

## SHORT COMMUNICATION

# Mass occurrence of the recent brachiopod *Magellania venosa* (Terebratellidae) in the fjords Comau and Reñihué, northern Patagonia, Chile

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## Keywords

Brachiopoda; Chile; *Magellania venosa*; mass occurrence; Terebratellidae.

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Accepted: 7 March 2008

doi:10.1111/j.1439-0485.2008.00240.x

## Abstract

Mass occurrences of the terebratellid brachiopod *Magellania venosa* with more than 200 individuals·m<sup>-2</sup> are reported from the fjords Comau and Reñihué in the northernmost region of the Chilean fjordland, whereas more southern fjords do not show these high numbers of the largest living brachiopod. This is an exception to earlier observations that the abundance of *M. venosa* on the Chilean shelf is positively correlated with increasing latitude. As the sympatric scleractinian coral *Desmophyllum dianthus* also occurs in unusually high numbers in the fjords Comau and Reñihué, the hydrographical regime and its associated environmental conditions in these fjords may be responsible for these mass occurrences.

## Problem

Globally, mass occurrences of living brachiopods are a rare phenomenon in recent benthic communities. Only a few brachiopod species are able to build up monospecific 'living shell beds' reminiscent of the Palaeozoic, when brachiopods used to be amongst the dominant benthic filter feeders in all oceans. Unusually high abundances of recent brachiopods have been reported only from nutrient-rich environments such as the Antarctic shelf (Peck & Robinson 1994) or shelf regions influenced by deep-sea upwelling currents, e.g. the South African west coast (Hiller 1993, 1994) or the west coast of the Americas (McCammon 1973; Pennington *et al.* 1999). The ability to dominate a benthic community is obviously independent of certain brachiopod morphological features, as mass occurrences of the spirolophid inarticulate *Disciniscia cf. tenuis* (Sowerby, 1846) in near-shore habitats of the Namibian Atlantic (Hiller 1993; C. Lüter, personal observation) principally do not differ from the large communities of the plectolophe, short-looped *Liothyrella uva*

(Broderip, 1833) in the Antarctic (Peck & Robinson 1994; Peck *et al.* 2001) or the beds of the plectolophe, long-looped *Laqueus californianus* (Koch, 1848) in the deeper parts of the Gulf of California (Pennington *et al.* 1999). Here, we report mass occurrences of the largest living brachiopod, *Magellania venosa* (Solander, 1789), in the fjords Comau and Reñihué, Chile. *Magellania venosa* has been described from the whole Magellan region with most frequent encounters in the Straits of Magellan and adjacent waters (see McCammon 1973 and references therein, Ríos *et al.* 2003). According to McCammon's account on the ecology of this species, it is restricted to a region south of 30° S on the Chilean coast, with increasing abundances towards the Straits of Magellan and Cape Horn. The fjords Comau and Reñihué lie in the northernmost part of the Chilean fjord region (approximately 42° S) and if abundance of *M. venosa* is exclusively correlated with latitude, one would not expect such unusually high concentrations in these fjords. Additional observations in the fjords and channels further south and at the Atlantic coast near Puerto Pirámides (Argentina) revealed

no mass occurrences of *M. venosa*, suggesting that the distribution of large accumulations of *M. venosa* along the Chilean coast is locally restricted and does not necessarily follow a latitudinal gradient. It is the first time that the dense communities of the largest living brachiopod have been explored, mapped and photographed by SCUBA divers.

## Material and Methods

Between 1997 and 2007, SCUBA diving surveys have been carried out by VH and GF between Arica (15° S) and Punta Arenas (53° S) with a focus on the Chilean fjord region between 42° and 50° S. During seven expeditions in this region and an ongoing research project in the fjord Comau, numerous dives have been carried out at more than 100 sites (Fig. 1), mainly along rocky substrate, down to 35 m (rarely 40 m) depth. During an ongoing initiative to describe and map the benthic invertebrate communities of the fjord region, specimens of all invertebrate taxa found were collected to be identified by taxonomists. Collections and general observations of brachiopods have been made during all dives. More detailed studies, especially with regard to density estimations and community structure of the brachiopod aggregations, are the subject of a still ongoing long-term investigation in the fjord Comau at the Huinay Scientific Field Station. More than 70 brachiopod specimens have been collected for identification. Before collection, *in situ* photos of the living animals were taken. One specimen of *M. venosa* was sampled for identification in Puerto Pirámides, Peninsula Valdes, Argentina, and preserved dry. All other brachiopod specimens were preserved in 96% ethanol. Several specimens of *M. venosa* were identified by Lloyd Peck, British Antarctic Survey, in 2000. All other material was identified by CL. Scaled photos in combination with a modified random dot method (Meese & Tomich 1992; Smith & Witman 1999; Försterra 2005) were used to estimate coverage and population densities.

Voucher specimens of the collected brachiopods were deposited at the Museum für Naturkunde der Humboldt-Universität zu Berlin, Germany, Zoologische Staatssammlung Munich, Germany, Universidad Austral de Valdivia, Chile, and The British Antarctic Survey, United Kingdom.

## Results

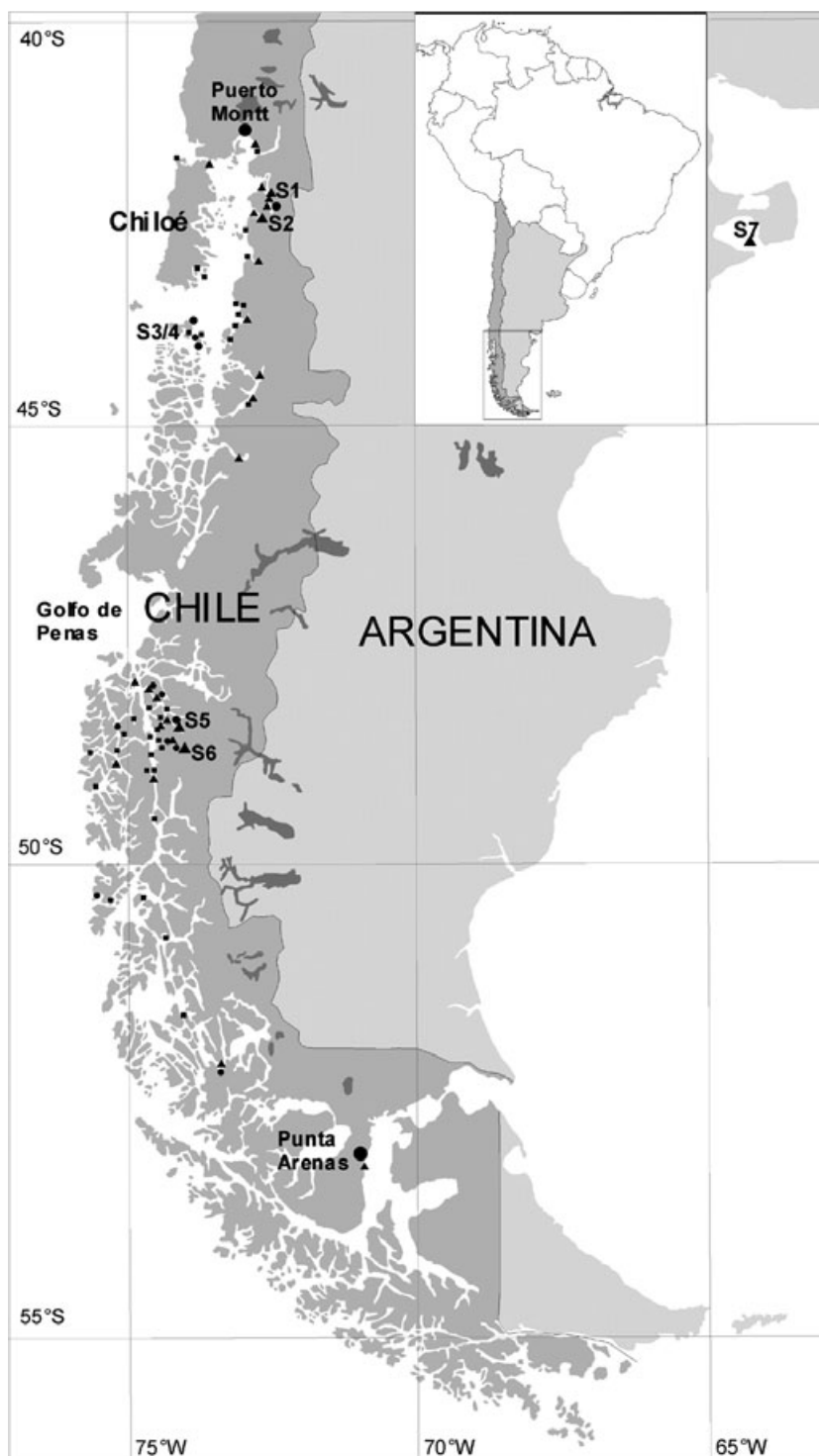
The terebratellid *Magellania venosa* has been observed in high abundances by VH and GF in the fjord Reñihué near Caleta Gonzalo between 15 and 25 m depth in 1998. In 2003, large accumulations have also been discovered below the 15 m depth in the neighbouring fjord Comau (Fig. 1). Although *M. venosa* was found at most sites in

shallow water throughout the entire fjord region, sometimes in high numbers, dense communities comparable to those of the fjords Comau and Reñihué were not observed anywhere else (for details see Table 1). Most specimens were recorded in depths between 20 and 35 m; however, in the central Patagonian channels, single specimens inhabited overhangs as shallow as 2 m depth. In several fjords, *M. venosa* was only found at the head of the fjord. At one site in the fjord Pitipalena (43°46.510' S/72°52.706' W) in the North Patagonian Zone (NPZ), *M. venosa* was found growing on soft sediments. Specimens were attached to grains of coarse sand.

The distribution of *M. venosa* throughout the fjord Comau seems to be patchy on different scales. At least in the inner parts of the fjord, where a permanent low salinity layer of 1–2 m in summer and up to 7–10 m in winter is present (salinity ranges between 2–28‰ in contrast to a stable 32‰ in the underlying main water column), and tidal amplitudes can reach more than 7 m, *M. venosa* only inhabits rocky substrates below 15 m depth. The brachiopods seem to prefer steep slopes, as nearly vertical sites and overhangs are covered with dense communities adjacent to dense aggregations of the stony coral *Desmophyllum dianthus* (Esper, 1794), which have their upper geographic limits in this region. In depths below 20 m the habitat is obviously dominated by *D. dianthus*, interspersed with only a few brachiopods.

In the center of the brachiopod aggregations, densities vary between 50 and 100 individuals·m<sup>-2</sup>. On vertical walls, densities may exceed 200 individuals·m<sup>-2</sup>. Specimens of *M. venosa* often grow in small groups of up to 20 individuals of different sizes, with smaller specimens growing on top of larger ones.

*Magellania venosa* was found to grow as large as 7.5 cm in diameter. Shell orientation is generally horizontal. Shells of living specimens are conspicuously clean and only rarely colonized by epibionts. Specimens were frequently observed to perform 'shaking' movements. When growing in dense groups, the shell orientation of single brachiopods is influenced by shape, size and orientation of neighbouring individuals. Here, movement of single brachiopods is restricted and sediment can accumulate on the shell surface (Fig. 2G). Brachiopods with a sediment layer were more often covered with epibionts (Fig. 2C). *Magellania venosa* growing in the inner fjords of the Central Patagonian Zone (CPZ), which is strongly influenced by sediment from glacial runoff, also showed more epizoic growth (Figs 3A, B). Epizoic invertebrates and associated biota encountered on shells of and next to *M. venosa* in the fjord Comau are listed in Table 2. When present, epizoic organisms predominantly settle along the front edges of both valves (see Fig. 2D–G). It is noteworthy that the geographic distribution of the most densely packed



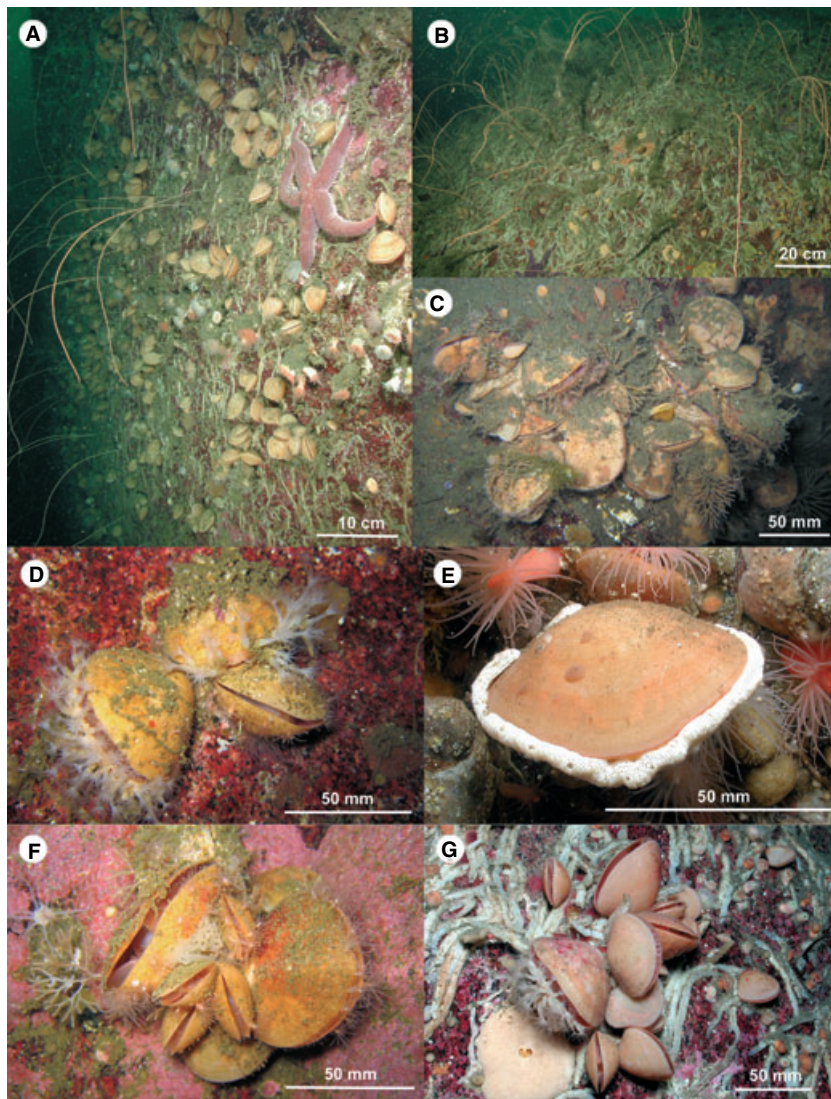
**Fig. 1.** Map of the Chilean fjord region with study sites. Triangles: sites where *Magellania venosa* was found. Circles: Sites where *Terebratella dorsata* was found. Quadrates: sites where *M. venosa* was not found. S1–S7: sites where brachiopods were collected (see Table 1, quadrates and circles larger than others), S1: Comau fjord, S2: Reñihué fjord, S3 and S4: Guaitecas Islands, S5: Bernardo fjord, S6: Témpano fjord, S7: Península Valdés.

populations of *M. venosa* coincides with that of *D. dianthus*. Both species are known from the entire fjord region but form mass occurrences only in the fjords Comau, Reñihué (Försterra & Häussermann 2003) and, most probably, in the fjord Reloncaví (north of Comau fjord).

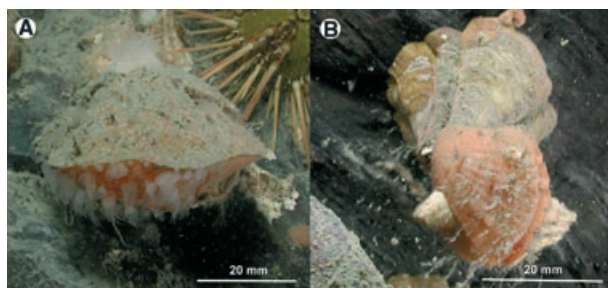
The only other brachiopod found in shallow water of the Chilean fjords is *Terebratella dorsata* (Gmelin, 1790) (Fig. 3B). It occurs in small numbers throughout the fjord region and in the fjord Comau it was only found as single isolated individuals (for details see Table 1).

**Table 1.** Details of stations in the Chilean fjord region and along the Argentinian coast, where *Magellania venosa* and *Terebratella dorsata* were collected during this study.

species	location	GPS data	depth (m)	collector	date of coll.	notes	site name
<i>Magellania venosa</i>	Comau fjord, Punta Llonco	42°20.634' S; 72°27.429' W	32	VH & GF	6.8.2003	juveniles	S1
	Bernardo fjord, km 12	48°29'37.4" S; 74°05'2" W	13 & 20	VH & GF	27.3.2005		S5
	Fjord Tempano, Station Tempano	48°42'59.7" S; 74°00'18.8" W	29.5	VH & GF	24.3.2005		S6
	Península Valdés, near Puerto Pirámides, Argentina	42°35'29" S; 64°17'28" W	20–25	VH & GF	4.2004		S7
<i>Terebratella dorsata</i>	Reñihué fjord, Caleta Gonzalo	42°2'46,6" S; 72°37'0,2" W	15–30	VH & GF	17.18.2.1998, 7.8.1.2001		S2
	Islote NW of Melinka, Guaitecas Islands	43°53' S; 73°43' W	20	VH & GF	8.3.2005		S3
	S Isla Leucayec, Guaitecas Islands	44°04' S; 73°39' W	8	VH & GF	7.3.2005		S4
	Comau fjord, Punta Llonco	42° 20.634' S; 72° 27.429' W	20–25	C.A. Viviani	2.12.2001		S1
	Bernardo fjord, km 12	48°29'37.4" S; 74°05'2" W	13	VH & GF	27.3.2005		S5



**Fig. 2.** *Magellania venosa* in situ in the fjord Comau. A: In the fjord Comau below 15 m, *M. venosa* can form dense aggregations, here with the starfish *Cosmasterias lurida*, the coral *Desmophyllum dianthus* and the sea whip *Primnoella chilensis*. B: On moderately steep slopes densities are lower; common associated species are *P. chilensis* and the polychaete *Chaetopterus* sp. C: Aggregations are more likely to accumulate sediment and also show more epizoic growth such as the bryozoan *Cellaria malviniensis*. D: The soft coral *Clavularia magelhaenica* regularly grow at the margin of the shell of *M. venosa*. E: The didemnid ascidian *Didemnum studei* growing on *M. venosa*. F: The sea anemone *Gonactinia prolifera* and the sponge *Clathrina* sp. in *M. venosa*. G: A small group of *M. venosa* with typical clean shells surrounded by *Chaetopterus* sp. and *Corynactis carnea*.



**Fig. 3.** A. *Magellania venosa* in situ in the Tempano fjord (S6), Central Patagonian fjords, covered with the sea anemone *Metridium senile* on the upper side and polyps of the scyphozoan *Aurelia* sp. on the underside. B. *Terebratella dorsata* in situ in the Guaitecas Islands, Northern Patagonian fjords.

*Terebratella dorsata* is more frequently encountered towards the exposed channels and islands. In contrast to *M. venosa*, it is much more subject to epibiotic overgrowth, often covered by more than one taxon.

## Discussion

Zoogeographically the Chilean fjord region can be subdivided in the NPZ from Puerto Montt at 42° S to the Golfo de Penas at 47° S, the CPZ from Golfo de Penas to the Straits of Magellan at 53° S, and the Southern Patagonian Zone (SPZ) from the Straits of Magellan to Cape Horn (see Pickard 1973; Viviani 1979; Stuardo & Valdovinos 1992; Häussermann & Försterra 2005). In the present study only fjords in the NPZ and CPZ were examined in detail, with the latter being strongly influ-

enced by sediment-rich freshwater from the large inland icefields (Pickard 1973). Although both brachiopod species *M. venosa* and *T. dorsata* were found throughout the entire study area, the mass occurrences are local exceptions to the common trend that *M. venosa* becomes more abundant towards the Straits of Magellan, at the southern end of its distribution (McCammon 1973). Mass accumulations of this species were only found in the fjords Comau and Reñihué, roughly in the middle of its Chilean distribution range from 30° to 53° S. Together with the fjord Reloncaví, Comau and Reñihué are the northernmost fjords of the Chilean south-west coast. These three fjords differ from the other fjords of the NPZ because they open towards the Golfo de Ancud (see Fig. 1); the more southern fjords of the NPZ open into a complex system of channels and islands (see Fig. 1).

Many areas in the fjords and channels of the NPZ are characterized by a high productivity: high values of 5 to more than 10 mg·m<sup>-3</sup> chlorophyll *a* have been measured during summer months (Intesal Chile), resulting in invertebrate communities with high biomass and turnover rates (V. Häussermann & G. Försterra, personal observations in fjord Comau). Additionally, deep-water emergence is a phenomenon regularly observed in the Chilean fjords (Försterra & Häussermann 2003; Häussermann & Försterra 2005) and is a common feature of fjords throughout the Pacific (Brattegard 1980; Pickard & Stanton 1980). These special water conditions may account for the high concentrations of *M. venosa* and other sessile suspension feeders in the fjords examined. The highest densities of *M. venosa* were observed at steep rocky slopes. This characteristic is shared with several

**Table 2.** List of epibionts on and invertebrates associated with living *Magellania venosa* in the fjord Comau.

Group	species	epibiont	associated	figure
Red algae	undetermined	x		–
Porifera	<i>Clathrina</i> sp.*	x		2F
Cnidaria	<i>Clavularia magelhaenica</i> Studer, 1878	x		2D
	<i>Desmophyllum dianthus</i> (Esper, 1794)		x	2A
	<i>Primnoella chilensis</i> (Philippi, 1894)		x	2A and B
	<i>Parazoanthus elongatus</i> McMurrich, 1904		x	–
	<i>Gonactinia prolifera</i> (Sars, 1835)	x		2F
	<i>Metridium senile</i> (Linnaeus, 1767)	x		3A
	<i>Actinostola chilensis</i> McMurrich, 1904*		x	–
	<i>Corynactis carnea</i> Studer, 1879		x	2G
	<i>Aurelia</i> sp.	x		3A
Polychaeta	<i>Hydrozoan polyps</i> , undetermined	x		–
	<i>Chaetopterus</i> sp.		x	2B and 2G
Bryozoa	<i>Cellaria malvinensis</i> (Busk, 1852)	x		2C and F
Echinodermata	<i>Cosmasterias lurida</i> (Philippi, 1858)		x	2A and B
Tunicata	<i>Didemnum studeri</i> Hartmeyer, 1911	x		2E

\*[Corrections added on 7 August 2008, after first online publication: "*Chlathrina* sp." changed to "*Clathrina* sp." and "*Actinostola chilensis* (McMurrich, 1904)" changed to "*Actinostola chilensis* McMurrich, 1904"]

other species and may indicate sensitivity to high sedimentation rates, which would coincide with specimens observed to shake off sediment by quick lateral movements. As epibionts were found to prefer *M. venosa* shells covered with a sediment layer, the animals with this behaviour may prevent shell encrustation.

## Acknowledgements

The authors thank L.S. Peck for identifying some of the collected specimens. This is publication no. 15 of the Hunay Scientific Field Station.

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