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Sunken wood from the Vanuatu Islands: identification of wood substrates and preliminary description of associated fauna

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Abstract

Two trawl samples of natural sunken wood collected near Vanuatu were identified based on histological studies. Detailed descriptions were made and microphotographs of the cell types were taken, using the three classical sections (cross, tangential and radial). The botanical characters were compared first to the native flora of Vanuatu, then also to the introduced species. The possibility of transportation by ocean currents with a mainly southern and eastern direction is discussed. The first sample lacks apparent colonization marks. Its main histologic character is the presence of 'paedomorphic type I rays' which relates it to the shrubby genera *Fitchia* (Asteraceae) and *Fuchsia* (Onagraceae): both are known in Polynesia but they seem not to be recorded from Vanuatu. The second wood sample is densely colonized by molluscs and other fauna. It comes from a tree close to the Fabaceae-Mimosoideae, possibly belonging to the genera *Leucaena* or *Serianthes*, both known from Vanuatu. Our work shows for the first time that, even after prolonged submergence in water at substantial depth (>500 m), the wood structure may be well preserved. Therefore, the botanical identification and the determination of the origin of the sunken wood were possible. The two selected samples show completely different colonization patterns, which could be related to differences in chemical composition or to time elapsed since sinking.

Problem

The occurrence of sunken wood and vegetal debris in deep oceanic environments has been known for a long time, as many oceanographic expeditions have reported the occurrence of remains of terrestrial plants in the deep sea. The Challenger expedition reported plant remains from 1500 to 3900 m depth stations (Murray 1895), near the Philippines and New Guinea. Since then, numerous expeditions reported wood falls in the West Indies, East Pacific, North Atlantic and Indonesian waters (see Wolff

1979 for references). Plant debris is thus abundant in many areas in the deep sea, at all depths, with higher densities near estuaries, and in sedimentary accumulation basins. Other deep-sea organic substrates, mainly whale skeletons, have been studied and described (see Smith & Baco 2003). Nevertheless, the most widespread and abundant may be terrestrial plant materials, and particularly sunken wood, which allows the development of long-lasting ecosystems, playing a key role in the deep sea (Cayré & Richer de Forges 2002). Wood, an end product of photosynthesis, reaches abyssal depths in sufficient

quantity to support locally dense populations of deep-sea wood borers. The activity of these borers, often aided by bacteria and fungi, rapidly converts the wood to an available food source in the form of fecal pellets for detritus feeders, larvae and adult borers for predators and dead remains of all these organisms for scavengers (Turner 1977).

Over the past few years, investigations of phylogenetic affinities between the fauna of whale falls, sunken wood and hydrothermal vents led to the hypothesis that ecosystems that develop around organic substrates in the bathyal zone could represent a step in the colonization of hydrothermal vents (Distel *et al.* 2000; Kiel 2006). This work has caused a renewal of the interest in these ecosystems, particularly sunken wood, which remains poorly known, although it houses a huge faunal diversity. Organisms commonly associated with sunken wood include gastropod, polyplacophoran and bivalve molluscs, decapod and peracarid crustaceans, polychaetes, and echinoderms (Turner 1977; Wolff 1979; Forest 1987; Cayré & Richer de Forges 2002). In addition, the diversity of the plant debris itself, and especially tree species, is poorly known. Determination of wood types present in wood falls is of major importance to infer geographical origin, and thus the ability of various types of wood to disperse and to form 'stepping stones' to other ecosystems, and also to understand the interactions between terrestrial and marine ecosystems. A second reason to determine wood types is to explore the possibility of specific associations between wood species and organisms, which can occur due to different structure or chemical composition of the substrate. The two aims of this study were, based on two wood samples, to: (i) determine if wood identification is still possible after prolonged exposure at the deep-sea floor (*e.g.*, to determine whether high hydrostatic pressure and seawater lead to wood structure modifications); and (ii) describe the fauna associated with those samples.

Material and Methods

Study area

Sunken wood samples were recovered during the BOA 0 cruise on the R/V *Alis* (November 2004) in Vanuatu; 27 trawl operations were conducted, between 200 and 1000 meters depth. The two samples studied here were recovered at depths of 560–580 m (the trawl area of this operation was ∼6000 m^2), between the islands of Malekula, Ambrym and Epi (16°37.4 S; 167°59.8 E, Fig. 1). Once on board, the trawl bag was emptied, its contents rinsed free of sediment, and wood and fauna samples sorted. Animals were sorted by genera and kept in various fixatives according to their future use. Plant debris and wood were kept (with their associated fauna) in alcohol for taxonomic identification of the wood and inventory of the associated organisms.

Fauna collection

Once at the laboratory, two selected wood samples were studied in detail for (i) botanical identification (see below) and (ii) analysis of the associated fauna. The wood samples were first measured and photographed to document external macrofaunal colonization. Then, the samples were dissected to collect the associated macrofauna (first specimens located at the surface and then those located in burrows inside the wood). Meio- and microfauna were not analysed in this study. Animals were sorted by phylum, and by order or family when possible. All individuals were measured; shell length was utilized for all molluscs; body length was used for annelids and sipunculids; diameter was used for echinoderms (diameter of the central disk for ophiuroids). Animals were then photographed and kept in 70° alcohol. To determine the volume of wood degraded by the boring macrofauna, we calculated the volume of the sample, as if it were intact. Wood sections were assumed to have originally been truncated cones, and the volume thus calculated following
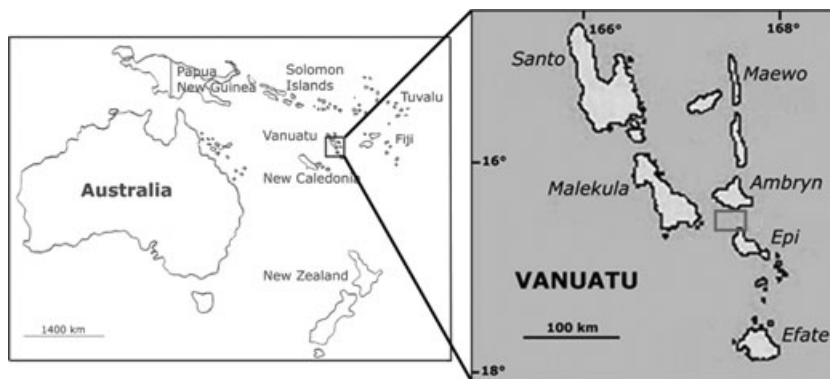

Fig. 1. Location of the Vanuatu archipelago and its main islands. The two samples were trawled at depths of 560–580 m in the square area, between the islands of Malekula, Ambryn and Epi.

the formula: $V = \pi(H/3)(R^2 + r^2 + Rr)$, where H is the height and R and r are respectively the base and apex radius of the truncated cone. The real remaining wood volume was calculated by immersion in water. The difference between the two gave the fraction of the wood removed by the colonizers.

Identification of the molluscs was provided by Anders Waren from the Swedish Museum of Natural History. Identification of the boring bivalve specimens was provided by Takuma Haga from the University of Tokyo.

Wood identification

The anatomical description and identification of wood species are based on the examination of three classic sections: (i) cross, (ii) tangential and (iii) radial. Four cellular types were studied: (i) vessel elements, (ii) parenchyma, (iii) rays and (iv) fibres.

The successive steps for each sample were: (i) to locate the three sections with a magnifying glass; (ii) to carve the samples to a cube of 1 cm^3; and finally, (iii) to make sections with a Reichert sliding microtome (thickness of 30 μm for cross-section, and about 17.5 μm for longitudinal sections). The sections were bleached and stained with iodic green, and mounted in gelatinous glycerine with phenol. Each cellular type was studied under a light microscope (distribution, number and size of cells, thickness of walls, *etc.*). Photographs of the most significant wood elements used for identification were taken with Pégase Pro software (3.0 version, 2I SYSTEM, 2000). A comparative anatomical study was realized with help of published descriptions of tropical woods, and reference collections of wood slides.

Results

The 27 trawls yielded a great variety of plant debris: wood trunks, branches or twigs, leaves, nuts (coco, nipa), sugar canes and tree fern. This preliminary study will be focused on two pilot samples (collected from the same trawl operation) with poor (sample 1) and rich (sample 2) macrofauna.

Anatomical wood description

Sample 1 (Fig. 2)
Macroscopic description (Fig. 2a): The wood sample is light beige. It seems to be a branch with opposite knots. The bark is missing and the core is lost with a narrow canal marking its position, but the sample is well preserved. No traces of colonization by organisms are visible.

Anatomical description (Fig. 2b, c): It is a hardwood, with weakly marked growth rings. Abundant medium-

sized vessels are observed in cross-section (from 18 to 20 per mm^2). They are solitary and in multiples of two, three, or four pores. Parenchyma is scarce and paratracheal. Fibres are abundant, with thick walls and usually septate. Rays are not clearly discernible in cross-section. In tangential section, they are arranged irregularly. Rays are very tall (up to 3 mm), mostly biseriate, and are constituted of elongated cells (up to 150 μm high, and 11.5–18 μm wide). These kinds of rays are called 'paedomorphic type I rays' (Carlquist 1988).

Sample 2 (Fig. 2)
Macroscopic description (Fig. 2d): The wood sample measures 83 cm in length and from 5.3 to 8 cm in diameter. It has a clear demarcation between yellowish sapwood and dark brown heartwood. The bark is missing. This sample exhibits abundant depressions and furrows made by limpets, and tunnels bored by bivalves (Fig. 3a).

Anatomical description (Fig. 2e,f): It is a hardwood, with weakly marked growth rings. Scattered medium-sized vessels are observed in cross-section, usually 5 per mm^2. Multiples of two, three and seven pores were found. The perforation plates are simple. Parenchyma is abundant and predominantly paratracheal, aliform and confluent when the vessels are close. In tangential section, parenchyma cells are grouped in vertical rows of 2–6. Crystal chambered cells are present in scattered strands of about 15 cells in the paratracheal parenchyma and among fibres. Rays are uni- or biseriate, homogeneous, and 3–36 cells high. Fibres are abundant, with thick walls, and are clearly septate.

Faunal characterization

Due to the collection methods, it should be noted that, even if numerous specimens were still found stuck on the wood surface, a part of the most exposed animals may have been washed away during the different steps of the sampling (trawling, ascent to the surface and washing of the sediments). A total of 378 animals were recovered in and on the colonized wood sample (*i.e.* sample 2), which corresponds to a density of 0.38 animals per cm^3 (wood sample volume: 991 cm^3). The number of recovered individuals of each species is given in Table 1 and their relative abundance in Table 2. The most abundant group is Mollusca, which represent 89.6% of the specimens found. Limpets dominate (68% of the total fauna and 75.8% of the molluscs). Among this group, three different species were determined. Eight individuals of *Coccopigya* sp. (family Pseudococculinidae) were found, with specimens ranging from 2 to 6 mm in length. One individual of a juvenile, unidentified pseudococculinid of 3 mm in length was also collected from the wood. The most numerous
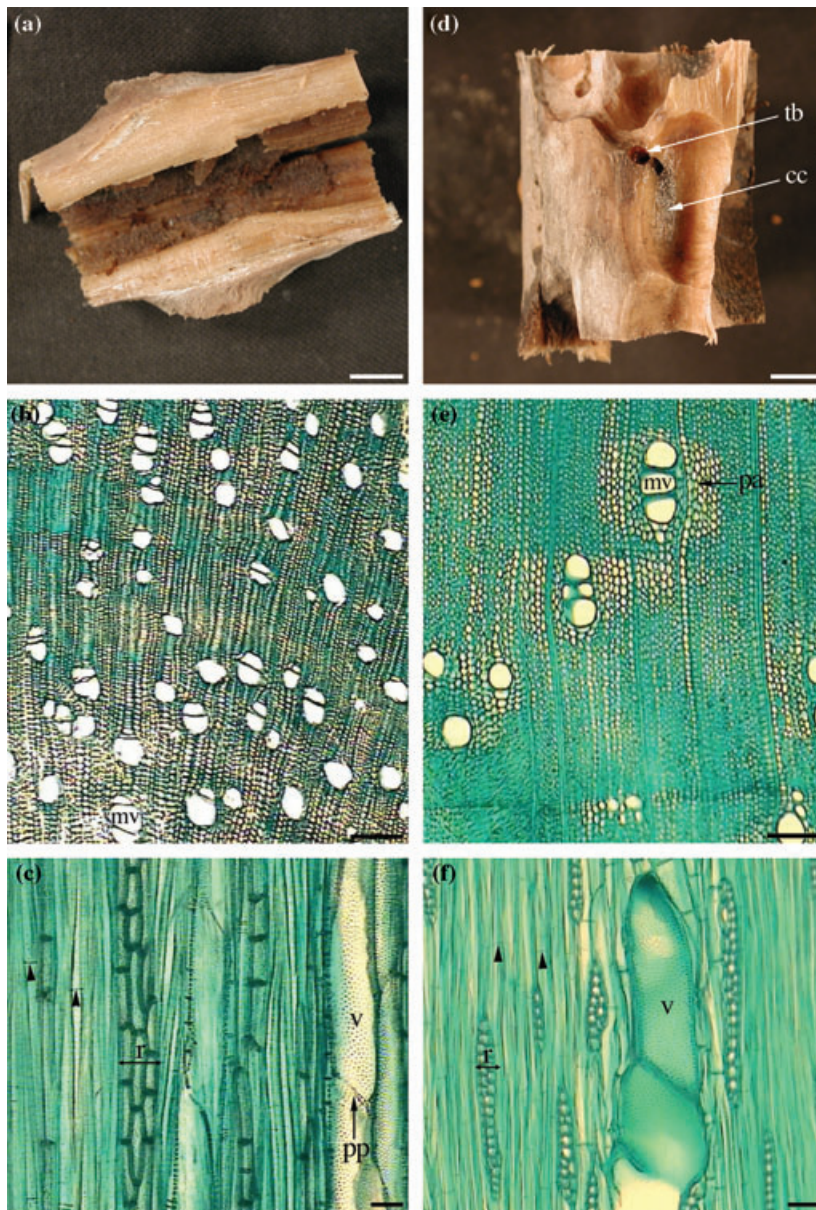
Fig. 2. Wood identification. Sample 1: (a) macroscopic view; (b) cross-section showing weak growth ring boundaries; abundant medium-sized vessels, often multiples of 2 or 3 (mv); parenchyma and rays weakly discernible; fibres with thick walls; (c) tangential section showing on the right, vessel (v) with wall pits and perforation plate simple (pp); uni or biseriate rays, very tall, composed of very elongated cells, 'paedomorphic type I rays' (r); septate fibres with very small pits (arrows). Sample 2: (d) macroscopic view showing presence of cavities excavated by limpets (cc), and openings of tunnels bored by bivalves (tb); (e) cross-section showing the weak growth ring boundaries; diffuse distribution of medium-sized vessels, isolated or multiples of 2 or 3 (mv), and some irregular clusters; abundant parenchyma (pa), paratracheal, aliform and confluent, and thin discontinued tangential lines; uni or biseriate rays, homogeneous; abundant fibres; (f) tangential section showing central vessel elements (v) split by an oblique perforation, and alternate wall pits; paratracheal parenchyma in strands from two to six cells; rays from 3 to 36 cells high, uni or biseriate (r); fibres clearly septate (arrows). Scale bars: a and d = 5 mm, b and e = 200 μm, c and f = 50 μm.

species was a true limpet (Patellogastropoda) of the genus *Pectinodonta* (family Acmaeidae), but the species seems still to be undescribed. Voucher specimens of *Pectinodonta* have been deposited in the Swedish Museum of Natural History under the catalogue number 86626. The various limpets occupy the surface of the wood. *Pectinodonta* specimens are located in hollows that they seem to dig if we consider the shape concordance of the hollows and the shells (Fig. 3b).

The next most abundant group was the wood boring bivalves, which belong to the families Pholadidae (subfamily Xylophagainae) and Teredinidae (subfamily Teredininae). Two species of Xylophagainae were recognized:

Xylophaga teramachii (Iw. Taki & Habe 1950) and *Xylophaga* cf. *gerda* Turner 2002. Among Teredininae, three species were recognized: *Lyrodus pedicellatus* Quatrefages, 1849, *Teredothyra matocotana* Bartsch, 1927 and one undetermined Teredininae species. Specimens were deposited in the collection of the National Science Museum of Tokyo with following registration numbers: *Xylophaga teramachii*: NSMT-Mo 73806 and 73807; *Xylophaga* cf. *gerda*: NSMT-Mo 73808 and 73809; *Lyrodus pedicellatus*: NSMT-Mo 73810. Some incomplete individuals could not be identified but are indicated in Table 1 to correctly indicate the proportion of the fauna comprised of wood-boring bivalves. The bivalves were found in burrows,

Fig. 3. Wood sample 2 with original fauna. (a) Piece of wood, as recovered from the trawl bag, before study; (b) closer view of cocculiniforms. The largest and most numerous are *Pectinodonta* sp. (mt3). Note also an individual of *Coccopigya* sp.(mt1), a chiton (ch) and a *Xylophaga teramachii* tube (xt); (c) closer view of the entrance of calcareous tubes of *Xylophaga teramachii*; (d) a *Xylophaga teramachii* with mesoplax (me) and truncated siphonal canals (sc); (e) a wood mussel of family Mytilidae (*Idas* sp.), another abundant taxon found on the sample. Scale bars: a and c = 2 cm, b = 1 cm, d and e = 0.5 cm.
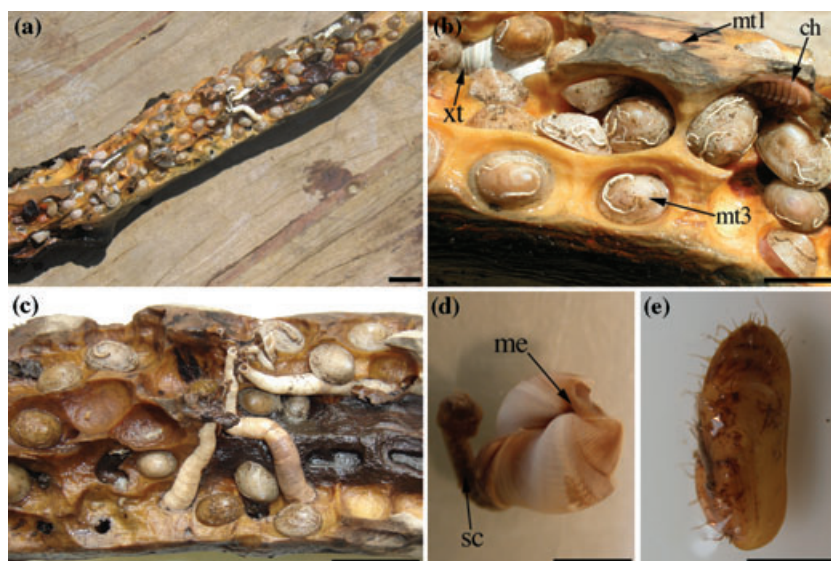
Table 1. Faunal composition of the megafauna (organisms visible to the naked eye) recovered on the colonized wood sample (*i.e.* sample 2, see Results). Numbers (N) of individuals in each taxonomic group are given, as well as their size and location on the wood sample.

taxonomic position	N	range size (mm)	location
Mollusca			
Polyplacophora	1	12	On the surface
Gastropoda			
Cocculiniform *Coccopigya* sp.	8	2–6	On the surface, exposed or in hollows
Cocculiniform *Pseudococculinidae* sp.	1	3	
Cocculiniform *Pectinodonta* sp.	248	9–16	On the surface, exposed or in hollows
Caenogastropoda	2	1, 11	
Bivalvia			
Xylophagainae *Xylophaga teramachii*	18	3–13	In calcareous or wood burrows, in heartwood or sapwood
Xylophagainae *Xylophaga* cf.*gerda*	4	3–6	
Teredininae *Lyrodus pedicellatus*	10	3–6	
Teredininae *Teredothyra matocotana*	1	No shell	
Teredininae Undetermined species	1	6	
Incomplete individuals	32		
Mytilidae *Idas* sp.	13	4–13	In holes, under a sediment layer. On the surface, hung on the wood, exposed or in hollows
Annelida			
Polychaeta			
Maldanidae	6	7–35	In holes
Undefined	2		
Sipuncula	7	9–20	In holes
Echinodermata			
Echinoidea	20	1.5–7	On the surface, exposed or in hollows or holes
Ophiuroidea	4	2.5–3	In holes on the surface

mostly made in the sapwood of the sample, but some of them were also found in heartwood, in knots and in a spiral grain area, although wood is harder in these areas.

Other molluscs (polyplacophorans, gastropods and mytilid bivalves) were found in lesser amount (mytilids represent 3.4% of the fauna, with sizes ranging from 4 to 13 mm; the two other groups are represented by one and two individuals, respectively). Echinoderms (represented by small sea urchins and brittle stars) represent 6.3% of the total abundance. Finally, Annelida and Sipuncula represent 2.1% and 1.9% of the total abundance respectively.

Table 2. Relative abundance of the different groups identified, recovered on the wood sample 2. Percentages are estimated from the Table 1 data. Relative abundances of each phylum are given, as well as those of the different taxa identified. Density of individuals on the sample is also indicated.

Taxa	N	Relative abundance of the taxa (percentages)
Mollusca (89.7%)		
Polyplacophora	1	0.3
Limpets	257	68.2
Caenogastropoda	2	0.5
Xylophagainae	18	5.8
Teredininae	12	3.2
Incomplete wood borer bivalves	32	8.5
Mytilidae	13	3.4
Annelida (2.1%)		
Polychaeta	8	2.1
Sipuncula (1.9%)	7	1.9
Echinodermata (6.4%)		
Echinoidea	20	5.3
Ophiuroidea	4	1.1
Total abundance	378	
Density (ind·cm^{-3})	0.38	

We found no crustaceans, whereas they have been found in the 'wood islands' experiments of Turner (1977) and in the plant remains collected by Wolff (1979).

Discussion

The pieces of wood were first compared to the endemic flora of Vanuatu. Nevertheless, because of climatic and human disturbance, new plants, not known from the primary vegetation, can grow and replace the native flora and form a secondary vegetation. Moreover, we cannot neglect the influence of marine currents bringing material from northern and eastern sources (*e.g.* the Solomon Islands, Fiji and Polynesia).

The anatomical identification of the first sample is based on paedomorphic type I rays. The existence of these particular rays leads us to formulate two hypotheses: (i) the wood sample was a young individual and in this case, the botanical identification is not easy because comparative anatomical study is based on adult individuals. This hypothesis will thus not be treated in the discussion; (ii) it was an adult individual, semi-herbaceous or shrub, with persistent young (*i.e.* neotenic) features.

According to Carlquist (1988), paedomorphic type I rays are known in some genera of Asteraceae (*Baccharis*, *Brachylaena* and *Verbesina*) and in some Onagraceae and Goodeniaceae.

A few shrubby species of Goodeniaceae are known in New Zealand and Polynesia (Willis 1973): *Scaevola taccada* was recorded by Mabberley (1997) in the Indo-Pacific zone, but according to Metcalfe & Chalk (1957) and Carlquist (1969) studies, the wood features of sample 1 are not sufficiently similar to be attributed to the Goodeniaceae family.

Concerning the Asteraceae, no members of the *Baccharis*, *Brachylaena* or *Verbesina* genera are found in Melanesia (Mabberley 1997). Nevertheless, the Asteraceae family must still be considered because of a great similarity between our sunken wood and another genus, *Fitchia*, known in Polynesia (Willis 1973). Carlquist (1957) mentioned rays with more than 100 erected cells in height, mostly biseriate, paratracheal parenchyma and septate fibres with thick walls. We compared our sample with *Fitchia taitensis* (Orliac reference collection no. 332, Museum National d'Histoire Naturelle, MNHN) and most of the features are similar, but some of them also differ: *F. taitensis* presents smaller and less numerous vessels and non-septate fibres with thicker walls. So our sample does not correspond to this species, but the genus *Fitchia* remains a possibility.

Onagraceae are known from all over the world (Willis 1973). The wood histology is interesting, particularly in the genus *Fuchsia* (known in Polynesia). Metcalfe & Chalk (1957) observed multiseriate rays, higher than 1 mm, heterogeneous; vessels are abundant (7–25 per mm^2), solitary or grouped; fibres are septate in most of the *Fuchsia* species. We also notice the presence of opposite knots in the genus. The description and photographs of *F. cyrtandroides* wood in Détienne & Jacquet's (1999) atlas supplement the description of Metcalfe and Chalk and show that our sample could be attributed to *Fuchsia*.

Through this comparative anatomical study, it appears that the first sample is likely to belong to the genus *Fitchia* or *Fuchsia*.

Numerous features listed lead us to attribute the second sample to the Mimosoideae subfamily (Fabaceae): (i) typical non-solitary vessels with simple perforation plates, (ii) paratracheal, aliform and confluent parenchyma, constituted of strands of two to six cells; chambered cells with crystals in strands of 15 cells on average, scattered in parenchyma and among fibres, (iii) homogeneous rays, uniseriate and biseriate, and (iv) fibres clearly septate.

In Vanuatu, according to Wheatley (1992) and Cabalion & Morat (1983), nine genera of Mimosoideae are present. However, only four genera have septate fibres, which is the most significant wood feature of the subfamily: these genera are *Albizia*, *Inga*, *Leucaena* (Metcalfe & Chalk 1957) and *Serianthes* (Détienne & Jacquet 1999). Hence, our discussion can be restricted to these four genera.

Albizia lebbeck and *Inga edulis* are listed among the introduced species in Vanuatu. However, both have bigger-sized vessels (and wider rays for *A. lebbeck*) than our wood sample (Metcalfe & Chalk 1957; Kribs 1968;

Détienne & Jacquet 1983; Bois des DOM TOM 1992). These features lead us to exclude the two genera *Albizia* and *Inga*.

Two species of *Leucaena* are present in Vanuatu in semi-deciduous lowland dry forest (Wheatley 1992): *L. forsteri* and *L. leucocephala*, the latter present in the reference collection of the MNHN (coll. Abong, Vanuatu, MA 25). Our sample could belong to this species, but we have no data on *L. forsteri* for comparison. Furthermore, Kanehira (1921) noted a dark brown heartwood for a species of *Leucaena*, like in our sample.

Four species of *Serianthes* are recorded by Wheatley (1992) in the Vanuatu evergreen lowland rain forest: *S. ebudarum*, *S. melanesica*, *S. myriadena* and *S. vitiensis*. Of these, we have information only on *S. myriadena*, described in the Détienne & Jacquet's (1999) atlas and present in the reference collection of the MNHN (coll. Orliac, no. 80). The anatomical study of this species shows that the second sample may correspond to *Serianthes*.

Through this comparative anatomical study, it appears that the second sample is likely to belong to the genus *Leucaena* or *Serianthes*.

The macrofaunal utilization of various plant remains (wood, bark, leaves, fruits, seagrass and *Sargassum*) in the deep-sea has been reviewed by Wolff (1979): animals use plant materials either as a substrate, a shelter, or as food. On the first sample, no traces of colonization by macrofauna were visible. In contrast, the second sample is densely covered by various animals and has numerous holes and openings of long ducts, revealing the occurrence of boring organisms. It has been experimentally shown (El-Shanshoury *et al.* 1994) that, because of the differences in the structure and chemical heterogeneity (presence of gums and tanins associated with the cellulose and other polymers), bacterial and fungal ability to digest cellulose in various types of woods is different. Colonization heterogeneity between our two selected wood samples could be related to their different chemical composition. Our preliminary results of an *in situ* experiment show that various woods, placed at the same depth, in the same conditions and for the same duration (20 months), exhibit completely different colonization patterns, suggesting that colonizers may actively select their substrate. But, as we have no idea of the duration of stay on the seafloor for our two trawled samples, differing seafloor exposure time cannot be excluded as a reason for the difference in colonization.

Biodeterioration of the wood is known to be mainly performed by bacteria and fungi, which produce extracellular enzymes destroying the material, and by molluscs and crustaceans, which bore into the wood, which they ingest and may subsequently utilize (Wolff 1979). In the present study, we did not investigate bacteria and fungi associated with samples.

The fauna collected on and inside the wood is mostly composed of cocculiform and wood-boring bivalve molluscs (Table 1). Although cocculiforms are usually not considered as borers, specimens of *Pectinodonta* sp. found on our samples may significantly contribute to the wood degradation, as they occur in notable grooves they likely dig on the surface. Comparing the original and remaining volume of wood after colonization, we estimate that 59.7% of the initial wood sample has been degraded by the boring fauna.

Among the plant remains collected from the Caribbean area (at depth below 1200 m), Wolff (1979) observed that the diversity and abundance of cocculinid gastropods is significant, with at least seven species occurring in and on wood. Wolff (1979) felt that there can hardly be any doubt that all cocculinids occurring on organic remains utilize them as food, and that both cocculinid gastropods and chitons utilize a cover of microbial organisms rather than the substrate. But our observations reveal that all *Pectinodonta* sp. specimens are located at the bottom of hollows (see Fig. 3c) that they very likely dig beneath themselves. Microscopic observations (M. Zbinden, pers. comm.) indicate that their gut is packed with wood chips that they undoubtedly rasp from the surface, possibly to detach the microbial cover, but a role of the wood in the diet is also conceivable. Furthermore, there is, until now, no report in the literature of *Pectinodonta* found on anything but wood (A. Waren, pers. comm.), which could be an indication that they do rely on wood for their diet. They may be able to either degrade cellulose with the help of gut symbiotic bacteria or use their own enzymes; both cases occur in so-called lower and higher wood-boring termites (Ohkuma 2003). Further analyses are under way and will shed light on this question.

Wood-boring bivalves have been described to be the most important organisms involved in converting the refractory cellulose carbon deposited in wood and other plant remains to a form more readily available for other deep-sea organisms (Turner 1977). As their shallow-water counterparts the shipworms (Teredinidae), which harbour endosymbiotic bacteria in their gills to help digest cellulose, the gills of Xylophagainae also contain bacteria, which are thought to have the same wood degrading role (Distel & Roberts 1997; Distel *et al.* 2002). Turner (2002) described the subfamily Xylophagainae as composed of three genera (*Xylophaga* comprising 37 species, *Xylopholas*, monospecific and *Xyloredo* comprising three species), with all of them, so far as known, being wood borers.

Experimental deployments of wood panels (Turner 1973, 1977; Romey *et al.* 1991) reveal that colonization by wood-borers can occur within a few months. On panels

submerged 1 year at 2000 m depth, Turner (1977) found 41 species, with colonization probably beginning within one or two months and the associated fauna increasing gradually with time. Considering the low diversity found on our sample, we can hypothesize that it did not stay longer than 1 year at the bottom before recovery. Furthermore, teredinids mainly occur on drift wood or sunken wood in shallow water (less than ca. 200 m), and live individuals are rarely found in deeper waters. The only exception belongs to the genus *Teredothyra*, which has been obtained from greater depths (*e.g.* Turner 1966) (the species of *Teredothyra* is easily distinguished, having a thick calcareous tube and 'septa' inside of the posterior tip of the tube). However, most teredinids which settle on a drift/float wood may survive if the wood sinks to the deep sea. In such cases, however, sunken wood cannot receive new recruitment. In our study, two species of teredinids were recovered: *Lyrodus pedicellatus* and *Teredothyra matocotana*. The occurrence of large numbers of *Lyrodus pedicellatus* may suggest that the wood has only been on the seafloor for a short period of time. Nevertheless, it has to be noted that Turner (1973) also reported that wood deployed at 2000 m depth for 6 months to 3 years had not begun to crumble. The fact that our first sample is not colonized does not necessarily indicate a short period on the seafloor.

Conclusions

Our purpose was to demonstrate that even after sinking to water depths of several hundred metres, sunken wood structure can be well-preserved and allow systematic botanical identification. With this approach, we can propose some affinities. Sample 1 is related to two shrubby genera: *Fitchia* (Asteraceae) and *Fuchsia* (Onagraceae), present in Polynesia and seemingly not mentioned in Vanuatu. Our second sample of sunken wood appears to come from a tree close to *Leucaena* or *Serianthes* (Fabaceae-Mimosoideae), two genera recorded in Vanuatu. These identifications favour a more local geographical origin for the *Leucaena-Serianthes* sample than for the *Fitchia-Fuchsia* one, the latter being introduced from more distant islands.

The fact that one of the specimens was not colonized by any fauna, whereas the other one was abundantly and diversely inhabited, might be due to a selection between substrates or to different immersion times. Preliminary results of *in situ* experiments give us a likely answer to this question, as various woods placed at the same depth, in the same conditions and for the same duration (20 months) exhibit completely different colonization patterns. Further studies on the botanical diversity of sunken wood linked with faunal inventory will be done and, we hope, will lead to more definitive answers.

Our goal for the future is to analyse numerous other samples, to identify specific associations between colonizing organisms and substrate, and, if the geographical origin is clear enough, to evaluate the role played by sunken wood as stepping stones to other ecosystems like hydrothermal vents.

Acknowledgements

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