Appendices S1–S3 to:

Legendre P, Salvat B. 2015 Thirty-year recovery of mollusc communities after nuclear experimentations on Fangataufa atoll (Tuamotu, French Polynesia). *Proc. R. Soc. B* **282**, 20150750.

Appendix S1

COMMUNITY COMPOSITION DATA TABLES

Table S1.1. Gastropod counts for the various sampling years, on the reef flat and reef edge of the Terme Sud transect. 7 quadrats on the reef edge, 15 on the reef flat; 24 species. Column headings: years and months of the surveys.

Species	1968.3	1969.3	1972.1	1974.10	1977.9	1987.1	1997.5	Feeding category
Scutellastra flexuosa	127	0	0	6	0	3	14	H
Turbo argyrostomus	0	2	0	0	0	0	0	H
Turbo setosus	60	7	37	26	24	13	23	H
Nerita plicata	0	4	6	5	3	38	6	H
Cerithium echinatum	0	5	0	14	3	12	0	H
Cerithium nesioticum	0	0	15	0	0	0	0	H
Cerithium sp.	0	0	17	0	0	0	3	H
Tectarius grandinatus	0	0	0	0	1	4	1	H
Canarium maculatus	0	5	0	2	1	2	0	H
Monetaria moneta	0	0	4	1	1	1	1	H
Tenguella granulata	37	7	26	32	29	31	41	C
Morula uva	45	27	83	108	109	81	46	C
Drupa grossularia	0	0	2	8	1	9	0	C
Drupa morum	0	0	0	0	0	0	13	C
Drupa ricinus	104	12	71	96	21	42	40	C
Mancinella armigera	0	0	0	0	0	0	33	C
Imbricaria conovula	0	0	5	1	7	2	1	C
Mitra litterata	43	79	60	149	105	38	85	C
Conus chaldaeus	0	0	0	0	0	0	5	C
Conus ebraeus	3	0	5	9	4	7	2	C
Conus miliaris	19	11	6	24	31	25	7	C
Conus nanus	5	3	4	7	11	9	5	C
Conus rattus	0	0	0	0	0	0	6	C
Conus sponsalis	3	1	1	1	10	18	0	C

Table S1.2. Gastropod counts for the various sampling years, on the supralittoral zone of the Terme Sud transect. 13 quadrats, 5 species. Column headings: years and months of the surveys.

Species	1968.3	1969.3	1972.1	1974.10	1977.9	1987.1	1997.5	Feeding category
Nerita plicata	13		7	28	17	54	32	H
Littoraria coccinea	0		0	0	0	0	9	H
Tectarius grandinatus	253		47	57	69	45	150	H
Tenguella granulata	0		0	0	1	0	1	C
Thalessa aculeata	0		0	0	0	0	1	C

Table S1.3. Gastropod counts for the various sampling years, on the reef flat and reef edge of the Hélène transect. 4 quadrats on the reef edge, 31 on the reef flat; 17 species. Column headings: years and months of the surveys.

Species	1967.10	1969.3	1972.1	1974.10	1977.9	1987.1	1997.5	Feeding category
Scutellastra flexuosa	29		2	1	5	32	40	H
Turbo setosus	8		7	6	0	37	17	H
Nerita plicata	0		5	14	22	9	0	H
Tectarius grandinatus	0		0	0	0	1	0	H
Cerithium sp.	0		0	0	0	0	12	H
Dendropoma maxima	22		79	33	59	76	76	D
Monetaria caputserpentis	0		0	0	0	0	8	H
Tenguella granulata	1		27	33	30	47	29	C
Morula uva	64		95	436	945	551	335	C
Drupa grossularia	6		1	4	0	4	12	C
Drupa ricinus	19		57	103	117	74	97	C
Imbricaria conovula	0		3	3	1	1	0	C
Mitra litterata	2		41	82	29	120	84	C
Conus chaldaeus	6		6	5	3	3	10	C
Conus miliaris	14		2	13	1	5	3	C
Conus nanus	68		28	80	27	38	33	C
Conus sponsalis	7		3	8	20	10	9	C

Table S1.4. Gastropod counts for the various sampling years, on the supralittoral zone of the Hélène transect. Number of quadrats: see footnotes. 3 species. Column headings: years and months of the surveys.

Species	1967.10	1969.3	1972.1	1974.10	1977.9	1987.1	1997.5	Feeding category
Nerita plicata[1]	12	34	5	21	10	21	3	H
Tectarius grandinatus[1]	450	24	14	112	161	136	146	H
Littoraria coccinea[2]	105	0	0	0	3	96	113	H

[1] Abundances of these species were counted on 10 quadrats with surface area summing to 60 m^2.

[2] That species extended much farther up the supralittoral zone than the other two species. Its abundance was counted on 67 quadrats summing to 402 m^2.

Table S1.5. Mollusc (and one echinoderm) counts for the various sampling years, on the reef flat and reef edge of the Manchot transect. 12 quadrats on the reef edge, 30 on the reef flat; 31 species. Column headings: years and months of the surveys.

Species	1968.3	1972.1	1974.10	1977.9	1987.1	1997.5	Feeding category
Gastropoda							
Scutellastra flexuosa	0	0	0	2	0	0	H
Turbo setosus	0	2	0	0	0	4	H
Nerita plicata	0	2	5	1	0	0	H
Cerithium columna	13	0	3	0	0	0	H
Cerithium echinatum	432	6	11	3	0	10	H
Cerithium punctatum[1]	0	0	0	0	112000	0	H
Cerithium zebrum	0	0	17	0	0	0	H
Canarium maculatus	1	0	1	1	0	0	H
Dendropoma maxima	36	22	2	9	28	76	D
Monetaria caputserpentis	1	0	3	0	23	3	H
Monetaria moneta	9	0	1	0	0	0	H
Tenguella granulata	4	16	92	78	76	61	C
Morula uva	142	112	30	116	170	316	C
Drupa grossularia	13	35	2	11	2	10	C
Drupa morum	5	3	1	5	3	0	C
Drupa ricinus	8	9	15	18	26	40	C
Thalessa aculeata	0	0	0	0	0	1	C
Mancinella armigera	0	1	1	1	7	0	C
Engina siderea	7	0	0	0	0	0	C
Imbricaria conovula	3	6	16	8	6	202	C
Mitra litterata	17	85	455	119	387	585	C
Vexillum cancellarioides	0	0	0	1	2	13	C
Conus chaldaeus	1	7	15	9	18	17	C
Conus ebraeus	20	17	13	32	44	7	C
Conus flavidus	0	0	0	0	2	0	C
Conus miliaris	18	16	11	12	16	16	C
Conus nanus	54	35	58	94	62	85	C

Conus sponsalis	5	2	2	16	39	29	C
Bivalvia							
Chama croceata	31	0	8	48	46	147	F
Tridacna maxima	4	0	1	0	0	1	F
Echinodermata							
Halodeima atra	171	6	13	32	7	8	D

[1] *Cerithium punctatum*: That small species (adult size 10-12 mm) was only found in 1987 where it was present in large abundance, probably the result of a temporary pullulation. The number quoted was obtained by estimation from a series of very small quadrats. That species was not included in the calculations of H and $N_1 = \exp(H)$ mollusc diversity indices in Table 1, but it was included in the calculation of species richness. It was not included in any of the other analyses reported in this paper.

Table S1.6. Scientific names of molluscs and echinoderms found on Fangataufa Atoll during the 1967 to 1997 surveys following current nomenclature. Third column: synonym names used in Lanctôt *et al*. (1997). Feeding categories: H = herbivore, C = carnivore, D = detritivore, F = filter feeder.

Family	Species	Synonyms used in Lanctôt *et al*. (1997)	Feeding category
Gastropoda			
Patellidae	*Scutellastra flexuosa* (Quoy & Gaimard, 1834)	*Patella flexuosa*	H
Turbinidae	*Turbo argyrostomus* Linnaeus, 1758		H
	Turbo setosus Gmelin, 1791		H
Neritidae	*Nerita plicata* Linnaeus, 1758		H
Cerithidae	*Cerithium columna* Sowerby, 1834	*Cerithium torulosum*	H
	Cerithium echinatum Lamarck, 1822	*Cerithium mutatum*	H
	Cerithium nesioticum Pilsbry & Vanatta, 1906		H
	Cerithium punctatum Bruguière, 1792		H
	Cerithium zebrum Kiener, 1841		H
	Cerithium sp.		H
Littorinidae	*Littoraria coccinea* (Gmelin, 1791)	*Littorina coccinea*	H
	Tectarius grandinatus (Gmelin, 1791)		H
Strombidae	*Canarium maculatus* (Sowerby, 1842)	*Strombus maculatus*	H
Vermetidae	*Dendropoma maxima* (Sowerby, 1825)		D
Cypraeidae	*Monetaria caputserpentis* (Linnaeus, 1758)	*Cypraea caputserpentis*	H
	Monetaria moneta (Linnaeus, 1758)	*Cypraea moneta*	H
Muricidae	*Tenguella granulata* (Duclos, 1832)	*Morula granulata*	C
	Morula uva (Röding, 1798)		C
	Drupa grossularia Röding, 1798		C
	Drupa morum Röding, 1798		C
	Drupa ricinus (Linnaeus, 1758)		C
	Thalessa aculeata (Deshayes @Milne Edwards, 1844)		C
	Mancinella armigera (Link, 1807)		C
Buccinidae	*Engina siderea* (Reeve, 1846)	*Engina alveolata*	C
Mitridae	*Imbricaria conovula* (Quoy & Gaimard, 1833)		C
	Mitra litterata Lamarck, 1811		C

Costellariidae	*Vexillum cancellarioides* (Anton, 1839)		C
Conidae	*Conus chaldaeus* (Röding, 1798)		C
	Conus ebraeus Linnaeus, 1758		C
	Conus flavidus Lamarck, 1810		C
	Conus miliaris Hwass in Bruguiere, 1792		C
	Conus nanus Sowerby, 1833		C
	Conus rattus Hwass in Bruguiere, 1792		C
	Conus sponsalis Hwass in Bruguiere, 1792		C
Bivalvia			
Chamidae	*Chama croceata* Lamarck, 1819	*Chama imbricata*	F
Cardiidae	*Tridacna maxima* (Röding, 1798) [1]		F
Echinodermata			
Holothuriidae	*Halodeima atra* Jaeger, 1833		D

[1]The small giant clam *Tridacna maxima*, a filter feeder, obtains most of the nutrients it requires from zooxanthellae living in its tissues.

Appendix S2

COMPARISON OF THE EVOLUTION OF THE TWO OUTER REEFS THROUGH TIME

The Terme Sud (T) and Hélène (H) transect community composition data were compared through a canonical analysis (RDA) of the supralittoral zone data on the one hand and of the reef flat and reef edge data on the other.

The mollusc data collected at matching dates after the *Canopus* nuclear test were used as response data for that comparison, that is, the sampling years {1972, 1974, 1977, 1987, 1997}; the data were subjected to a $\log(y + 1)$ transformation. The explanatory variables were a binary variable distinguishing the two sites (Terme Sud and Hélène) and a 2^{nd}-degree orthogonal polynomial function of time, which allowed each time series to be represented by a folded curve in the ordination plots.

For the **supralittoral zones**, only three species were used in the analysis: *Nerita plicata*, *Littoraria coccinea* and *Tectarius grandinatus*. The other two species found on Terme Sud were anecdotal (Table S1.2). Figure S2.1 shows that the difference between the Terme Sud and Hélène time series, which is significant (partial RDA p-value = 0.043), is associated with greater abundances of *Nerita plicata* on Terme Sud during all 5 years, and greater abundances of *Tectarius grandinatus* (from 1974 to 1987) and *Littoraria coccinea* (from 1977 to 1997) on Hélène (Tables S1.2 and S1.4).

For the **reef flat and reef edge zones**, all 25 species (Tables S1.1 and S1.3) were used in the analysis. Figure S2.2 shows that the difference between the Terme Sud and Hélène time series, which is highly significant (partial RDA p-value = 0.008), is associated with greater abundances on Terme Sud of the species pointing to the left of the plot, and greater abundances on Hélène of the species pointing to the right.

Indicator species analysis (Dufrêne & Legendre 1997, De Cáceres & Legendre 2009; R package *indicspecies*, De Cáceres & Jansen 2011) of the reef flat and edge data showed that seven species were significant indicators, at the 0.05 significance level, of one or the other transect:

• *Conus miliaris* was found in greater abundance on Terme Sud during all five surveys, whereas *Conus ebraeus* and *Monetaria moneta* were found exclusively on Terme Sud;

• *Morula uva*, which was the most abundant species on both transects, was found in much greater abundance on transect Hélène. *Conus chaldaeus* and *Conus nanus* were also more abundant on Hélène, whereas *Dendropoma maxima* was only found on Hélène.

The main message of the triplot (figure S2.2) is that the two transects had greatly different species compositions and that different species (red arrows pointing left and right) were driving the evolution of the assemblages on the Terme Sud (left) and Hélène (right) reef flats and edges.

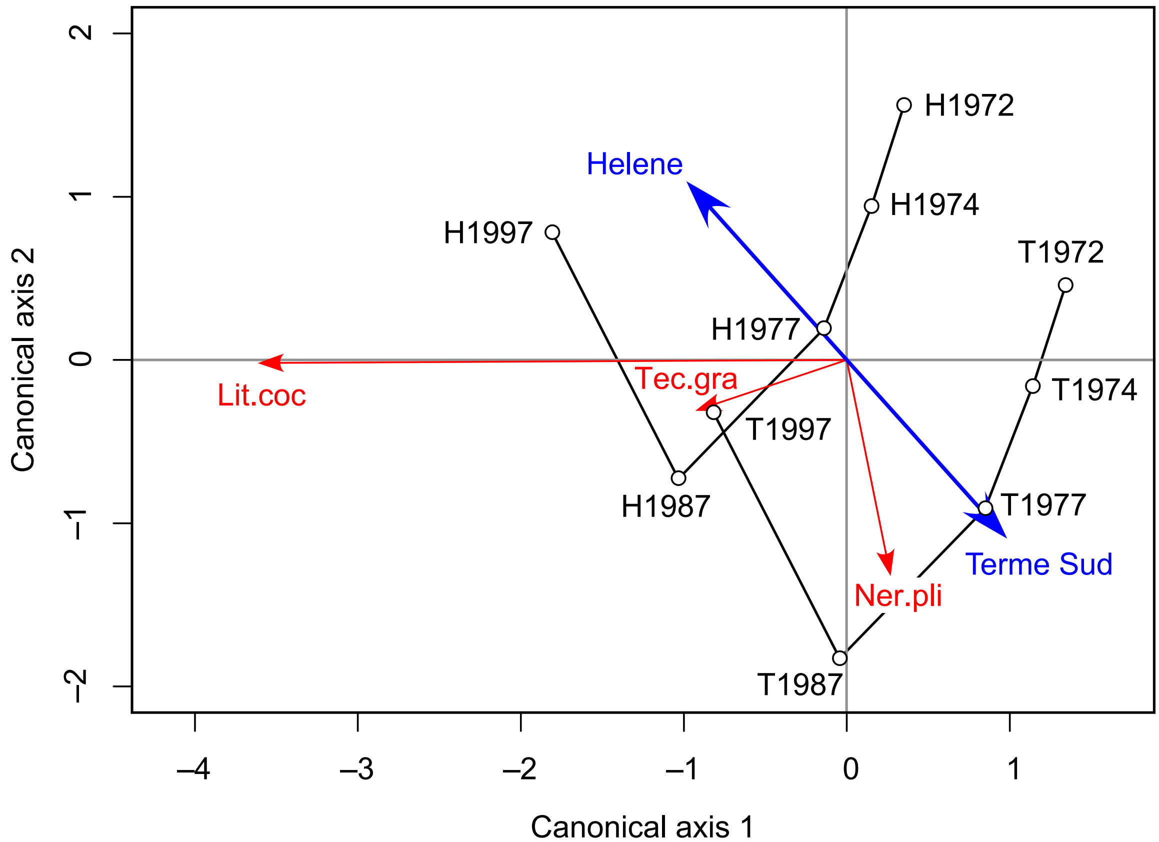

Figure S2.1. RDA triplot comparing the evolution through time of the communities in the supralittoral zones of the two transects (Terme Sud and Hélène, represented by blue arrows with large arrowheads). Black lines materialize the survey time sequence. Species are represented by thin red arrows. Species abbreviations: see Appendix S1. The year points labelled T correspond to Terme Sud are those labelled H to Hélène. The explanatory variables year and $year^2$ are not shown.

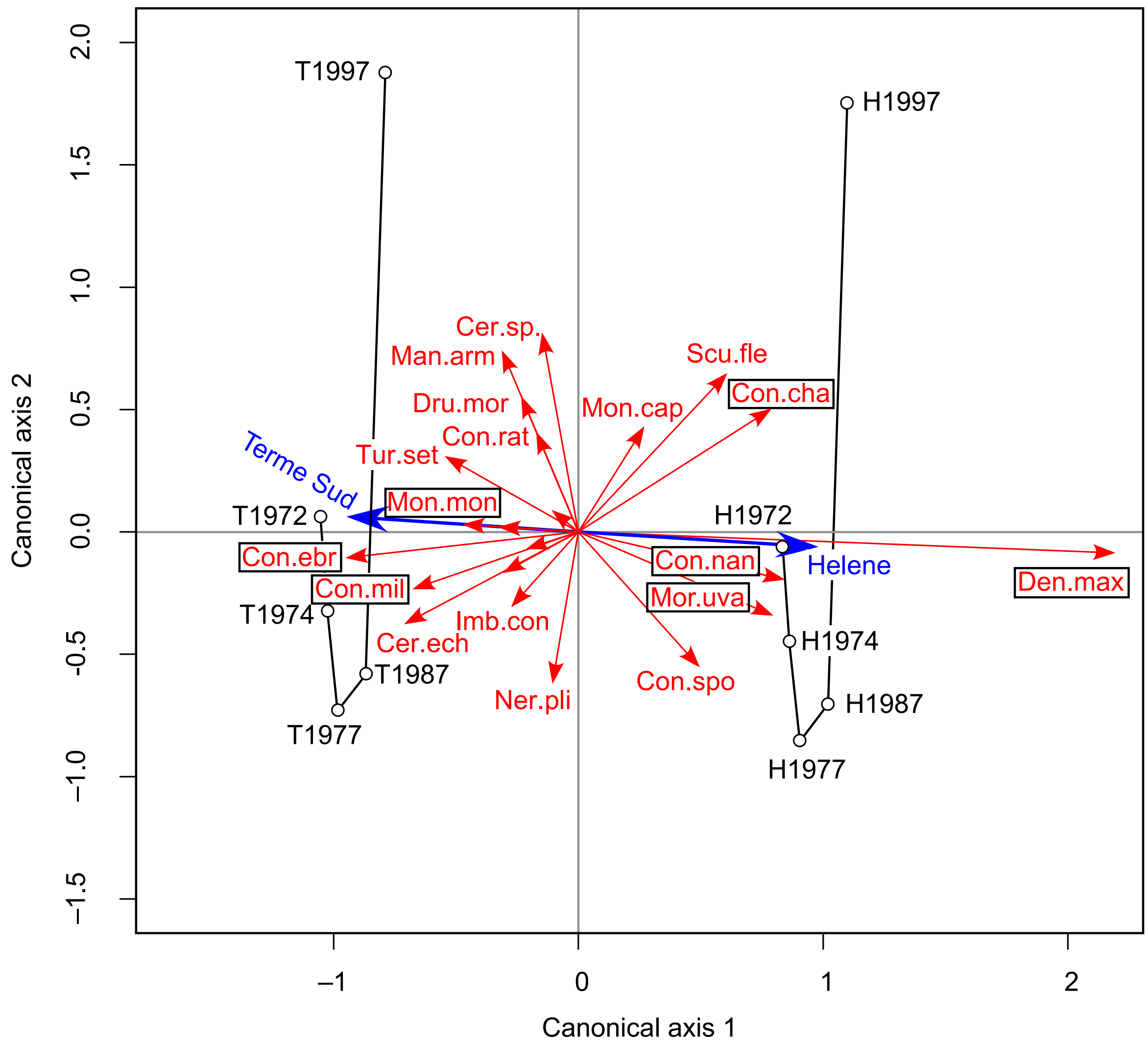

Figure S2.2. RDA triplot comparing the evolution through time of the communities on the reef flats and edges of the two transects (Terme Sud and Hélène, represented by blue arrows with large arrowheads). Black lines materialize the survey time sequence. Species are represented by thin red arrows. Significant indicator species at the $\alpha = 0.05$ level have boxed names. Species abbreviations: see Appendix S1. Names of species with the shortest arrows were not printed to make the plot easier to read. The explanatory variables year and year^2 are not shown.

References

De Cáceres M, Jansen F. 2011 indicspecies: Functions to assess the strength and significance of relationship of species site group associations. R package version 1.6.0. http://cran.r-project.org/web/packages/indicspecies/.

De Cáceres M, Legendre P. 2009 Associations between species and groups of sites: indices and statistical inference. *Ecology* **90**, 3566–3574.

Dufrêne M, Legendre P. 1997 Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecol. Monogr.* **67**, 345–366.

Appendix S3

A CHANNEL DUG IN THE NORTHERN PORTION OF THE ATOLL CROWN

The inner-reef communities were subjected to another major man-made impact. Fangataufa atoll was originally a completely closed atoll without passes and no important exchange of water between the ocean and the lagoon. Water entered the lagoon through small and shallow channels between islets, called "hoas" [1,2] (http://www.atolls-polynesie.ird.fr/glossaire/coupatol.htm), found mostly on the eastern side of the atoll where the Hélène site is located, and across reef flats found for example in the northern portion of the rim near the Manchot site. Through these hoas and flats, oceanic waves pushed water into the lagoon where the level was always a little higher, by some decimetres, than the mean ocean level. This is not the case in an open atoll, which has one or several passes. In these atolls, the tidal exchange of water between the ocean and the lagoon is immediate and the water level is nearly identical in the lagoon and the ocean.

In June 1965, a channel was dug in the northern portion of the atoll crown to give transport ships access to the lagoon in order to build the nuclear testing facilities. The channel is about 100 m wide, 350 m long and 8 m deep and plays the same role as a natural pass in an open lagoon.

This opening caused a lowering of the water level by about 30 cm in the lagoon, with immediate impact on the reef flat communities on the lagoon side of the atoll crown, including the Manchot transect, sampled from 1968 to 1997, which is included in the present study. Due to the lowering of the water level inside the lagoon, a portion of the Manchot reef flat emerged at low tide.

Unfortunately, no comparative survey data are available from the period before the opening of the channel. The anthropogenic lowering of the water level in the lagoon affected only the inner reefs, including the Manchot transect, and not Terme Sud and Hélène which are facing the ocean and are separated from the lagoon by a motu (islet made of sand, coarse coral rubble and sediment, with some vegetation in most cases).

References

1. Chevalier JP. 1972 Observations sur les chenaux incomplets appelés hoa sur les atolls des Tuamotu. Pp. 477–488 in: *Proc. Symp. Corals and Coral reefs*, India.

2. Battistini R. 1975 Eléments de terminologie récifale indopacifique. *Téthys* 7. Marseille, France: Station marine d'Endoume.