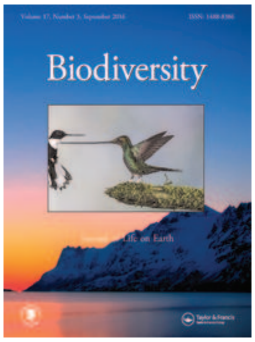

Biodiversity

ISSN: 1488-8386 (Print) 2160-0651 (Online) Journal homepage: http://www.tandfonline.com/loi/tbid20

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To cite this article: M. H. Schleyer, Y. Benayahu, S. Parker-Nance, R. W. M. van Soest & J. P. Quod (2016) Benthos on submerged lava beds of varying age off the coast of Reunion, western Indian Ocean: sponges, octocorals and ascidians, Biodiversity, 17:3, 93-100, DOI: 10.1080/14888386.2016.1190669

To link to this article: https://doi.org/10.1080/14888386.2016.1190669

Published online: 06 Jul 2016.

TBID 1190669
1 October 2016
Revision
CE: XX QA: XX
Coll:XX QC:XX

BIODIVERSITY, 2016
VOL. 17, NO. 3, 93–100
http://dx.doi.org/10.1080/14888386.2016.1190669

Benthos on submerged lava beds of varying age off the coast of Reunion, western Indian Ocean: sponges, octocorals and ascidians

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ABSTRACT
Benthic surveys were conducted on submerged lava beds of varying age off the east coast of Reunion in 2011. Scuba-mediated collecting and photography was undertaken within depth zones at 10 sites on four pre-1977 lava beds and those formed in 1977, 2002, 2004 and 2007. Sponges (23 species in 18 genera and 17 families), octocorals (20 species in 9 genera and 5 families) and ascidians (4 species in 4 genera and 2 families) were identified and these were differentially distributed in terms of lava bed age but not depth. Older lava formations had a greater biotic density and diversity, and colonisation of the lava beds appeared to be slow. The benthic fauna differed from that on the west coast of Reunion and the octocoral diversity was impoverished relative to published records elsewhere in the region. These characteristics of the benthos were attributed primarily to harshness of the lava reef, abrasive nature of the associated sediment and the turbulent sea conditions.

ARTICLE HISTORY
Received 8 October 2015
Accepted 13 May 2016

KEYWORDS
Biodiversity; reefs; Porifera; Alcyonacea; Ascidiacea; Reunion; volcano; *Piton de La Fournaise*

Introduction

Marine lava flows form sublittoral habitats that offer an opportunity to investigate their colonisation by reef biota, particularly benthic invertebrates. Studies of this nature have been undertaken in both warm (Hawaii: Townsley, Trott, and Trott 1962; Doty 1967; Grigg and Maragos 1974; Indonesia: Barber, Moosa, and Palumbi 2002; Tomascik, van Woesik, and Mah 1996) and cold waters (Norway: Gulliksen, Haug, and Sandnes 1980; Iceland: Gunnarsson and Hauksson 2009; Alaska: Jewett et al. 2010). In tropical regions, interest in this field has focussed particularly on scleractinian corals (Grigg and Maragos 1974; Townsley, Trott, and Trott 1967) but no studies had until recently been conducted in the western Indian Ocean, despite the fact that Reunion has one of the world's most active volcanos (Michon and Saint-Ange 2008; Tanguy, Bachèlery, and LeGoff 2011), the flows of which commonly reach the ocean (Coppola, Staudacher, and Cigolini 2005; Michon and Saint-Ange 2008). An expedition (BIOLAVE) was thus mounted to lava beds derived from recent eruptions of the *Piton de La Fournaise* on the east coast of Reunion in 2011 to assess their biodiversity. Details on the echinoderms (Bollard et al. 2013) and fish (Pinault et al. 2013a,b) have been published and this paper covers the sponges, alcyonacean octocorals and ascidians, taxa which were not considered in any of the previous literature. The Scleractinia are the subject of a separate study.

Methods

Study area

Piton de La Fournaise lies on the south-east side of Reunion (Figure 1) and is the only active volcano in the region, erupting on average every nine months (Michon and Saint-Ange 2008; Tanguy, Bachèlery, and LeGoff 2011). The island is very steep with a narrow coastal shelf due to its volcanic origin. The shore of the study area has been subjected to lava flows that entered the sea prior to 1977 as well as in the years 1977, 2002, 2004, 2005 and 2007. It has thus been shaped by lava flows that have expanded the shoreline, generating steep cliffs and massive boulders that are eroding in places into rubble and black sand. These features extend sublittorally, forming massive subterranean structures with steep walls interspersed by rubble and sand (Figure 2). The subsequent reefs are fairly uniform in these attributes, with little variation. The eastern shore of Reunion is exposed to trade winds and oceanic swells that are strong in the austral winter (Tessier et al. 2008),

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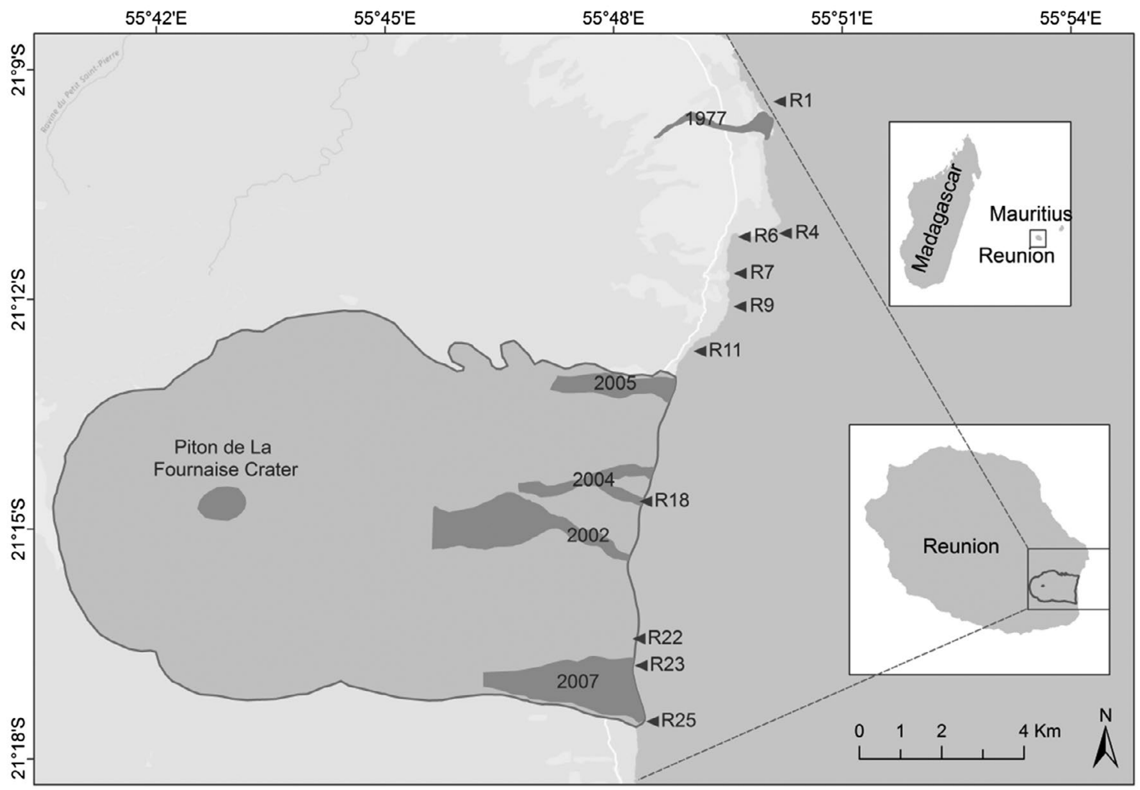

Figure 1. Map showing the *Piton de La Fournaise* on the south-east coast of Reunion, its recent lava flows and the BIOLAVE sampling sites.

rendering the coastal environment turbulent with concomitant sediment mobilisation and movement. Sea temperatures range seasonally at Reunion between 23°C and 28°C (Conand et al. 2007).

Reef surveys and analysis

Scuba dives were undertaken at the sampling sites listed in Table 1 between 25 November and 2 December 2011. The survey approach entailed commencing the dives at the outer edges of the shallower lava beds at ~30 m and working shore-wards through defined depth zones. Specimens representative of all the sponges, soft corals and ascidians encountered within each depth zone were photographed and collected. The samples were fixed overnight in 4% formal-saline and the sponges and soft corals were subsequently transferred to 70% ethanol. Sponges were identified by RWMVS at the Naturalis Biodiversity Center in Leiden, The Netherlands; ascidians by SP-N at Nelson Mandela Metropolitan University in Port Elizabeth, South Africa; and the alcyonacean octocorals by YB and MHS at Tel Aviv University, Israel.

Results

Samples comprising 54 sponges, 45 alcyonaceans and six ascidians were collected; their identifications are listed in Table 2. Together, the identified taxa represent 24 families and 31 genera (Table 3) that were differentially distributed in terms of reef age (Table 4) but not depth (Table 5). They were sparsely distributed on the reefs (Figure 2) and visual assessment of their abundance using indices was impractical. However, the older, pre-1977 reef formations clearly had a greater diversity (Figure 2) and cover of these vulnerable biota. A few species normally found on deeper reefs (>15 m) did not occur at shallower depths (e.g. *Annella reticulata*).

It is also noteworthy that, in addition to the above groups, a corallimorph was collected (*Rhodactis* sp.), a zoanthid (*Palythoa* sp.), a hydrozoan (*Distichopora* sp.) and a black coral (*Cirrhipathes* sp.).

Discussion

This is the first study of the taxa under consideration on lava beds of known age. There is a paucity of information on the biodiversity of these groups around the tropical south-west Indian Ocean islands (Table 6), in general, and the BIOLAVE survey appears to be the first on ascidians in the region. Sponges were recently collected on the west coast of Reunion (Bourmaud 2003) and, numerically, their biodiversity appears similar to that of the lava beds (Table 6). However, the east and west coasts shared only seven genera, but no

TBID 1190669
1 October 2016
Revision
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Coll:XX QC:XX

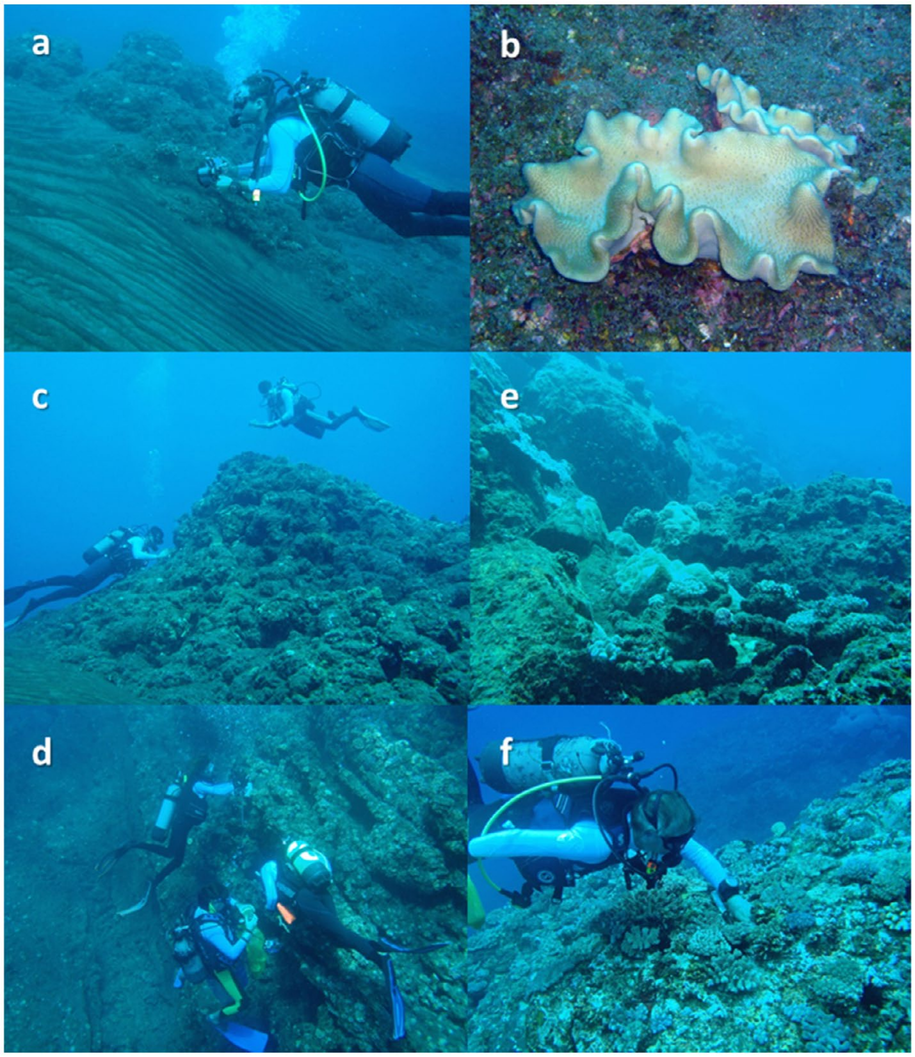

Figure 2. (a) There is considerable sediment movement on the lava beds. (b) A colony of *Lobophytum patulum* showing the sparseness of the benthic community on the lava bed, as do views (c, d) of recent lava flows. Older, pre-1977 lava beds (e, f) have a more established benthic community.

Table 1. Details of the sites sampled during the BIOLAVE expedition.

Name	Reference		Depth (m)	Coordinates	
Coulée 1977	R1	H9.1	15–25	−21° 9.417	55° 50.177
		H9.2	0–15		
Roche de Césari	R4	H9.2	20–30	−21° 11.135	55° 50.253
		H2	0–20		
Anse des Cascades	R6	H9.2	7–12	−21° 11.182	55° 49.713
Radiale 7	R7	H9.1	20–30	−21° 11.659	55° 49.662
		H2	18–20		
		H9.2	10–18		
Radiale 9	R9	H11	18–30	−21° 12.090	55° 49.657
		H2	14–18		
		H4	0–14		
Tombant J. Pat	R11	H9.1	25–30	−21° 12.676	55° 49.132
		H9.2	15–25		
		H4	0–15		
Coulée 2004	R18	H9.1	15–25	−21° 14.638	55° 48.422
		H9.2	0–15		
Grand Tombant (2002)	R22	H6	20–30	−21° 16.431	55° 48.333
		H7	15–20		
		H4	0–15		
Coulée 2007	R23	H2	10–12	−21° 16.780	55° 48.361
		H4	0–10		
	R25	H2	10–15	−21° 17.510	55° 48.510
		H4	0–10		

Table 2. Ascidians, soft corals and sponges found on submerged lava beds off the south-east coast of Reunion during the BIOLAVE expedition.

Ascidiacea
Cystodytes dellachiajei (Della Valle 1877)
Didemnum millari Monniot, F. 2001
Eudistoma atypicum Monniot and Monniot 2006
Trididemnum areolatum (Herdman 1906)

Alcyonacea
Annella reticulata (Ellis and Solander 1786)
Chironephthya sp.
Cladiella sp.
Dendronephthya sp.
Lobophytum crassum von Marenzeller 1886
Lobophytum patulum Tixier-Durivault 1956
Ovabunda biseriata (Verseveldt and Cohen 1971)
Rhytisma fulvum fulvum (Forskål 1775)
Sarcophyton flexuosum Tixier-Durivault 1966
Sarcophyton glaucum (Quoy and Gaimard 1833)
Sarcophyton roseum Pratt 1903
Sinularia abrupta Tixier-Durivault 1970
Sinularia brassica May 1898
Sinularia densa (Whitelegge 1897)
Sinularia erecta Tixier-Durivault 1945
Sinularia hirta (Pratt 1903)
Sinularia humesi Verseveldt 1968
Sinularia muralis (May 1899)
Sinularia numerosa Tixier-Durivault 1970
Sinularia peculiaris Tixier-Durivault 1970

Porifera
Acanthella pulcherrima Ridley and Dendy 1886
Arenosclera sp.
Axinella donnani (Bowerbank 1873)
Biemna ehrenbergi (Keller 1889)
Chondrilla mixta Schulze 1877
Chondrilla sacciformis Carter 1879
Chondrosia debilis Thiele 1900
Cinachyrella providentiae Dendy 1922
Clathria (Thalysias) sp.
Haliclona (Reniera) sp.
Hyrtios erectus (Keller 1889)
Ircinia sp. 1
Ircinia sp. 2
Ircinia sp. 3
Penares sp.
Petrosia (Strongylophora) mauritiana (Carter 1885)
Petrosia sp.
Pipestela aff. *hooperi* (Van Soest, Desqueyroux-Faúndez, Wright and König 1996)
Placospongia carinata (Bowerbank 1858)
Plakortis aff. *simplex* Schultz 1880
Plakortis kenyensis Pulitzer-Finali 1993
Pseudoceratina arabica (Keller 1889)
Spongia aff. *sweeti* (Kirkpatrick 1900)

Table 3. Families and genera of ascidians, soft corals and sponges found on submerged lava beds off the south-east coast of Reunion during the BIOLAVE expedition.

	Family	Genus	Species
Ascidiacea	Didemnidae	*Didemnum*	1
		Trididemnum	1
	Polycitoridae	*Cystodytes*	1
		Eudistoma	1
Totals	2	4	4
Alcyonacea	Alcyoniidae	*Cladiella*	1
		Lobophytum	2
		Rhytisma	1
		Sarcophyton	3
		Sinularia	9
	Nephtheidae	*Dendronephthya*	1
	Nidalidae	*Chironephthya*	1
	Subergorgiidae	*Annella*	1
	Xeniidae	*Ovabunda*	1
Totals	5	9	20
Porifera	Ancorinidae	*Penares*	1
	Aplysinellidae	*Pseudoceratina*	1
	Axinellidae	*Axinella*	1
		Pipestela	1
	Callyspongiidae	*Arenosclera*	1
	Chalinidae	*Haliclona (Reniera)*	1
	Chondrillidae	*Chondrilla*	2
	Chondrosiidae	*Chondrosia*	1
	Desmacellidae	*Biemna*	1
	Dictyonellidae	*Acanthella*	1
	Irciniidae	*Ircinia*	3
	Microcionidae	*Clathria (Thalysias)*	1
	Petrosiidae	*Petrosia (Strongylophora)*	2
	Placospongiidae	*Placospongia*	1
	Plakinidae	*Plakortis*	2
	Spongiidae	*Spongia*	1
	Tetillidae	*Cinachyrella*	1
	Thorectidae	*Hyrtios*	1
Totals	17	18	23

species; this is not surprising as the habitats are so dissimilar. A comparison of the regional distribution of soft corals was the most revealing as the Alcyonacea have been more extensively collected. Mauritius was poorer in both genera and species than the east coast of Reunion according to an early, possibly incomplete work (Vennam and Parulekar 1994), but both the west coast of Reunion (Benayahu and van Ofwegen 2008) and NW Madagascar (Evans, Steer, and Belle 2011; Tixier-Durivault 1966; Verseveldt 1969, 1971) have substantially more soft corals (Table 6). The diversity of the alcyonacean fauna off the *Piton de La Fournaise* thus appears low by regional standards, making the reefs unique in this regard in the south-west Indian Ocean. The reasons for this are discussed below.

The low biodiversity of the benthic groups considered here seems attributable to the recentness of the reef formations, the harshness of the environment and the abrasiveness of the associated sediment (pers. obs.), being volcanic in origin. The latter was abundant in places (Figure 2(a)), being a product of erosion of the lava formations by the turbulent sea conditions. The darkness of the substrata must also absorb rather than reflect incident light, limiting its availability to benthos with symbiotic algae. Amongst the groups studied, this would affect zooxanthellate Alcyonacea in particular. Furthermore, the strong winter swells that pound the coast regularly remobilise the abrasive sediment; a soft coral partially smothered by volcanic sand is illustrated in Figure 3. All these factors must militate against the recruitment and success of soft-bodied reef benthos and warrant further investigation.

Table 4. The incidence of ascidians, soft corals and sponges found on submerged lava beds of different age off the south-east coast of Reunion during the BIOLAVE expedition.

Taxon	Pre-1977 (R4, 6, 7, 9, 11)	1977 (R1)	2002 (R22)	2004 (R18)	2007 (R23, 25)
Ascidiacea					
Cystodytes dellachiajei	+				
Didemnum millari	+	+		+	
Eudistoma atypicum				+	
Trididemnum areolatum				+	+
Alcyonacea					
Annella reticulata				+	
Chironephthya sp.			+		
Cladiella sp.	+				
Dendronephthya sp.			+		+
Lobophytum crassum	+	+	+		
Lobophytum patulum	+		+		
Ovabunda biseriata		+			
Rhytisma fulvum fulvum	+				
Sarcophyton flexuosum	+				
Sarcophyton glaucum	+				
Sarcophyton roseum	+				
Sinularia abrupta	+				
Sinularia brassica	+				
Sinularia densa	+				
Sinularia erecta	+				
Sinularia hirta	+				
Sinularia humesi			+		
Sinularia muralis	+	+	+		
Sinularia numerosa	+				
Sinularia peculiaris	+				
Porifera					
Acanthella pulcherrima	+	+			
Arenosclera sp.		+	+		
Axinella donnani			+		
Biemna ehrenbergi	+				
Chondrilla mixta	+	+	+	+	+
Chondrilla sacciformis			+	+	
Chondrosia debilis			+	+	
Cinachyrella providentiae	+				
Clathria (Thalysias) sp.				+	
Haliclona (Reniera) sp.					
Hyrtios erectus					+
Ircinia spp.				+	
Penares sp.	+				+
Petrosia (Strongylophora) mauritiana	+	+			
Petrosia sp.	+				
Pipestela aff. *hooperi*			+		
Placospongia carinata	+		+		
Plakortis aff. *simplex*	+				+
Plakortis kenyensis	+				
Pseudoceratina arabica	+	+			+
Spongia aff. *sweeti*		Incidental 'by-catch' on other samples			
Totals	28	9	13	9	7

Low and slow colonisation of the reefs by these vulnerable taxa was evident in the results of the benthic surveys; pre-1977 lava flows were, on average, colonised by 28 different sponges, soft corals and ascidians (Table 4) and these included more delicate organisms such as the soft corals *Sarcophyton* spp. and *Rhytisma fulvum fulvum*. The younger reefs had fewer of these soft-bodied organisms and were inhabited by more robust taxa (Table 4). The BIOLAVE survey of echinoderms yielded similar results (Bollard et al. 2013).

Colonisation of recent lava flows has been demonstrated to be fast in some areas, e.g. the Banda Islands in Indonesia (5 years: Tomascik, van Woesik, and Mah 1996), but can be dependent on the degree to which the coast is exposed to recolonisation from the sea (Grigg and Maragos 1974). The process is slower at Hawaii where SSTs would be comparable with those at Reunion and the development of a normal benthic reef community on exposed lava flows takes ~20 years (Grigg and Maragos 1974). The east coast of Reunion is indeed exposed to the force of the open sea and sufficient time has elapsed for the older lava flows to develop a full reef community. The fact that the taxa under consideration have not done so highlights the harshness of this environment.

Table 5. The depth partitioning of ascidians, soft corals and sponges between the shallow turbulent (<15 m) and deeper reef (15–30 m) zones on submerged lava beds off the south-east coast of Reunion during the BIOLAVE expedition.

Taxon	≤15 m	15–30 m
Ascidiacea		
Cystodytes dellachiajei	+	
Didemnum millari		+
Eudistoma atypicum	+	
Trididemnum areolatum	+	
Alcyonacea		
Annella reticulata		+
Chironephthya sp.		+
Cladiella sp.	+	
Dendronephthya sp.	+	+
Lobophytum crassum	+	+
Lobophytum patulum	+	+
Ovabunda biseriata	+	
Rhytisma fulvum fulvum		+
Sarcophyton flexuosum	+	
Sarcophyton glaucum		+
Sarcophyton roseum	+	+
Sinularia abrupta		+
Sinularia brassica		+
Sinularia densa	+	+
Sinularia erecta		+
Sinularia hirta	+	
Sinularia humesi		+
Sinularia muralis	+	+
Sinularia numerosa	+	
Sinularia peculiaris	+	+
Porifera		
Acanthella pulcherrima	+	+
Arenosclera sp.	+	
Axinella donnani		+
Biemna ehrenbergi		+
Chondrilla mixta	+	+
Chondrilla sacciformis		+
Chondrosia debilis	+	+
Cinachyrella providentiae	+	
Clathria (Thalysias) sp.		+
Haliclona (Reniera) sp.		
Hyrtios erectus	+	
Ircinia spp.	+	+
Penares sp.	+	+
Petrosia (Strongylophora) mauritiana	+	+
Petrosia sp.	+	+
Pipestela aff. *hooperi*		+
Placospongia carinata		+
Plakortis aff. *simplex*	+	
Plakortis kenyensis		+
Pseudoceratina arabica	+	+
Totals	27	31

Table 6. The biodiversity of ascidians, soft corals and sponges on submerged lava beds off the south-east coast of Reunion relative to its west coast (Benayahu and van Ofwegen, 2008; Bourmaud 2003) and Mauritius (Vennam and Parulekar 1994); nd = no data. The number of species of soft coral recorded at NW Madagascar is included but is approximate due to uncertainty in the taxonomy in the source references (Evans, Steer, and Belle 2011; Tixier-Durivault 1966; Verseveldt 1969, 1971).

	Reunion			
	E coast lava beds	W coast	Mauritius	NW Madagascar
Ascidiacea				
Genera	4	nd	nd	nd
Species	4	nd	nd	nd
Alcyonacea				
Genera	8	8	4	17
Species	19	34	15	~50
Porifera				
Genera	18	17	nd	nd
Species	23	20	nd	nd

Figure 3. A soft coral, *Lobophytum crassum*, partially smothered and surrounded by black volcanic sand off the *Piton de La Fournaise* on the south-east coast of Reunion.

Acknowledgements

The authors thank the BIOLAVE team for excellent support and assistance during the expedition. Special tribute is given to Stephanie Bollard who capably organised the expedition and prematurely lost her life later in the field. Alex Shlagman kindly curated the alcyonacean collection.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

BIOLAVE was funded by the *Délégation Régionale de la Recherche et de la Technologie* with co-financing from the European Union. The grant for BIOLAVE formed part of the CPER 2007-2013 under the measure GP4 3-01.

References

Barber, P. H., M. K. Moosa, and S. R. Palumbi. 2002. “Rapid Recovery of Genetic Diversity of Stomatopod Populations on Krakatau: Temporal and Spatial Scales of Marine Larval Dispersal.” *Proceedings of the Royal Society of London B* 269: 1591–1597.

Benayahu, Y., and L. P. Van Ofwegen. 2012. “Octocorals (Cnidaria, Anthozoa) from Reunion, with a Description of Two New Species of the Genus *Sinularia* May, 1898 and Notes on the Occurrence of Other Species.” *Zoosystema* 34: 673–699.

Bollard, S., M. Pinault, J.P. Quod, E. Boissin, L. Hemery, and C. Conand. 2013. “Biodiversity of Echinoderms on Underwater Lava Flows with Different Ages, from the Piton De La Fournaise (Reunion Island, Indian Ocean).” *Cahiers De Biologie Marine* 54: 491–497.

Bourmaud, C. 2003. “Inventaire de la biodiversité marine récifale à la Réunion. Rapport Université, WWF, Museum de la Réunion, ARVAM. Maître d’ouvrage: Parc Marin de La Réunion, Région Réunion [Inventory of Marine Biodiversity on Reefs in Reunion. Report of the University, WWF, Museum of Reunion and ARVAM for the Marine Park of Reunion, Reunion Region].”

Conand, F., F. Marsac, E. Tessier, and C. Conand. 2007. “A Ten-Year Period of Daily Sea Surface Temperature at a Coastal Station in Reunion Island, Indian Ocean (July 1993-April 2004): Patterns of Variability and Biological Responses.” *Western Indian Ocean Journal of Marine Science* 6: 1–16.

Coppola, D., T. Staudacher, and C. Cigolini. 2005. “The May-July 2003 Eruption at Piton De La Fournaise (La Reunion): Volume, Effusion Rates and Emplacement Mechanisms Inferred from Thermal Imaging and Global Positioning System (GPS) Survey.” In *Kinematics and Dynamics of Lava Flows*, edited by M. Manga and G. Ventura, 103–124. Boulder Co: Geological Society of America Special Paper.

Doty, M. S. 1967. “Pioneer Intertidal Population and the Related General Vertical Distribution of Marine Algae in Hawaii.” *Blumea* 15: 95–105.

Evans, A. J., M. D. Steer, and E. M. S. Belle. 2011. “The Alcyonacea (Soft Corals and Sea Fans) of Antsiranana Bay, Northern Madagascar.” *Madagascar Conservation and Development* 6: 29–36.

Grigg, R. W., and J. Maragos. 1974. “Recolonization of Hermatypic Corals on Submerged Lava Flows in Hawaii.” *Ecology* 55: 387–395.

Gulliksen, B., T. Haug, and O. K. Sandnes. 1980. “Benthic Macrofauna on New and Old Lava Grounds at Jan Mayen.” *Sarsia* 65: 137–148.

Gunnarsson, K., and E. Hauksson. 2009. “Succession and Benthic Community Development in the Sublittoral Zone at the Recent Volcanic Island, Surtsey, Southern Iceland.” *Surtsey Research* 12: 161–166.

Jewett, S. C., J. L. Bodkin, H. Chenelot, G. G. Esslinger, and M. K. Hoberg. 2010. “The Nearshore Benthic Community of Kasatochi Island, One Year after the 2008 Volcanic Eruption.” *Arctic, Antarctic and Alpine Research* 42: 315–324.

Michon, L., and F. Saint-Ange. 2008. “Morphology of Piton De La Fournaise Basaltic Shield Volcano (La Reunion Island): Characterization and Implication in the Volcano Evolution.” *Journal of Geophysical Research-Solid Earth* 113 (B0323): 1–19.

Pinault, M., N. Loiseau, P. Chabanet, P. Durville, and J. P. Quod. 2013a. “Influence of Environmental Factors on the Spatial Structure of Non-Reef Fish Populations in Reunion Island.” *Cybium* 37: 95–109.

Pinault, M., N. Loiseau, P. Chabanet, P. Durville, H. Magalon, and J. P. Quod. 2013b. “Marine Fish Communities of Shallow Volcanic Habitats - Piton De La Fournaise - Reunion Island (SW Indian Ocean).” *Journal of Fish Biology* 82: 1821–1847.

Tanguy, J. C., P. Bachèlery, and M. LeGoff. 2011. “Archeomagnetism of Piton De La Fournaise: Bearing on Volcanic Activity at La Réunion Island and Geomagnetic Secular Variation in Southern Indian Ocean.” *Earth and PlanetaryScience Letters* 303: 361–368.

TBID 1190669
1 October 2016
Revision
CE: XX QA: XX
Coll:XX QC:XX

Tessier, E., L. Bigot, C. Cadet, B. Cauvin, P. Chabanet, C. Conand, J. B. Nicet, and J. P. Quod. 2008. "Coral Reefs of Réunion Island in 2007: Status Report and Monitoring Network." *Revue D'Ecologie La Terre Et La Vie* 63: 85–102.

Tixier-Durivault, A. 1966. "Octocoralliaires de Madagascar et des Iles Avoisinantes [Octocorals of Madagascar and the Surrounding Islands]." *Faune De Madagascar* 21: 1–456.

Tomascik, T., R. van Woesik, and A. J. Mah. 1996. "Rapid Coral Colonization of a Recent Lava Flow following a Volcanic Eruption, Banda Islands, Indonesia." *Coral Reefs* 15: 169–175.

Townsley, S. J., L. Trott, and E. Trott. 1962. "A Preliminary Report of the Rehabilitation of the Littoral Marine Community on a New Lava Flow at Kapoho." *Hawaii. Ecology* 43: 728–730.

Vennam, J., and H. Parulekar. 1994. "*Sinularia mauritiana*, a New Species of Soft Coral (Coelenterata: Octocorallia) from Mauritius, Indian Ocean." *Zoologische Mededelingen Leiden* 68: 127–133.

Verseveldt, J. 1969. "Octocorallia from North-Western Madagascar (Part I)." *Zoologische Vehandlingen Leiden* 106: 1–38.

Verseveldt, J. 1971. "Octocorallia from North-Western Madagascar (Part II)." *Zoologische Vehandlingen Leiden* 117: 1–73.