ADDING PIECES TO A COMPLEX PUZZLE

discovering the benthic life in the channels and fjords of Chilean Patagonia

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At the dock in Melinka, 25 m:
Boloceropsis platei and *Aplidium fuegiense*

With its almost 1600 km of north–south extension, the fjord region of southern Chile is comparable in size to the expansive fjord coastline of Norway. This extension is formed by two parallel mountain ranges, the high Andes on Chile's eastern border and the coastal mountains along its western edge combine to make it the most structured in the world. The Chilean oceanographic institute SHOA calculated that the thousands of islands, channels and fjords enlarge the coast to a length of almost 90,000 km (map scale). Coast morphology in combination with a highly complex interference pattern of physical factors and gradients such as salinity, sedimentation, light exposure, currents, wave exposure etc., create an immense diversity of habitats. The marine life of the Chilean fjord region, however, belongs to the least studied worldwide (Global Marine Environment 1, 2004, p. 12–13). Therefore it is no surprise that new species and even entire new benthic communities such as cold-water coral banks and mats of chemotrophic bacteria are regular findings of recent studies.

Only some portions of the inner northern fjords of this area are accessible from land via the gravel road *Carretera Austral*; a majority of the region between the Peninsula Taitao and the Straits of Magellan are extremely isolated and are only accessed with boat transport. To access most of the channels and islands, longer and, due to harsh weather conditions, sometimes adventurous boat trips are required.

With no end in sight and despite the previously stated logistic problems imposed on projects within this region the aquaculture industry in the Chilean fjords is still growing at a breathtaking speed, and today Chile is the world's largest producer of farmed salmon. Additional industries and fisheries that impact the marine life in this region have expanded and diversified, with the number of people dedicated to professional sea food harvesting quadrupling in the last decade, consequently improving both harvesting techniques and the efficiency with which it is accomplished. The escalating pressure on this marine ecosystem demands sustainable management, with an emphasis on the urgent and appropriate designation of Marine Protected Areas. In this context, definitive knowledge of the zoogeographic patterns of the multifaceted Chilean fjords are more pressing than ever.

Since we started working in the Chilean fjords in 1997, questions on the zoogeography of this region have increasingly become the driving force of our activities. In particular, the potential of possible subdivisions within this

This page, below left to right: Protected from sediments under overhang: *Desmophyllum dianthus Acesta* aff. *patagonica* and *Arbacia dufresnei*; Bernardo fjord, 25 m: Sediments reduce diversity in glacial influenced fjords of the south: Tempano fjord, 10 m: Soft-bodied hexacorals are common in the southern channels; Messier channel, 28 m.

Happily returned from Melinka.

region as distinct entities has manifested into a primarily unresolved question. Several authors posed the hypothesis of a zoogeographic limit around 48°S. Oceanographic conditions and the Peninsula Taitao that extends far into the Pacific together with the Golfo de Penas represent potential migration barriers at these latitudes. However, poor sampling south of these coastal discontinuities inhibits definite conclusions. Particularly the shallow rocky subtidal, where the highest biomass and macrobenthic species numbers can be found is practically unstudied. Also questions concerning the faunal changes from the inner fjords to the outer remain completely unexamined.

In March 2005 we embarked on a series of expeditions, the first to Chiloé island and the Guaitecas Archipelago, while the second took us to the fjords and channels around 49°S, approximately adjacent to the southern icefield. A main focus was set on the distribution of cold water coral banks that we described from fjords of the northern part of Chilean Patagonia.

To be able to operate in an area without scientific infrastructure, we had to take everything with us, from a compressor to fill the tanks, diving and photographic equipment to aquaria and chemicals for sample preservation. It was crucial to calculate enough redundancy for potential equipment failures. With ten boxes full of equipment we left Huinay Scientific Field Station, our base in the fjord Comau (www.huinay.cl). The Guaitecas Archipelago is connected to Chiloé island by a weekly ferry but for a more extensive exploration of the area it was necessary to rent a boat and crew. After several dives on Chiloe Island and an unexpected two days wait for the delayed boat, together with five colleagues from Belgium and Brazil we left Quellon harbour shortly before deteriorating weather conditions would close it. During the rough gulf crossing on the crowded boat everything from the stowed dishes to our young sea captain became unsettled. Upon safely reaching the harbour of Melinka, the main village on the Guaitecas the bad weather kept us pinned down for another day before we could finally start our work. Accompanied by only minor problems (motor damage, clogging of the toilet, failure of the generator,…) we were able to realize sampling dives at five sites distributed all over the islands.

Although we did not see as many sites as we had wished, we got a good impression of the area and collected a considerable amount of material. We were surprised of the high diversity (on first sight it seemed higher than in the inner fjords), patchiness and heterogeneity on several scales in this area. Each site hosted very different communities, sometimes even in close vicinity. And the benthic communities were quite different to those we knew from the inner fjords, e.g. ascidians which are very rare in the fjords were quite abundant in the channels between the islands. We found many species we did not know from the fjords, and the ones we recognized were often of major or minor importance than in the fjords. Our coral studies brought some very peculiar findings. Corals in general played a minor role at the sites that we examined although the coast morphology often was similar to those fjord sites where large coral banks can be found. Practically all the *Desmophyllum dianthus*, the framework species for coral banks in the fjords that we found were dead and there were almost no signs of recovery or new recruitment. Inferring from the grade of erosion of the corallites (some of them approximately 60 years and older) it seems that all the corals of the area have died simultaneously, some 2–4 years ago, a phenomenon that remains a riddle to us.

The second part of the trip was logistically more challenging. It would take us to the fjords Tempano and Bernardo and adjacent channels for a study of the biodiversity. To get to this remote place we boarded the Navimag ferry that connects Puerto Montt with Puerto Natales and leaves approximately once a week. The ferry that transports an interesting mixture of cattle and tourists needs three days for the entire distance. After a day in calm channels and fjords the ship enters open waters to round Cabo Raper on Taitao Peninsula and to cross the Golfo de Penas. The latter portion (translated Gulf of Sorrows) honoured its name and forced many of the passengers to bed, but usually not before a short visit or two to the bathroom. After two days we reached Puerto Eden, a small village within an Indian reservation and the only stop during this trip. Here German, Manuel, Guillermo y Aliro, the crew of

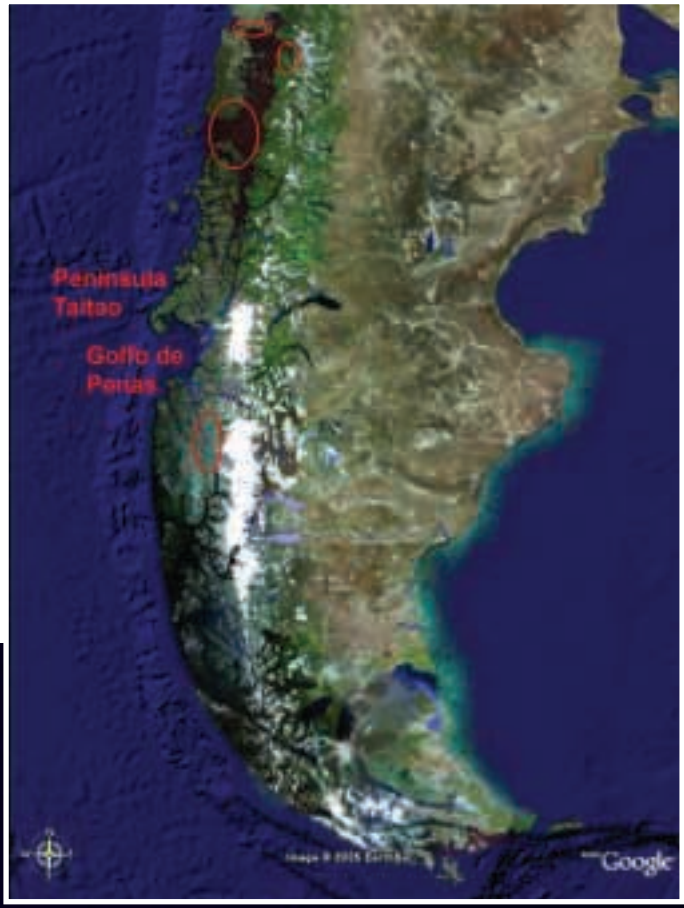
Science “on the rocks”; Tempano fjord.

This page, below left to right: Diverse fauna in high current Chacao channel, Chiloe Island, 15 m: *Gorgonocephalus chilensis* on hydrocoral; Messier channel, 25 m: Colourful rock lobster; Melinka, 20 m.

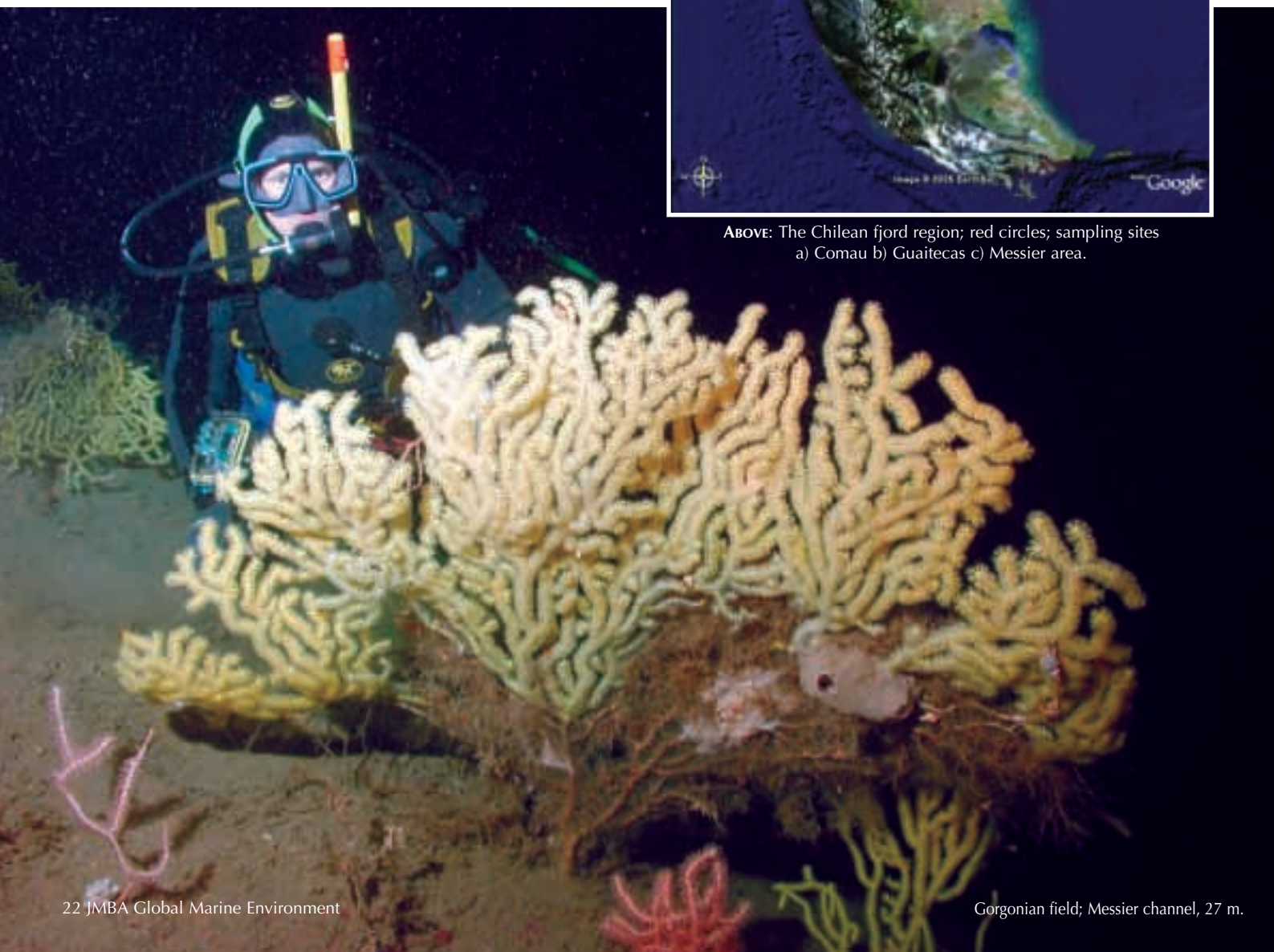
the Yepayek (the boat of the CONAF - the national park rangers), were waiting for us. After seven more hours on this boat we reached the Tempano refuge, a station primarily built for the observation and protection of the huemul, an endangered Patagonian deer species. The next ten days we stayed on the boat where our 16 hour daily routine consisted of preparing dives, underwater sampling and photographing, registering and preserving samples, filing digital photographs, recharging batteries and tanks and drinking hot chocolate to regain warmth.

The landscape adjacent to the large inland icefield is of breathtaking wild beauty. Tempano fjord is characterized by a calving glacier at its head and the influence of glacier-sediment loaded melt–water. The sediment that was easily disturbed by our every move reduced visibility often to zero and made diving very difficult. Our dry suits that worked fine in the northern fjord region hardly isulated enough to prevent us from shivering after 45 minutes in its iceberg cooled water. Bernardo fjord is without direct glacier contact, but influenced by sediment-loaded melt-waters. Due to the quite thick freshwater layer caused by the many glaciers and rivers, the most interesting benthic communities started below 20 m. After eight days of diving two to four times a day at 13 sites and collecting 249 samples which we all photographed in the habitat and preserved carefully and separately, we were completely exhausted, saturated with nitrogen, but happy about all the great things we had seen.

Both taxonomic and quantitative diversity analyses are still in process, but as a preliminary summary of our findings we can point out that the general diversity in the inner fjords of the southern fjord region seems to be significantly lower compared to fjords north of the Taitao Peninsula. This seems to be correlated with the load of sediments coming from the glaciers, that play an important role in the southern fjord region. In the Tempano fjord, rocks were thickly covered by fine glacial sediment. This situation did not improve towards the head of the fjord, since here a large milky river is entering the fjord. We found very few species, most of them restricted to vertical and overhanging walls where sediment stress is lower. Among those species however, were some very interesting representatives such as the bivalve *Acesta* aff. *patagonica* in less than 20 m depth. The Bernardo fjord is less affected by glacial sediments and consequently was richer in life. Overall diversity was increasing the further we went away from the glaciers



Above: The Chilean fjord region; red circles; sampling sites a) Comau b) Guaitecas c) Messier area.



Gorgonian field; Messier channel, 27 m.

towards the channels further west. The ‘Enlish Narrow‘ in Messier channel with its strong currents was with distance the most diverse site we examined. Although at first sight we could not find a difference in diversity of the benthic life in the channels south of Golfo de Penas to the channels north of Peninsula Taitao, we were surprised how different the communities were in the two parts of the fjord region. In the south we found communities that were characterized by organism groups and species that we never found in the northern fjord region. Ophiurids were much more common than in the north, at some sites large bryozoans were very abundant. It was our first recorded observation of large hydrocorals, giant fan gorgonians and crinoids. The dominating sea anemone species from the northern part (*Anthothoe chilensis* and *Corynactis carnea*) were replaced in the south by *Metridium senile lobatum* which covered impressive swathes of substrate. Although all three shallow water *Scleractinia* species from the northern fjords (Cairns et al., 2005) were sporadically present at overhanging portions of the fjords Tempano and Bernardo, corals played a minor role in the benthic communities of the southern fjords and were never present in large accumulations as we described them from the northern fjords.

Concluding from these findings we can confirm the hypothesis about a subdivision of the Chilean fjord region. As in the northern fjord region we found a very complex, patchy pattern with very different conditions and benthic communities even within short distances. And -as in the north- these patterns can only partly be correlated with factors that can be read from a chart such as coast morphology, bathymetry or currents.

Although this is an interesting fact which shows the enormous diversity of this region, it indicates the extent to which levels of understanding must be raised before we have data sets that permit reasonable coastal management. The best that can be done in such a situation is to base decisions on the accumulation of prior knowledge from the experiences that have been made in comparable regions, along with increasing the efforts for benthic inventories and mapping. In these prevailing circumstances it is a question of reason to exclude large areas from exploitation and designate marine protected areas until we know more about the distribution and responses of the affected communities.

Our next expedition that shall bring us to the outer channels and the exposed islands of the southern fjord region is already scheduled for next summer. We hope it will help us to add more pieces to this very complex puzzle.

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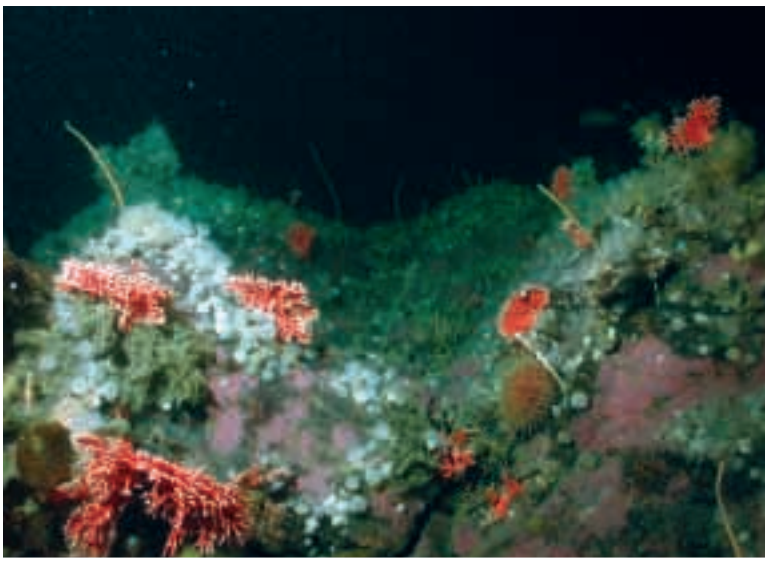

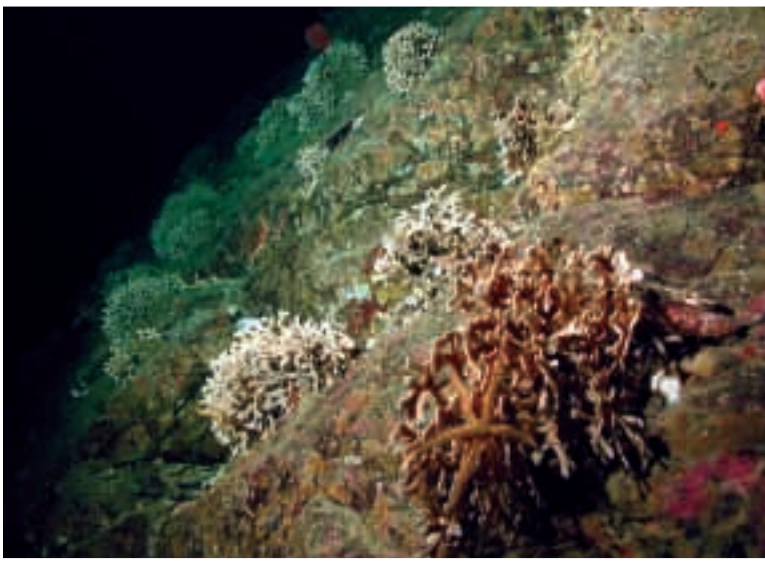

Right, top to bottom:

Dactylanthus antarcticus preys on gorgonians (here *Primnoella* sp.); Messier channel, 15 m: Hydrocorals and *Metridium senile lobatum* were only found in the southern channels; Messier channel, 25 m: Field of large bryozoans *Adeonella* sp. in Messier channel, 28 m: Channels in the Guaitecas Archipelago.