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Lists of Species

Intertidal rockpool icthyofauna of El Pital, La Libertad, El Salvador

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Abstract: The composition of the rockpool fish community of El Pital was described. A total of 29 rockpools with volumes ranging from 0.12 to 0.83 m^3 were sampled from March to September 2009 using dip nets and clove oil anesthetic solution. A total of 106 fishes belonging to 19 species were captured. The most abundant species were *Bathygobius ramosus*, *Abudefduf concolor*, *Mugil curema* and *Mugil hospes*, representing 66% of all fishes collected. Resident fish comprised 32%, transients comprised 60%, and accidental visitors comprised 8%. High percentages of juvenile fish were recorded (87%), showing that the intertidal zone may act as an important nursery site for fish.

Introduction

The rocky intertidal zone is a harsh and dynamic environment and depressions on it form rockpools that act as refuges for many organisms, like fish, that use this zone during their life stages and could be classified as residents, transients and accidental visitors. Residents are those who spend all their life in this zone and possess anatomical, morphological and physiological adaptations to live there, transients only spend a part of their lives (usually as juveniles) and accidental visitors are those who enter during high tide and are trapped in pools when the tide recedes (Gibson and Yoshiyama 1999).

The presence of juvenile fish in rockpools has promoted the idea that rockpools could act as nursery sites, especially for transient fish, that come from adjacent sites such as reefs or estuaries (Andrade *et al*. 2007).

The abundance and composition of the intertidal fish assemblage in temperate latitudes have been well described (e.g., Yoshiyama 1981; Moring 1986; Davis 2000). Nevertheless in tropical latitudes these studies are scarce (e.g., Weaver 1970; Gibson 1982; Mahon and Mahon 1994, Castellanos-Galindo *et al.* 2005). The size and characteristics of each pool as well as the dynamics of the distribution, dispersion and mobility of fish, have made the study of fish ecology difficult despite the intertidal zone accessibility (Zander *et al.* 1999).

Despite the ecological importance of the coastal line and of fish as regulator agents of the structure and composition of intertidal zone communities (Varas and Ojeda 1990, Quijada and Cáceres 2000), little is known about intertidal ichthyofauna in El Salvador. Consequently, the main objective of this study is to describe the taxonomic composition of the rockpool fish assemblage in the rocky intertidal zone.

Materials and Methods

The rocky shore El Pital (13°30'31" N, 89°36'39" W; Figure 1), Department of La Libertad, El Salvador, is comprised of a small area of cliffs on the coast. Monthly samples were obtained from March to September at the lowest tides. A total of 29 rockpools were sampled (1 time each). The number of rockpools sampled per month varied from 3 to 6. From March to June fish were caught using hand nets with sampling efforts of 45 minutes in each rockpool, from July to September we also used clove oil dissolved in 70% ethanol in a ratio of 2:8 as an anesthetic solution, in

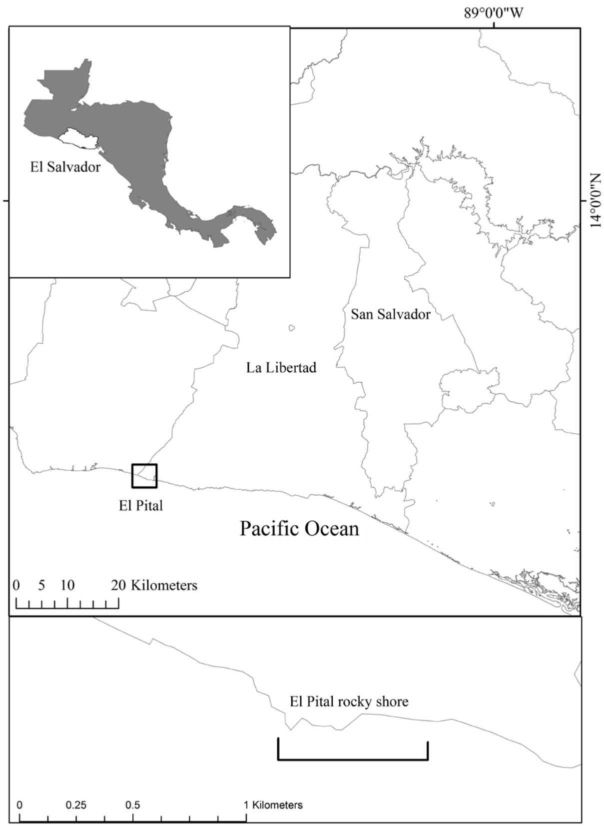

Figure 1. Location of the rocky platform El Pital, La Libertad department, SW of El Salvador.

addition to hand nets. Rockpool volumes were calculated measuring their width, length and depth. Rockpool areas, depths and volumes range from 0.33 to 1.92 m^2, 0.12 to 0.84 m, and 0.12 to 0.83 m^3, respectively.

All fish were collected and identified at the University of El Salvador, using the Tropical Eastern Pacific keys for fish by Robertson and Allen (2008). Total length (TL in mm) of each fish was measured and used to estimate the life history of each fish by using minimum length of postlarval fish (2 cm) for each species with published records of maximum lengths and dividing the length range into three equal size classes to represent juvenile, subadult and adult. In this study, fish are classified into two groups, juvenile or adult (including subadult and adult) (Pfister 1996, Faria and Almada 2001, Griffths 2003b, Ghanbarifardi and Malek 2009). Finally, all fish were preserved in 70% alcohol and donated to the University of El Salvador Zoology Museum (UES) under registration numbers UES 1 to UES 43 and two specimens of *Tomicodon zebra* were donated to Museo de Historia Natural de El Salvador (MUHNES) under registration number MUHNES 40-381.

For the residence time and the presence of anatomical, morphological and physiological adaptations, fishes were classified as: residents (R); transients (T); and accidental visitors (A) (Gibson and Yoshiyama 1999). Also fish were categorized by behavioral affinities under the categories proposed by Griffiths (2003a) as: solitaries (S), species observed alone or in pairs but not in schools; aggregating (A), species that form schools or small aggregations; cryptic (C), species which possess camouflaged coloration and/or tend to be secretive by hiding in crevices and under rocks; and territorial (T), species which display aggressive behavior to defend a particular area.

Results and Discussion

A total of 106 specimens comprising 13 families, 15 genera and 19 species were captured (Table 1). The most species rich families were Pomacentridae (4 species), Mugilidae and Blenniidae (2 species each). Dominant families in abundance were Mugilidae (n=30, 28% of total captured), Pomacentridae (n=27, 25%) Gobiidae (n=21, 19%) and Labrisomidae (n=8, 7%). Most abundant species were *Bathygobius ramosus* (Ginsburg) (19%), *Abudefduf concolor* (Gill) (19%), *Mugil curema* (Valenciennes) (14%) and *Mugil hospes* (Jordan & Culver) (14%), followed by *Malacoctenus zonifer* (Jordan & Gilbert) (7%), *Tomicodon zebra* (Jordan & Gilbert) (4%), *Sargocentron suborbitalis* (Gill) (4%), *Abudefduf troschelii* (Gill) (4%) *and Tomicodon* sp. (2%).

Resident fish were represented by 3 species and 34 individuals, transients were represented by 7 species and 64 individuals, and accidental visitors were represented by 8 species and 8 individuals. Life history analysis shows that resident fish included juvenile and adult fish, transient fish were represented by juvenile fish only and accidental visitors includes both stages, juvenile and adult fish (Table 1).

Seven species were classified as cryptic, with camouflaged coloration and tend to be secretive by hiding in crevices and under rocks. Four species presented solitary behavior and two territorial behavior. *Mugil curema, M. hospes, A. troschelii, and A. concolor* were seen alone and in highly active schools, so they were classified as solitary and aggregated species (Table 1).

In the Tropical Eastern Pacific (TEP) the richness of families (13), genera (15) and species (19) recorded by this study is lower than the reported by Weaver (1970) with 25 families, 49 genera, and 60 species in the Pacific coast of Costa Rica. Richness differences could be due to greater area of sampling effort or pool sampling closer to estuaries which allowed occurrence of fresh water and brackish waters species. On the other hand the species richness recorded in this study is higher than the reported for Palma Island, Colombia by Castellanos-Galindo *et al*. (2005) with 12 families, 13 genera and 14 species and by Castellanos-Galindo & Giraldo (2008) with 7 families, 7 genera and 8 species in Palma Island, also in Colombia. In El Salvador the most similar habitat is Los Cóbanos rocky reef with 206.2 km^2 and 22 km away from El Pital with 201 fish species recorded (Chicas and Leiva 2009) therefore El Pital comprises 9.45% of the fish richness of Los Cóbanos and could be considered high despite its size (600 m) and the distance from the reef.

Studies from temperate latitudes show that resident species are more abundant than transients and accidental visitors in the intertidal zone (Yoshiyama 1981, Varas and Ojeda 1990, Griffiths 2003a, Ghanbarifardi and Malek 2009). The reason is that resident fish spend all their lives in the intertidal zone (some in the larval stage) and have developed anatomical, morphological and physiological adaptations as adhesive disks, fins that allow them to hold onto the substratum avoiding being flushed by tide, and physiological adaptations to cope with changes in environmental conditions (Martin and Bridges 1999, Zander *et al*. 1999).

In the southeastern coast of the colombian TEP, Castellanos-Galindo *et al*. (2005) described a similar pattern to those in temperate latitudes with resident fish more abundant than transients (65.17% *vs*. 34.27%, respectively). In El Pital, resident species *B. ramosus* and *T. zebra* have adaptations like pectoral fins modified into suckers and mucous body covering to avoid dehydration; however, a different pattern was observed, with transients being more abundant than resident species (60.37% *vs*. 32.07%, respectively).

It can be thought that the transients species recorded in this study are the result of the applied methodology because the use of hand nets enhanced the capture of highly active transient species, but it was less effective to catch cryptic and benthic species (Wilding *et al*. 2001). The use of clove oil as anesthetic did not enhance the number of fish caught in each pool; nevertheless, it made easier their capture. We did not observe a change in composition of the catch, and transients continued being more abundant than residents. Arakaki and Tokeshi (2006) did not find differences between a visual census and capture with anesthetic solution. Then, other hypothesis should be considered. For example, the effect of lobster *Panilurus gracilis* and crabs *Menippe* spp. fisheries in the intertidal zone, modifying the substrata and destroying eggs of resident species that lay clumps of eggs attached to the rocks. Furthermore, transient fish could be more abundant than resident because the species richness of transient fish is higher than resident fish species, and transient fish usually displayed aggregating behavior. Finally the rockpools in El Pital could represent an attractive site to transient fish because of its structural complexity as Macieira and Joyeux (2011) recorded in rockpools of Praia dos Castelhanos, Espírito Santo, Brazil.

In El Pital most of captured fish are in juvenile life stage (87%), and they develop their adult life stage in the subtidal zone, so the intertidal zone could act as a refuge from predators that are more abundant in subtidal zone (Gibson 1982). Moring (1986), Mahon and Mahon (1994), and Andrade *et al*. (2007) also recorded high abundance of juvenile fish that come from the subtidal zone and consider that the intertidal zone is an important habitat that could act as a nursery site.

Table 1. Abundance (n), life stage, behavior, residence time, total length (LT) and occurrence of captured fishes on rocky intertidal zone, El Pital, El Salvador from March to September 2009. Abbreviations: A, adult; J, juvenil; BA, behavior affinities; C, cryptic; S, solitary; A, aggregating; T, territorial; RC, residence category; R, resident; T, transitory; A, accidental; SD, standard deviation; %, percentage of total occurrence.

TAXON	N	LIFE STAGE	BA	RC	TOTAL LENGTH (MM)		OCCURRENCE							
					Average ±SD	Range	%	Mar	Apr	May	Jun	Jul	Aug	Sep
Muraenidae														
Echidna nocturna	1	A	C	A	-	307	14			x				
Mugilidae														
Mugil curema	15	J	S-A	T	48.00 ± 6.15	38-58	42	x	x	x				
Mugil hospes	15	J	S-A	T	47.93 ± 7.99	31-56	57	x	x		x	x		
Holocentridae														
Sargocentron suborbitalis	4	J	S	T	51.25 ± 11.92	40-68	57			x	x		x	x
Scorpaenidae														
Scorpaena mistes	1	J	C	A	-	90	14			x				
Serranidae														
Epinephelus labriformis	1	J	S	A	-	66	14						x	
Gerreidae														
Eucinostomus currani	1	J	S	A	-	67	14					x		
Polynemidae														
Polydactylus approximans	1	J	S	A	-	29	14				x			
Cirrhitidae														
Cirrhitus rivulatus	2	J	S	T	50 ± 4.24	47-53	14	x						
Pomacentridae														
Abudefduf concolor	21	J	S-A	T	24.57 ± 3.86	17-35	85	x	x	x	x	x		x
Abudefduf troschelii	4	J	S-A	T	30.25 ± 6.60	21-35	42		x			x		x
Stegastes flavilatus	1	J	TE	A	-	36	14		x					
Stegastes acapulcoensis	1	J	TE	A	-	21	14	x						
Blenniidae														
Ophioblennius steindachneri	3	J	C	T	59.00 ± 6.55	52-65	28	x	x					
Plagiotremus azaleus	1	J	C	A	-	42	14	x						
Labrisomidae														
Malacoctenus zonifer	7	J-A	C	R	42.42 ± 11.08	20-54	57	x	x		x			x
Gobiosocidae														
Tomicodon zebra	4	J	C	R	20.57 ± 3.93	15-24	14						x	
Tomicodon sp.	2	J	C	R	19.1 ± 1.41	18-20	14							x
Gobiidae														
Bathygobius ramosus	21	J-A	C	R	48.00 ± 14.17	17-75	100	x	x	x	x	x	x	x

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Literature Cited

Andrade, F., C. Monteiro and M. Carvalho. 2007. Temporal and spatial variations in tidepool fish assemblages of the northeast coast of Brazil. *Biota Neotropica* 7(1): 112-118.

Arakaki, S. and M. Tokeshi. 2006. Short-term dynamics of tidepool fish community: diel and seasonal variation. *Environmental Biology of Fishes* 76(2-4): 221-235.

Castellanos-Galindo, G., A. Giraldo and A.E. Rubio. 2005. Community structure of an assemblage of tidepool fishes on a tropical eastern Pacific rocky shore, Colombia. *Journal of Fish Biology* 67(2): 392-408.

Castellanos-Galindo, G. and A. Giraldo. 2008. Food resource use in a tropical Eastern Pacific tidepool fish assemblage. *Marine Biology* 153(6): 1023-1035.

Chicas F.A. and A. Leiva. 2009. Preliminary inventory of fish species in eleven watersheds of southwestern El Salvador; pp:76-105. *In* O. Komar (Ed.). *Comprehensive Inventories of Selected Biological Resources within Targeted Watersheds and Ecological Corridors of Southwestern El Salvador.* San Salvador: USAID.

Davis, J.L. 2000. Spatial and seasonal patterns of habitat partitioning in a guild of southern California tidepool fishes. *Marine Ecology Progress Series* 196: 253-268.

Faria, C. and V. Almada. 2001. Microhabitat segregation in three rocky intertidal fish species in Portugal: does it reflect interespecific competition? *Journal of Fish Biology* 58(1): 145-159.

Ghanbarifardi, M. and M. Malek. 2009. Distribution, diversity and abundance of rocky intertidal fishes in the Persian Gulf and Gulf of Oman, Iran. *Marine Biology Research* 5(5): 496-502.

Gibson, R.N. 1982. Recent studies on the biology of intertidal fishes. *Oceanography and Marine Biology. Annual Review* 20: 363-414

Gibson, R.N. and R.M. Yoshiyama. 1999. Intertidal Fish Communities; p. 264-296. *In* M.H. Horn, K.L. Martin and M.A. Chotkowski (Ed.) *Intertidal Fishes: Life in Two Worlds.* San Diego: Academic Press.

Gónzález-Murcia S. and C. Marín. 2011. First record of the clingfish *Tomicodon zebra* (Pisces: Gobiesocidae) from El Salvador waters.

Marine Biodiversity Records 4,e50.

Griffiths, S.P. 2003a. Rockpool ichthyofaunas of temperate Australia: species composition, residency and biogeographic patterns. *Estuarine Coastal Shelf Science* 58(1): 173-186.

Griffiths, S.P. 2003b. Spatial and temporal dynamics of temperate australian rockpool ichthyofaunas. *Marine Freshwater Research* 54(2): 163-176.

Hernández, C.E., P.E. Neill, J.M. Pulgar, F.P. Ojeda and F. Bozinovic. 2002. Water temperature fluctuations and territoriality in the intertidal zone: two possible explanations for the elevational distribution of body size in *Graus nigra*. *Journal of Fish Biology* 61(2): 472-488.

Macieira R.M. and J.C. Joyeux. 2011. Distribution patterns of tidepool fishes on a tropical flat reef. *Fishery Bulletin*. 109(3): 305-315

Mahon R. and S. Mahon. 1994. Structure and resilience of a tidepool fish assemblage at Barbados. *Environmental Biology of Fishes* 41: 171-190.

Martin L.M. and C.R. Bridges. 1999. Respiration in water and air; pp. 54-78. *In* M.H. Horn, K.L. Martin and M.A. Chotkowski (Eds.). *Intertidal Fishes: Life in Two Worlds*. San Diego: Academic Press.

Moring, J.R. 1986. Seasonal presence of tidepool fish species in a rocky intertidal zone of northern California, USA. *Hydrobiología* 134(1): 21-27.

Pfister, C.A. 1996. The role and importance of recruitment variability to a guild of tide pool fishes. *Ecology* 77(6): 1928-1941.

Quijada, P. and C. Cáceres 2000. Patrones de abundancia, composición trófica y distribución espacial del ensamble de peces intermareales de la zona centro-sur de Chile. *Revista Chilena de Historia Natural* 73(4): 1-11.

Robertson, R. and G. Allen. 2008. Shorefishes of the Tropical Eastern Pacific Online Information System. Smithsonian Tropical Research Institute. Balboa, Panamá. Electronic data base accessible at http://biogeodb.stri.si.edu/sftep/. Captured on 1st September 2009.

Varas, E. and P. Ojeda. 1990. Intertidal fish assemblages of the central Chilean coast: diversity abundance and trophic patterns. *Revista Biología Marina Valparaiso* 25(2): 59-70.

Weaver, P.L. 1970. Species diversity and ecology of tidepool fishes in three Pacific coastal areas in Costa Rica. *Revista de Biología Tropical* 17(2): 165-185.

Wilding, T.A., R.N. Gibson and D.J. Sayer. 2001. Procedural guideline No. 4-4 sampling fish in rockpools; pp. 363-367. *In* J. Baxter, J. Bradley, M. Connor, D. Khan, J. Murray, E. Sanderson, W. Turnbull, C. Vincent and M. Davies (Ed.). *Marine Monitoring Handbook*. City Road: Joint Nature Conservation Committee.

Yoshiyama, R.M. 1981. Distribution and abundance pattern of rocky intertidal fishes in central California. *Environmental Biology of Fishes* 6(3): 315-332.

Zander, C.E, J. Nieder and K. Martin. 1999. Vertical distribution patterns; pp. 26-53. *In* M.H. Horn, K.L. Martin and M.A. Chotkowski (Ed.). *Intertidal Fishes: Life in Two Worlds.* San Diego: Academic Press.

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