus vulgaris* (table 2). While these species disturbed soft sediment and the benthic community therein, four follower fish species preyed on small fishes and invertebrates.

Three species were observed performing cleaning activities (table 3). The Trindade goby, *Elacatinus* sp. appears to be a highly specialized cleaner and was observed cleaning 21 fish species on defined stations. The juveniles of the Brazilian wrasse, *Thalassoma noronhanum*, one of the most abundant fish on the island, is a facultative cleaner fish that was seen interacting with eight diurnal, medium-sized reef fishes and a green turtle. On one occasion, two juveniles of rock beauty, *Holacanthus tricolor* were observed cleaning on one longjaw squirrelfish, *Holocentrus ascensionis*. Another interesting interaction was also observed: sharksuckers, *Echeneis naucrates* attached to reef sharks *Carcharhinus perezi*, and to large stoplight parrotfish, *Sparisoma* aff. *viride* suggesting cleaning activities.

Zoogeographic affinities

Zoogeographical affinities of the shore fishes of Trindade and comparisons with the mid-Atlantic Ridge tropical islands can be examined by dividing the species in seven groups (table 4).

Trindade has a richer shorefish fauna than the mid-Atlantic Ridge islands, showing great affinity with the western Atlantic fauna (32%). One-third of the species (34.7%) are widely distributed in the tropical Atlantic. A further 12.3% are known from central and western Atlantic. This may be a consequence of the presence of the Vitória–Trindade Ridge. Distances of less than 250 km separate each of the six major linearly arranged sea mounts from its closest neighbours (Leal and

Table 2. Interspecific foraging tactics observed at Trindade Island.

'Nuclear' species	Followers	Reported similar interactions
Pseudupeneus maculatus	*Cephalopholis fulva*, *Epinephelus adscensionis*, *Halichoeres maculipinna* and *H. poeyi*.	The mullids have been reported as being 'nuclear' species; see Smith and Tyler (1972).
Myrichthys breviceps	*Cephalopholis fulva* and *Epinephelus adscensionis*.	Feeding interactions involving the sharptail eel as a 'nuclear' species was reported from Barbados (Dubin, 1982).
Octopus vulgaris	*Cephalopholis fulva* and *Epinephelus adscensionis*.	A similar interaction involving octopus and reef fishes in the Red Sea were described by Diamant and Shpigel (1985).

Table 3. Cleaning symbiosis observed at Trindade Island.

Cleaners	Clients trophic categories	Reported similar interactions
Elacatinus sp.	**Reef fishes (teleosts):** **benthic invertivores (45%)** *Holacanthus tricolor*, *Bodianus rufus* *Myripristis jacobus Anisotremus surinamensis*, *Chaetodon striatus*, *Cantherhines macrocerus*, *Acanthostracion quadricornis*, *Pseudupeneus maculatus* **herbivores (25%)** *Sparisoma* aff. *rubripinne*, *S.* aff. *viride*, *Acanthurus bahianus*, *A. coeruleus*, *Stegastes fuscus trindadensis* **reef piscivores (20%)** *Gymnothorax moringa*, *G. miliaris*, *Cephalopholis fulva*, *Epinephelus adscensionis* **omnivore (5%)** *Abudefduf saxatilis* **planktivore (5%)** *Chromis multilineata*	The behaviour of *Elacatinus* sp. n. is similar to that of *Elacatinus figaro*, its sister species from the continental margin (Sazima *et al.*, 1997).
	Sharks: reef shark *Carcharhinus perezi* (juvenile) and nurse shark *Ginglymostoma cirratum*	Cleaning events between reef sharks and *Elacatinus* aff. *randalli* have been recorded in another offshore Brazilian island, Fernando de Noronha (Sazima and Moura, 2000).
Thalassoma noronhanum (Juvenile)	**Reef fishes:** **herbivores (62.5%)** *Acanthurus bahianus*, *A. coeruleus*, *Sparisoma* aff. *viride*, *S.* aff. *rubripinne*, *Kyphosus sectatrix* **omnivores (25%)** *Melichthys niger*, *Diplodus argenteus* **benthic invertivore (12.5%)** *Pseudupeneus maculatus*	Cleaning symbiosis involving the genus *Thalassoma* is well documented (see Johnson and Ruben, 1988 for references). This is the first record for the Brazilian endemic wrasse, *T. noronhanum*, being a facultative cleanerfish.
	Turtle: green turtle *Chelonia mydas* (Linnaeus, 1758)	Relationship between green turtles and the genus *Thalassoma* were reported from Hawaii (Losey *et al.*, 1994) and Australia (Booth and Peters, 1972)
Holacanthus tricolor (Juvenile)	*Holocentrus ascensionis*	Occasional cleaning behaviour between *H. tricolor* and the genus *Holocentrus* has been reported by Thresher (1979) in the Bahamas.

Bouchet, 1991). Summits come close to the surface (10–110 m) and may function as 'stepping stones' for the shore fauna, particularly during the last glacial maximum, in the Late Pleistocene (16 000 to 14 000 years BP) when the sea level along the Brazilian coast was about 130 m below the present level (Suguio *et al.*, 1985; Martin

Table 4. Geographical ranges of shore fishes found at Trindade Island and at the three tropical mid-Atlantic Ridge islands.

Range (%)	Trindade	St. Paul's Rocks	Ascension	St. Helena
Pan Atlantic	34.7	36.4	30	34.2
Western Atlantic+Trindade	32	0	0	0
Central+Western Atlantic	12.3	30.3	30	15.2
Central Atlantic	0	6.1	17.1	20.3
Central and Eastern	0	0	7.1	16.4
Brazilian Province	14.6	15.2	0	0
Endemic	6.2	12.1	15.7	13.9
Species	97	50	71	81
Distance from mainland (km)	1160	1000	1536*	1870*
Area (km^2)	32**	0.5**	97	50
References	Present study	Lubbock and Edwards, 1981	Lubbock, 1980	Edwards and Glass, 1987

* = Distance from Africa.
** = Shallow platform (< 50 m deep).

et al., 1987). A considerable portion of the sea mount tops would have been aerially exposed, thus causing a reduction in the distances between summits of the Ridge and increasing the available surface for larvae settlement. The rising sea levels of the Flandrian Transgression (14 000 to 8000 years BP) by increasing distances between shallow marine habitats of the coast, sea mounts and Trindade Island, is likely to have reduced faunal interchange.

Fourteen species (14.6%) are shared only with the Brazilian Province (*sensu* Briggs, 1974, 1995). Not a single eastern Atlantic species was recorded at Trindade and St. Paul's Rocks (table 4). This strongly contrasts with the proportions recorded in Ascension (7.1%) and St. Helena (16.4%). We should thus follow Briggs (1974, 1995) and Edwards and Lubbock (1983) and consider Trindade and St. Paul's Rocks as impoverished outposts of the Brazilian Province. An overview of the taxonomic composition and zoogeography of the reef fish fauna in the western Atlantic continental margin and oceanic islands is provided by Floeter and Gasparini (2000).

The paucity of species found on Trindade as well as on the other isolated tropical islands of the mid-Atlantic Ridge (table 4) could be explained by the reduced habitat availability that is likely to influence the fish fauna in several ways. The size of an island affects whether it can provide sufficient living space for a resident population to persist (Robertson and Allen, 1996) and might also affect recruitment from other sources (MacArthur and Wilson, 1967).

Endemic species

Trindade has at least six endemic species belonging to three families: *Malacoctenus* sp., (Labrisomidae) (figure 3), *Scartella* sp. (figure 4), *Entomacrodus* sp. (Blenniidae), *Arcos* sp. (Gobiesocidae), *Elacatinus* sp. (figure 5) and *Lythrypinus* sp. (Gobiidae). The endemism rate of Trindade Island (6.2%) is lower than what is found on the tropical mid-Atlantic islands of St. Helena (13.9%), Ascension (15.7%) and St. Paul's Rocks (12.1%).

Although having a different colour pattern, the recently described *Stegastes*

FIG. 3. *Malacoctenus* sp. (UFRJ 5377) 44.0 mm SL, a new, scaled blenny from Trindade Island.

FIG. 4. *Scartella* sp. (UFRJ 5378) 85.0 mm SL, a new blenny from Trindade Island.

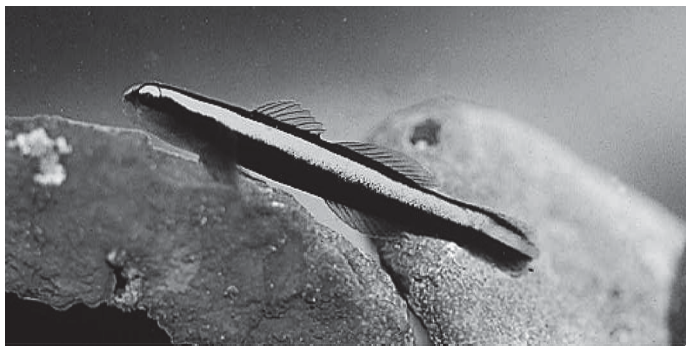

FIG. 5. *Elacatinus* sp. (UFRJ 5415) 23.3 mm SL, a new cleaner goby from Trindade Island.

trindadensis Gasparini, Moura and Sazima, 1999 (Gasparini *et al.*, 1999) (figure 6) is genetically very closely related to *S. fuscus* (Cuvier, 1830), which is its sister species. The mtDNA sequence divergence is only *c.* 0.7%, thus it should be classified as a subspecies (D. R. Robertson, personal communication). It was not considered endemic.

All the endemic species are small (< 100 mm SL) benthic fishes, with demersal spawning that appear to spend a relatively short period of time (2–5 weeks) in the

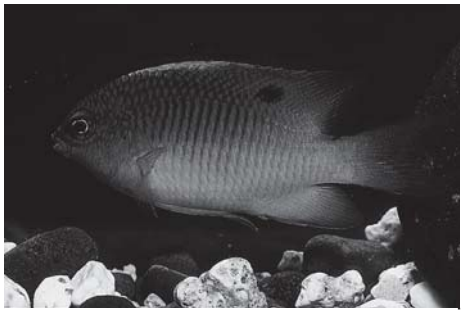

FIG. 6. *Stegastes fuscus trindadensis* (MBML 229), juvenile, 45.5 mm SL, a new damselfish subspecies from Trindade Island.

plankton (Thresher, 1991). Demersal spawners probably underwent fast isolation and divergence from parental populations due to smaller chances of repeated arrivals. The great morphological similarity between most of the endemic species of Trindade and their likely continental margin sister species (e.g., *Scartella* sp. vs. *Scartella* aff. *cristata* (Linnaeus, 1758), *Elacatinus* sp. vs. *Elacatinus figaro* Sazima, Moura and Rosa, 1997) suggests a recent divergence between the faunas of the Brazilian continental shelf and Trindade. This recent divergence is interpreted as having begun during the Flandrian Transgression, an event which may have interrupted a phase of increased faunal interchange between the Brazilian continental shelf and its offshore islands during the late Pleistocene Regression.

Taxonomic comments

The sea chub, *Kyphosus sectatrix* is found in Trindade in two distinct colour morphs: one uniform dark grey with faint stripes along scale rows of flanks, and yellow-phase individuals (*c.*2%), entirely bright lemon yellow, with dark eye. *Kyphosus lutescens* (Jordan and Gilbert, 1882), a species restricted to the Revillagigedos in the eastern Pacific, displays a similar colour pattern.

On Trindade Island the goldentail moray, *Gymnothorax miliaris* was found in three colour morphs: the common dark colour '*miliaris*' and two other pale morphs '*flavopicta*' and '*irregularis*' (*sensu* Böhlke *et al.*, 1989). *Labrisomus trindadensis* (Pinto, 1957) is a synonym of *Labrisomus nuchipinnis* (Quoy and Gaimard, 1824) (see Springer, 1959). Recent mtDNA studies demonstrated that the *Ophioblennius* sp. from Trindade is the same species of the Brazilian coast. This species is endemic to the Brazilian Province (B. Bowen, personal communication). The *Enneanectes* sp. is probably endemic too, but unfortunately it was not collected.

The description of the six new species from Trindade Island are in preparation: *Malacoctenus* sp. by Guimarães, Nunan and Gasparini, *Scartella* sp. by Gasparini, Rangel and Guimarães, *Entomacrodus* sp. by Rangel, Guimarães and Gasparini, *Arcos* sp. by Briggs, Gasparini and Floeter, *Elacatinus* sp. by Guimarães, Gasparini and Rocha, and *Lythrypinus* sp. by Guimarães, Gasparini and Rangel.

The Brazilian yellowhead jawfish, *Opistognathus* aff. *aurifrons* is currently being described by W. Smith-Vaniz. All the scarids and the Brazilian longsnout butterflyfish, *Prognathodes brasiliensis* are new taxa widely distributed in Brazilian waters.

Curious distributions

The pomacanthid family has a curious zoogeographic pattern; *Holacanthus ciliaris* (Linnaeus, 1758) and *Pomacanthus paru* (Bloch, 1787) occur in the Caribbean, on the Brazilian coast, Atol das Rocas, Fernando de Noronha Archipelago and St. Paul's Rocks. Surprisingly, on Trindade Island both species are apparently replaced by *Holacanthus tricolor* (Bloch, 1795) and *Centropyge aurantonota* Burgess, 1974. Trindade is the only South Atlantic offshore island where the two latter species have established populations.

The following species are present in Trindade but were not found on the other South Atlantic oceanic islands: *Myrichthys breviceps*, *Ophichthus ophis*, *Mugil curvidens*, *Opistognathus* aff. *aurifrons*, *Mycteroperca interstitialis*, *Mycteroperca venenosa*, *Lutjanus* cf. *vivanus*, *Prognathodes brasiliensis*, *Chromis flavicauda*, *Microspathodon chrysurus*, *Halichoeres maculipinna*, *Halichoeres poeyi*, *Xyrichthys novacula* and *Sparisoma* aff. *atomarium*. On the other hand *Lutjanus jocu* was not found in Trindade, and it is present in all the other Brazilian offshore islands. These distribution patterns may be related to the Vitoria–Trindade Ridge as well as the Brazil Current. An additional circulation pattern observed by Miranda and Castro-Filho (1982) consists of a northward transportation of tropical waters by a weak counter flow to the Brazil Current with a width of about 35 km. This current could have some importance for the zoogeography of Trindade Island, and should be further investigated.

Note

All photographs were taken by J. L. Gasparini. Fishes were photographed in aquarium immediately after collection.

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Appendix

Voucher specimens. Data are arranged in alphabetic order. Species not listed were photographed, sight records or from literature. Key to museums see *Material and methods*.

Abudefduf saxatilis—MBML 120, 219, 312, UFES 1372, 1397 and LIUEFS 3045; *Acanthostracion polygonius* —MBML 297; *Acanthurus bahianus*—MBML 217, 307, 399, ZUEC 2826, UFES 1389 and MZUSP 55036; *Acanthurus coeruleus*—MBML 314, 321 and ZUEC 2823; *Aluterus scriptus*—MBML 303 and ZUEC 2828; *Anisotremus surinamensis*—ZUEC 2694; *Apogon americanus*—MNRJ 11889; *Arcos* sp. UFPB 4486 and ZUEC 2764; *Balistes vetula*—ZUEC 2833; *Bodianus rufus*—MBML 306 and MNRJ 4164; *Bothus lunatus*—MBML 216, 308, LIUEFS 3049 and ZUEC 2695; *Cantherhines macrocerus*—MBML 200 and ZUEC 2824, 2692; *Cantherhines pullus*—MBML 201; *Carangoides ruber*—ZUEC 2811; *Caranx latus*—MBML 203, 401; *Caranx lugubris*—MBML 175 and ZUEC 2829; *Carcharhinus perezi*—ZUEC 2767 (head and fins) and 2757 (embryo); *Centropyge aurantonota*—UFRJ 5143; *Cephalopholis fulva*—MBML 210 and ZUEC 2822, 2700; *Chaetodon*

striatus—MBML 215, LIUEFS 3046 and ZUEC 2683; *Chromis multilineata*—UFES 1388 and MBML 319; *Decapterus macarellus*—MBML 393; *Diodon holocanthus*—MBML 309 and ZUEC 2819; *Diplodus argenteus*—MBML 202, UFES 1371, 1391, UFPB 3579 and ZUEC 2821; *Echidna catenata*—MBML 125, 295, ZUEC 2831, 2699 and MZUSP 55034; *Elacatinus* sp.—UFRJ 5415; *Enchelycore nigricans*—MBML 294, 400 and UFES 1367, 1395 and ZUEC 2698, 2656; *Entomacrodus* sp.—UFES 1376 and MBML 208, 324; *Epinephelus adscensionis*—MBML 121, 327, 388, UFES 1370, 1387, UFPB 3575 and ZUEC 2820; *Gonioplectrus hispanus*—MBML 274; *Gnatholepis thompsoni*—MBML 320 and UFRJ 194; *Gymnothorax miliaris*—MBML 213, MNRJ 1922 and ZUEC 2801, 2693; *Gymnothorax moringa*—MBML 124, 293, 398, ZUEC 2832 and MZUSP 55035; *Gymnothorax polygonius*—MBML 340; *Halichoeres maculipinna*—MBML 223, 318, 395, UFES 1366, 1386, LIUEFS 3047 and ZUEC 3299; *Halichoeres brasiliensis*—MBML 212, 305, UFES 1398 and ZUEC 2859; *Halichoeres poeyi*—MBML 205, 316 and UFES 1396; *Harengula* cf. *juguana*—MBML 326, 392 and ZUEC 2701; *Hemiramphus brasiliensis*—ZUEC 2813; *Heteropriacanthus cruentatus*—ZUEC 2839; *Holacanthus tricolor*—MBML 204 and ZUEC 2835, 2697; *Holocentrus ascensionis*—MBML 119, 209, UFES 1368, 1394 and UFPB 3578; *Kyphosus sectatrix*—MBML 211, ZUEC 2830 (Yellow pattern); *Labrisomus nuchipinnis*—MBML 122, 323, 396, UFES 131369 and ZUEC 2682; *Lythrypinus* sp.—UFRJ 195; *Malacoctenus* sp.—MBML 207, UFES 1375, UFRJ 5377, 5382, 5383 and ZUEC 2652; *Melichthys niger*—MBML 176, 177, 178, UFES 1385, ZUEC 2825, 2702 and LIUEFS 2714; *Microspathodon chrysurus*—MBML 218 and ZUEC 2696; *Moringua edwardsi*—MNRJ 11804; *Mugil curvidens*—MBML 224, UFES 1399 and ZUEC 2814; *Mulloidichthys martinicus*—MBML 311 and ZUEC 2812; *Myripristis jacobus*—MBML 304 and ZUEC 2681; *Myrophis* sp.—UFPB 4487; *Ophioblennius* sp.—MBML 225, 298, 322, 397, UFES 1377, ZUEC 2685, 2686, LIUEFS 3044 and UFRJ 196; *Rypticus saponaceus*—ZUEC 2821; *Scartella* sp.—MBML 325, UFRJ 5378, 5384 and MNRJ 12039; *Scorpaena plumieri*—MBML 317 and UFES 1368; *Serranus phoebe*—MBML 407 and UFES 1401; *Sparisoma* aff. *rubripinne*—MBML 310, 391, UFES 1392 and ZUEC 2857; *Sparisoma* aff. *viride*—ZUEC 2858; *Stegastes fuscus trindadensis*—MBML 229, 315, MNRJ 2048, 4155, MZUSP 51245, 51246 and ZUEC 2688, 2689; *Synodus synodus*—MBML 206, LIUEFS 3052 and ZUEC 2770; *Thalassoma noronhanum*—MBML 230, 313, UFES 1374, MNRJ 11983, UFPB 3577, LIUEFS 2647 and ZUEC 3298, 2684; *Trachinocephalus myops*—MBML 390.