VIE ET MILIEU - LIFE AND ENVIRONMENT, 2015, 65 (1): 41-45

PRELIMINARY STUDY TO EXPLORE THE CAPTURE POTENTIAL OF ENDEMIC LARVAL FISH IN THE MARQUESAN ISLANDS (FRENCH POLYNESIA)

J. C. GORDON[1,2], *M. TAQUET*[2,3], *D. LECCHINI*[1,2*]

[1] *USR 3278 CNRS-EPHE-UPVD, CRIOBE, BP1013 Papetoai, 98729 Moorea, French Polynesia*
[2] *Laboratoire d'Excellence "CORAIL", BP1013 Papetoai, 98729 Moorea, French Polynesia*
[3] *UMR EIO 241, Centre IRD Papeete, 98719, Tahiti, French Polynesia*
[*] *Corresponding author: lecchini@univ-perp.fr*

LARVAL FISH
MARQUESAN ISLANDS
ENDEMIC SPECIES
RECRUITMENT

ABSTRACT. – This preliminary study explored the capture potential of the Marquesan Islands for fish larvae, especially endemic species, with the set up of light traps on either offshore site or coastal site between January and March 2012. Among the 323 fish larvae belonging to 29 captured species, 151 fish larvae belonging to five species were endemic. Light traps captured more endemic larvae in coastal site than in offshore sites. Overall, this study allows to better understand larval supply of endemic fish species in an isolated region such as the Marquesan Islands.

INTRODUCTION

The Marine Protected Areas Agency (France) organized a scientific expedition "*Pakaihi i te Moana*" (meaning "respect of the ocean in Tahitian") at Marquesan Islands in 2011 and 2012. This expedition aimed to evaluate the marine biodiversity in order to present the Marquesas as a potential marine biodiversity hot spot to the UNESCO world heritage list. The present study explored the capture potential of endemic and non-endemic fish at larval stage with the use of light traps.

Most marine fish species in coral reefs have a stage-structured life history with a pelagic larval phase and a sedentary benthic phase (mostly juveniles and adults) (for review, see Lecchini & Galzin 2003). The transition from a pelagic oceanic environment to a benthic reef environment, during which the relationship between the organism and its environment changes radically, is a particularly dangerous phase of their life cycle (e.g. Kaufman *et al*. 1992, Lecchini 2005, Nakamura *et al*. 2009a,b). For example, the mortality of recruited larvae may eliminate up to 90 % of the total population during this transition phase (e.g. Doherty *et al*. 2004, Lecchini *et al*. 2007). Thus, larval supply at recruitment represents a real natural ichthyological production of fish adult stock, in number of individuals (Lecchini *et al*. 2006, Lo-Yat *et al*. 2011). In contrast to the large number of studies conducted on vertical and horizontal distributions of fish larvae in ocean (for review, see Leis & McCormick 2002), only a few studies have attempted to describe the spatio-temporal variation of larval supply in open water just before their reef colonization (e.g. Doherty & Carleton 1997, Hendriks *et al*. 2001, Fisher & Bellwood 2002, Lecchini *et al*. 2004, Huebert *et al*. 2010). The main conclusion of all these studies is that one of the vital steps in creating predictive models of fish population dynamics is the identification of environmental factors that influence the patterns of larval fish supply (Lecchini & Galzin 2003). For example, Stier *et al*. (2014) developed and tested a colonization–extinction model to reveal how larval dispersal patterns shape the ocean-scale gradient in trophic structure in the Pacific. However, we lack of data on larval supply of endemic species in an isolated region such as the Marquesan Islands.

Due to the scientific expedition "*Pakaihi i te Moana*", the present study explored the capture potential of the Marquesan Islands for fish larvae. As the Marquesan Islands are geographically isolated from other South Pacific Islands, this study allowed to know the larval supply of some endemic species at recruitment (species that are unique to the Marquesan Islands). Specifically, the study was divided into two parts: offshore capture potential of fish larvae around FADs (Fish Aggregating Devices) from January 31 to February 24, 2012 and coastal capture potential from February 27 to March 8, 2012.

MATERIALS AND METHODS

The Marquesan Islands are one of the most isolated groups of oceanic islands in the world, situated in the South-East Pacific Ocean between 8° and 11° South latitude and 139° and 141° West longitude (Fig. 1). The Marquesas have little coral reef development. Only sparse reefs fringe a few of the bays and coastal plains. The capture of fish larvae was carried out with light traps (for more description, see Lecchini *et al*. 2013). The light source (consisting of a 56 cm long, white emitting LED strip with terminals soldered on for attachment to a power source) was glued on to a cylindrical PVC pipe (approximately 30 cm internal diameter and 15 cm in length). The LED strip was glued onto the PVC in a spiral manner to ensure 360° light radiance. Two rechargeable sealed Yuasa lead-acid 12V, 2.1Ah batteries (soldered together and taped securely) were used to power the light source and, when fully charged, had sufficient power to illuminate the light source for up to 48 hours. Night diving showed that the light had an illumination area of up to 10 m (horizontal distance) and 4 m (vertical distance: 2 m above and below the light trap) during a clear night with clear visibility.

For the offshore study (January 31 to February 24, 2012), light traps were set around FADs (Fish Aggregating Devices) on six different sites in Marquesas Archipelago (Fig. 1). The FADs (anchored between 85-1370 m depth) were set up before the oceanographic campaign by the French Polynesia government.

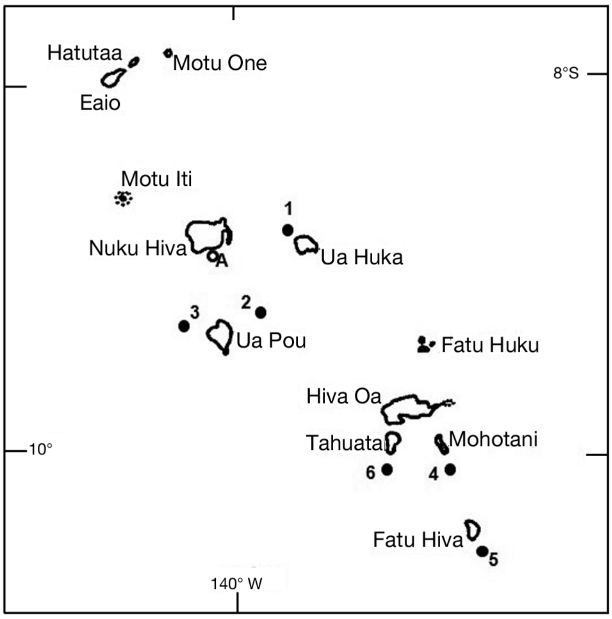

Fig. 1. – Map of the Marquesas Islands with the light trap set up on either coastal sites (represented by the white circle and the letter A) or offshore sites (represented by the black circles and the number 1 to 6).

A total of three light traps, each separated by 25 m, were moored to the floating buoy of the FADs from 6PM to 6AM.

For the coastal study (February 27 to March 8, 2012), three light traps, each separated by 25 m, were moored to a buoy (anchored at 4 m depth) in the bay of Taiohae at Nuku-Hiva Island (Fig. 1) from 6PM to 6AM.

Light trap catches were sorted every sampling day and fishes were transferred to aquaria for identification of larvae to the lowest taxonomic level possible following the keys by Leis & Trnski (1989) and by Maamaatuaiahutapu *et al*. (2006). The spatial patterns of endemic and non-endemic larvae were studied at offshore and coastal sites with a two-way ANOVA (sites x endemic or not species). A log (X+1) transformation was applied to the larval abundance captured per day and per site in order to fit the assumptions of parametric statistical test.

RESULTS

For the offshore study (5 sampling days from January 31 to February 24, 2012), 25 species and 91 larvae were captured (Table I). Among the 25 species captured, the three most abundant were: *Caranx sexfasciatus* (27 % of total abundance - non endemic species); *Apogon novemfasciatus* (14 % - non endemic species) and *Pomacentrus coelestis* (9% - non endemic species). Offshore light traps allowed to capture 12 larvae belonging to four endemic fish species (*Abudefduf conformis, Entomacrodus macrospilus, Khulia petiti* and *Plectroglyphidodon sagmarius*).

For the coastal study (six sampling days from February 27 to March 8, 2012), 15 species and 232 individuals were captured (Table I). Among the 15 species captured, the three most abundant were: *A. conformis* (51 % - endemic species); *A. novemfasciatus* (27 % - non endemic species) and *P. sagmarius* (13 % - endemic species). Coastal light traps allowed to capture 139 larvae belonging to three endemic fish species (*A. conformis, Apogon evermanni* and *P. sagmarius*).

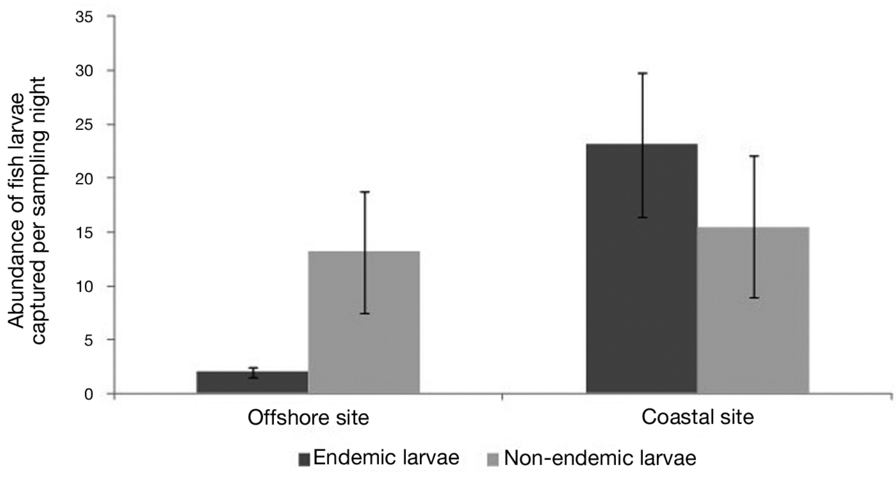

Fig. 2. – Larval abundance of endemic vs. non endemic fish species captured with light traps set up on either coastal site or offshore sites. Bars represent standard deviation computed per sampling day.

Table I. – Potential capture of fish larvae with light traps set up on either offshore sites in the Marquesan Islands, or coastal sites at Nuku-Hiva Island (see Fig. 1 for the geographical location of the sites).

	Date	Site	Family	Genus	Species	Abundance	Endemic (E)
	04 Feb	UA HUKA (1)	Pomacentridae	*Abudefduf*	*conformis*	1	E
offshore	**08 Feb**	UA PAO (2)	Apogonidae	*Apogon*	*novemfasciatus*	4	
capture			Blenniidae	*Entomacrodus*	*macrospilus*	1	E
			Kuhliidae	*Kuhlia*	*petiti*	3	E
			Pomacentridae	*Pomacentrus*	*coelestis*	1	
	09 Feb	UA PAO (3)	Apogonidae	*Apogon*	*novemfasciatus*	1	
			Carangidae	*Selar*	*crumenophthalmus*	1	
			Fistulariidae	*Fistularia*	*commersonii*	1	
	13 Feb	HIVA OA S (4)	Apogonidae	*Apogon*	*novemfasciatus*	3	
			Blenniidae	*Blennie*	*sp.*	1	
			Carangidae	*Gnathanodon*	*speciosus*	5	
			Kyphosidae	*Kyphosus*	*vaigiensis*	1	
				Sectator	*ocyurus*	1	
			Polynemidae	*Polydactylus*	*sexfilis*	1	
			Pomacentridae	*Abudefduf*	*conformis*	2	E
				Abudefduf	*sordidus*	1	
				Plectroglyphidodon	*sagmarius*	1	E
	16 Feb	FATU HIVA (5)	Apogonidae	*Apogon*	*novemfasciatus*	7	
			Acanthuridae	*Acanthurus*	*xanthopterus*	1	
				Acanthurus	*triostegus*	2	
			Aulostomidae	*Aulostomus*	*chinensis*	1	
			Blenniidae	*Blennie*	*sp.*	1	
			Carangidae	*Caranx*	*sexfasciatus*	14	
				Selar	*crumenophthalmus*	1	
			Lutjanidae	*Lutjanus*	*fulvus*	1	
			Monacanthidae	*Cantherhines*	*dumerilii*	1	
			Pomacentridae	*Plectroglyphidodon*	*sagmarius*	2	E
				Pomacentrus	*coelestis*	7	
	20 Feb	TAHUATA (6)	Apogonidae	*Ostorhinchus*	*angustatus*	6	
			Blenniidae	*Plagiotremus*	*tapeinosoma*	1	
			Carangidae	*Caranx*	*sexfasciatus*	11	
				Naucrates	*ductor*	1	
			Pomacentridae	*Abudefduf*	*sordidus*	1	
				Plectroglyphidodon	*leucozonus*	2	
				Plectroglyphidodon	*sagmarius*	2	E
coastal	**29 Feb**	**Nuku-Hiva**	Apogonidae	*Apogon*	*novemfasciatus*	11	
capture				*Ostorhinchus*	*apogonides*	3	
			Carangidae	*Gnathanodon*	*speciosus*	1	
			Monacanthidae	*Cantherhines*	*dumerilii*	1	
			Pomacentridae	*Pomacentrus*	*coelestis*	5	
				Plectroglyphidodon	*leucozonus*	1	
				Plectroglyphidodon	*sagmarius*	15	E
				Abudefduf	*conformis*	2	E
	01 Mar	**Nuku-Hiva**	Apogonidae	*Apogon*	*novemfasciatus*	39	
			Acanthuridae	*Acanthurus*	*triostegus*	1	
			Blenniidae	*Blennie*	sp.	1	
			Lutjanidae	*Lutjanus*	*monostigma*	1	

Table I. – Continued.

Date	Site	Family	Genus	Species	Abundance	Endemic (E)
		Mullidae	*Parupeneus*	*ciliatus*	1	
		Pomacentridae	*Abudefduf*	*conformis*	1	E
			Plectroglyphidodon	*leucozonus*	3	
			Plectroglyphidodon	*sagmarius*	14	E
02 Mar	**Nuku-Hiva**	Apogonidae	*Apogon*	*novemfasciatus*	3	
			Apogon	*evermanni*	1	E
		Pomacentridae	*Pomacentrus*	*coelestis*	3	
			Plectroglyphidodon	*sagmarius*	1	E
			Stegastes	*nigricans*	4	
			Abudefduf	*conformis*	12	E
04 Mar	**Nuku-Hiva**	Apogonidae	*Apogon*	*novemfasciatus*	5	
		Pomacentridae	*Abudefduf*	*conformis*	14	E
05 Mar	**Nuku-Hiva**	Apogonidae	*Apogon*	sp.	3	
		Pomacentridae	*Abudefduf*	*conformis*	23	E
06 Mar	**Nuku-Hiva**	Apogonidae	*Pomacentrus*	*coelestis*	2	
		Apogonidae	*Apogon*	*novemfasciatus*	2	
		Mullidae	*Parupeneus*	*ciliatus*	1	
		Pomacentridae	*Abudefduf*	*conformis*	56	E
			Abudefduf	*sordidus*	1	
			Plectroglyphidodon	*leucozonus*	1	

Among the 29 fish species captured at coastal and offshore sites, five species were endemic. The comparison of larval abundance of endemic vs. non-endemic species captured at coastal vs. offshore sites (although the sampling dates are different) showed a significant difference between the sites (ANOVA: $F = 9.8$, $p = 0.005$ - more fish larvae captured on coastal sites), but not between endemic or non-endemic species ($F = 3.6$, $p = 0.06$). The interaction between sites and species was significant ($F = 11.9$, $p = 0.002$) highlighting that more endemic fish larvae were captured on the coastal sites than on the offshore sites (Fig. 2).

DISCUSSION

Among the 323 fish larvae belonging to 29 species, light traps set up on either offshore or coastal sites allowed to capture 151 fish larvae belonging to five endemic species. Our study had some weak points due to the logistic of scientific expedition aboard the New-Zealand research vessel "Braveheart": offshore and coastal sites not studied at the same time, low spatial replicates on offshore sites. These differences in time and in space make the study of larval supply patterns at recruitment more difficult to interpret. Nevertheless, this study is the first one to explore the larval supply of endemic fish species in an isolated region such as the Marquesan Islands. The main results are that light traps allowed to catch some endemic species at larval stage, and more endemic larvae in coastal site than in offshore sites at Marquesan Islands. Thus, 46 % of the total abundance of captures were endemic larvae. This result shows the strong capture potential of endemic larvae in the Marquesan Islands. DeMartini & Friedlander (2004) showed that endemic fish species were disproportionally more abundant on reefs in the North-western Hawaiian Islands compared to non-endemics. They suggested that the high endemic fish abundance could be linked to higher level of recruitment and/or greater post-settlement survival of endemic than non-endemic larvae. In our study, *Abudefduf conformis* was the most abundant species captured at larval stage (36 % of total abundance), which supports the assumption of higher level of recruitment for some endemic species. Moreover, *A. conformis* is a potential fish for the ornamental trade with high commercial value. Several governments, non-government organizations and other stakeholders in the South Pacific are striving to develop practices and policies to make the tropical marine ornamental trade sustainable. Small-scale fisheries based on larval capture and culture (PCC) promise to contribute to this goal by collecting larvae with light traps or crest nets (Lecchini *et al*. 2006, Bell *et al*. 2009). Indeed, as fish larvae stock is numerically more important than adult stock, and as catches of aquarium fish are based upon a number of individuals (and less on biomass or size), it is preferable to encourage fishing pressure on larvae stock and rear them with aquaculture methods to increase their survival (Bell *et al*. 2009). In the wild, 90%

of fish larvae disappear before adult age (e.g. Doherty *et al*. 2004, Lecchini *et al*. 2007). The adult breeding stock would be thus preserved and the recruitment rate would be the exploitable theoretical limit not to be exceeded for overfishing (Bell *et al*. 2009). Thus, the high potential capture of some endemic fish species at larval stage in the Marquesan Islands could constitute a new product in terms of species, sizes and quality of ornamental fish on the international aquarium market.

To conclude, the present study allowed to know that some endemic fish species could be captured in high abundance at larval stage. The Marquesan Islands have then a potentially unique marine heritage, but also a potential source of income for the local community (PCC). It is therefore important to better understand the population dynamics of endemic species at both larval and adult stages in order to aid the future protection and management of the Marquesan biodiversity.

ACKNOWLEDGEMENTS. – Sampling were proceeded thanks to the *Pakaihi I Te Moana* research cruise funded jointly by the Agence des Aires Marines Protégées, the CNRS and the EPHE.

REFERENCES

Bell JD, Clua E, Hair CA, Galzin R, Doherty PJ 2009. The Capture and culture of post-larval fish and invertebrates for the marine ornamental trade. *Rev Fish Sci* 17: 223-240.

DeMartini EE, Friedlander AM 2004. Spatial patterns of endemism in shallow-water reef fish populations of the Northwestern Hawaiian Islands. *Mar Ecol Prog Ser* 271: 281-296.

Doherty PJ, Carleton JH 1997. The distribution and abundance of pelagic juvenile fish near Grub Reef, Central Great Barrier Reef. *Proc 8th Inter Coral Reef Symp Panama* 2: 1155-1160.

Doherty PJ, Dufour V, Galzin R, Hixon MA, Meekan MG, Planes S 2004. High mortality during settlement is a population bottleneck for a tropical surgeonfish. *Ecology* 85: 2422-2428.

Fisher R, Bellwood DR 2002. Undisturbed swimming behaviour and nocturnal activity of coral reef fish larvae. *Mar Ecol Prog Ser* 263: 177-188.

Hendriks IE, Wilson DT, Meekan MG 2001. Vertical distributions of late stage larval fishes in the nearshore waters of the San Blas Archipelago, Caribbean Panama. *Coral Reefs* 20: 77-84.

Huebert KB, Sponaugle S, Cowen RK 2010. Predicting the vertical distributions of reef fish larvae in the Straits of Florida from environmental factors. *Can J Fish Aquat Sci* 67: 1755-1767.

Kaufman L, Ebersole J, Beets J, McIvor CC 1992. A key phase in the recruitment dynamics of coral reef fishes: post-settlement transition. *Environ Biol Fish* 34: 109-118.

Lecchini D, Galzin R 2003. Influence of pelagic and benthic, biotic and abiotic, stochastic and deterministic processes on the dynamics of auto-recruitment of coral reef fish. *Cybium* 27: 167-184.

Lecchini D, Dufour V, Carleton J, Strand S, Galzin R 2004. Study of the fish larval flux at Moorea Island: is the spatial scale significant? *J Fish Biol* 65: 1142-1146.

Lecchini D 2005. Spatial and behavioural strategies used by coral reef fish post-larvae to integrate into their settlement habitat. *Mar Ecol Prog Ser* 301: 247-252.

Lecchini D, Polti S, Nakamura Y, Mosconi P, Tsuchiya M, Remoissenet G, Planes S 2006. New perspectives to aquarium fish trade. *Fish Sci* 72: 40-47.

Lecchini D, Planes S, Galzin R 2007. The influence of habitat characteristics and conspecifics on attraction and survival of coral reef fish juveniles. *J Exp Mar Biol Ecol* 341: 85-90.

Lecchini D, Waqalevu VP, Holles S, Lerohellec M, Brie C, Simpson SD 2013. Vertical and horizontal distributions of coral reef fish larvae in open water immediately prior to reef colonization. *J Fish Biol* 82: 2135-2140.

Leis JM, Trnski T 1989. The Larvae of Indo-Pacific Shorefishes. New South Wales Univ. Press, Sydney, Australia, and Univ. of Hawaii Press, Honolulu, Hawaii: 371 p.

Leis JM, McCormick MI 2002. The Biology, Behavior, and Ecology of the Pelagic, Larval Stage of Coral Reef Fishes. *In* Sale PF ed, Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem. Academic Press: 421 p.

Lo-Yat A, Simpson SD, Meekan M, Lecchini D, Martinez E, Galzin R 2011. Extreme climatic events reduce ocean productivity and larval supply in a tropical reef ecosystem. *Glob Change Biol* 17: 1695-1702.

Maamaatuaiahutapu M, Remoissenet G, Galzin R Eds 2006. Guide d'Identification des Larves de Poissons récifaux de Polynésie française. Éditions Tethys.

Nakamura Y, Shibuno T, Lecchini D, Watanabe Y 2009a. Habitat selection by emperor fish larvae. *Aquat Biol* 6: 61-65.

Nakamura Y, Shibuno T, Lecchini D, Kawamura T, Watanabe Y 2009b. Spatial variability in habitat associations of pre- and post-settlement stages of coral reef fishes at Ishigaki Island, Japan. *Mar Biol* 156: 2413-2419.

Stier AC, Hein AM, Parravicini V, Kulbicki M 2014. Larval dispersal drives trophic structure across Pacific coral reefs. *Nature Comm* 5: 5575.

Received on November 25, 2014
Accepted on March 19, 2015
Associate editor: N Coineau