First report on large scleractinian (Cnidaria: Anthozoa) accumulations in cold-temperate shallow water of south Chilean fjords

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Försterra, G. & V. Häussermann. First report on large scleractinian (Cnidaria: Anthozoa) accumulations in cold-temperate shallow water of south Chilean fjords.
Zool. Verh. Leiden 345, 31.x.2003: 117-128, figs 1-5.— ISSN 0024-1652/ISBN 90-73239-89-3.
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Key words: azooxanthellate solitary corals; *Desmophyllum dianthus*; *Caryophyllia*; fjords, Chile; benthos; cold-temperate waters; shallow water.
South Chilean fjords contain an astonishing diverse benthic macrofauna of which anthozoans form a major portion. Azooxanthellate solitary scleractinians, which were hitherto known from major depths, were found as shallow as 8 m during several expeditions to the south Chilean fjord region. At some sites, stony corals dominate the macrofauna and form dense aggregations, which may cover several 10's of square meters in depths below 25 m. The discovery of these communities in shallow water for the first time allows for in situ observations and structural analysis of these populations by means of SCUBA diving. For further studies, living and dead corals were sampled, photographed, and dried for preservation. Several specimens and tissue samples were preserved in 96% ethanol. The sampled specimens were identified as *Desmophyllum dianthus* (Esper, 1794) and *Caryophyllia* Lamarck, 1801 spec. nov. Specimens of *D. dianthus* found on a shipwreck allowed for growth rate estimations. Minimum growth rates were estimated as 2.3 mm longitudinal growth per year and 1.6 mm diameter growth. Due to increasing human impact on benthic communities in Chilean fjords, especially through salmon farming, it cannot be excluded that these coral communities are in danger before they are even studied.

Introduction

The cold and temperate waters along the Chilean coast between 41.5°S and 53°S belong to the biologically least studied marine regions of the world with only fragmentary information (Arntz, 1999). The morphologically very structured coast composed of fjords, channels and archipelagos with protected and exposed portions in combination with varying terrestrial influences such as influx of fresh water, sediment and organic matter contains a large variety of habitats. This situation gives rise to an astonishing diverse and abundant benthic epi-macrofauna on a large scale (own observation; Carlos Viviani, in litt., 2001; Matthias Gorny, in litt., 2001). It is not surprising that this region contains many species that are new to science. What is surprising is the presence of an entire community, which was not known in this form before: in Chilean fjords, large biocenoses of azooxanthellate solitary scleractinians can be found even in shallow water. Although the solitary individuals form rather two-dimensional populations with non- or scarcely pseudo-ramified units on vertical and overhanging walls, the covered surfaces and densities of these coral aggregations are comparable to those formed by *Lophelia pertusa* (Linnaeus, 1758) in the Atlantic (Hov-

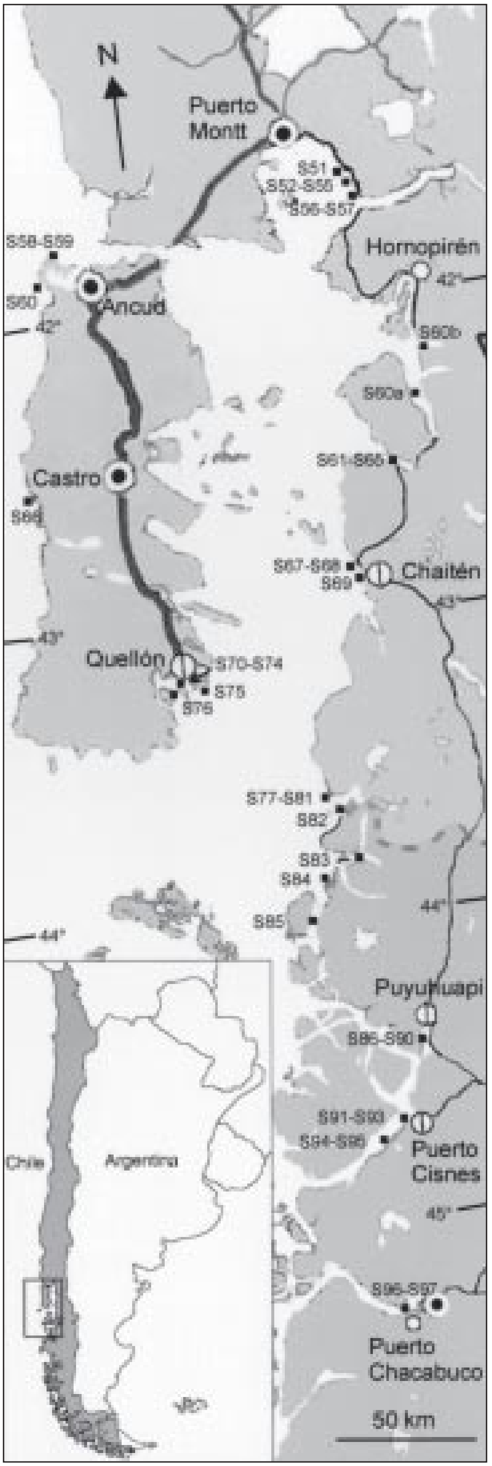

Fig. 1. Study sites (S51-S97) in the south Chilean fjord region.

land et al., 1997; Fossa et al., 2002). The existence of these populations in depths that are accessible for SCUBA-divers, for the first time allows for in situ observations of whole populations and the gathering of data from animals in their habitat. Due to the fact that the Chilean fjord region encounters an extreme boom in salmon farming with dramatic impacts on the marine life in the fjords (Gowen & Bradbury, 1987; Johannessen et al., 1994), these coral communities may be in danger before they are even studied. Only by bringing these unique biocenoses to the attention of the public, the fish-farming community, and enforcement agencies, through photo-documentation and education will there be better understanding and acceptance for the need of protection for these little known resources (Reed, 2002).

Material and methods

During three major expeditions in 1997/98, 1999/2000, 2001, and an ongoing research project in 2002/2003 (Försterra, 2002), we investigated the anthozoan fauna of the south Chilean fjord region from Lenca (41°38'S; 72°40' W) to Puerto Chacabuco (45°26'S; 72°49' W) (Försterra, 1998 (unpublished); Häussermann, 1998 (unpublished)). Thirty-seven sites, mainly with rocky substrate, were examined by SCUBA-diving (fig. 1; app. 1). Dives below 25 m were made at 27 sites; 17 of them showed rocky substrate over the whole depth range. Pictures of living animals were taken in the habitat with a reflex camera and a digital camera in underwater housings and a Nikonos V underwater camera. As the light source an amphibic flash was used. Scaled photos in combination with a modified random dot method (Smith & Witman, 1999; Meese & Tomich, 1992) were used to estimate coverage and population densities. Samples were taken from living and dead animals both from the walls and from broken off specimens at the bottom of the walls. The collected specimens were photographed and dried for conservation. Some smaller specimens were transferred to 96% ethanol for potential molecular studies; from larger specimens apical portions with polyp tissue were broken off for this purpose. Specimens of *Desmopyhllum dianthus* (Esper, 1794) (Caryophylliidae Gray, 1847) on the hull of a sunken boat (S88) allowed for minimum growth rate estimates. Stephen Cairns, Smithsonian Institution, identified the corals.

Deposited material.— **Chile:** *Desmophyllum dianthus*. 2 pseudocolonies from Caleta Gonzalo (S61), collected 23.ii.1997 by G. Försterra and V. Häussermann, 25 to 35 m depth (Zoologische Staatssammlung in Munich: ZSM 20020240); 2 pseudocolonies from Punta Llonco (S60a), collected 6.viii.2003 by GF (Universidad Austral de Chile, IZUA-CNI-0039 and 0040); 2 pseudocolonies collected from Caleta Gonzalo (S61), collected 23.ii.1997 by GF and VH (Nationaal Natuurhistorisch Museum Leiden, RMNH Coel. 32192); 4 specimens from Lenca (S53), collected 24.i.2001 by GF and VH, 25 to 30 m depth (Natural History Museum in Washington, D.C.: USNM 1009656-1009659).

Results

Physical conditions

In the fjords, a more or less distinct pycno-thermocline was observed in depths of 3 to 7 m. At some sites a third water layer was observed, separated by a distinct thermocline at 15 to 20 m. Measured surface temperatures at dive sites where corals were found ranged from 12 to 22°C and surface salinities from 7 to 31‰. Temperatures in depths where corals occurred (below thermocline) ranged from 8 to 13.5°C and salinities from 28.5 to 34‰ (below pycnocline, where present).

Coral species, habitat and associated species

The species were identified as *Desmophyllum dianthus* and *Caryophyllia* spec. nov. The presence of a third species is also indicated.

Scleractinians were found at 22 of 39 dive sites in the examined region (fig. 1). Where rocky substrate was present and dives below 25 m could be realized, scleractinians were found at 18 of 19 dive sites. *Desmophyllum dianthus* was by far the most abundant coral species and present at a total of 19 sites, *Caryophyllia* spec. nov. at eight sites and a possible third species at five sites.

The shallowest finding of a specimen of *Desmophyllum dianthus* was in 8 m at S72 and at S60c. In the examined region *D. dianthus* was regularly found to form large assemblages at vertical and overhanging walls below 25 m. In some fjords stony corals dominate any rocky substratum below 20 m that is vertical or overhanging, with an estimated coverage of up to more than 80% (fig. 2). The upper portion of the largest observed aggregation covered an estimated surface of 50 by 15 m. Due to security considerations, the bathymetric extension of these communities could only be determined down to a maximum depth of 45 m. Maximum population density within

Fig. 2-3. Large, dense accumulations of *Desmophyllum dianthus* in south Chilean fjords. Fig. 2. Accumulations of *D. dianthus* were found on overhanging walls in south Chilean fjords, 28m (S60a). Fig. 3. Maximum population density within dense aggregations of *D. dianthus* may exceed 60%. *Caryophyllia* spec. nov. (arrow) was found associated with *D. dianthus*.

this aggregation was estimated to be more than 1500 specimens / m^2 (fig. 3). Especially in the centre of dense aggregations, specimens of *D. dianthus* develop extremely elongated and delicate column-like coralla (fig. 4). The longest corallum measured 400 mm in length with a greater calicular diameter of 32 mm and a minimum base diameter of 27 mm. Specimens outside or at the edge of aggregations grow shorter, generally broader, conically or trumpet shaped, are more massive and exhibit more „branching". The maximum calicular diameter measured was 63 mm. Neighbouring coralla often partially fuse. Elongated coralla may have "adventive roots" which re-enforce the frequently slender base. Especially on vertical walls, coralla of *D. dianthus* often grow downwards (fig. 5). In general, only the apical end of each corallum of *D. dianthus* is covered with polyp tissue. The portions below tend to be covered by many epibionts such as algae, polychaetes, bryozoans and sponges. Frequently younger coralla grow on basal portions of older ones (figs 3-4). Up to five successive settlements were observed, giving the impression of ramified colonies. Many, especially older coralla, are infested in their basal portion with boring sponge, which perforate and hollow out the calcareous skeleton. The basal plate frequently is perforated and undermined by polychaetes. Terraces below coral aggregations may bear several layers of broken off corals of which the uppermost specimens may still be alive.

Desmophyllum dianthus is regularly associated with the brachiopod *Magellania venosa* (Dixon, 1789) and was always found associated with the sea anemone *Actinostola intermedia* Carlgren, 1899, which occupies less steep portions of the rock walls.

Caryophyllia spec. nov. was exclusively found to grow close to or within populations of *Desmophyllum dianthus* (fig. 3). Often specimens of this species were found on the basal portion of coralla of *D. dianthus*. At S60b on big rock boulders on sandy ground that were covered on their overhanging portion with stony corals, specimens of ***C.*** spec. nov. were dominating on the lowest portion of the boulder, close to the sandy bottom. The habitus of this species showed very little variation. The maximum calicular height was 10 mm and maximum calicular diameter 8 mm.

At three sites (S79, S83, S85) specimens of a coral species were found, which could not be clearly identified as one of the former species. Coralla of this species were growing on less steep rocky slopes, which were subject to slight mud sedimentation where the typical forms of the other two species were absent.

Growth rates

At site S88 at 22 m depth, we discovered the fibre hull of a sunken fisher boat, which was covered with specimens of *Desmophyllum dianthus*. The sinking of the boat could be dated between 1991 and 1992. The overhanging portions of the ship hull were more densely populated with scleractinians than the neighboured rocks, where overhanging portions were rare. Measurements of the sampled specimens allowed for minimum growth rate estimates. The largest specimen collected in 2001 measured 21 mm in height and had a calicular diameter of 15 mm. The resulting minimum growth rate of this specimen was estimated approximately 2.3 mm/year length growth and approx. 1.6 mm/year diameter growth.

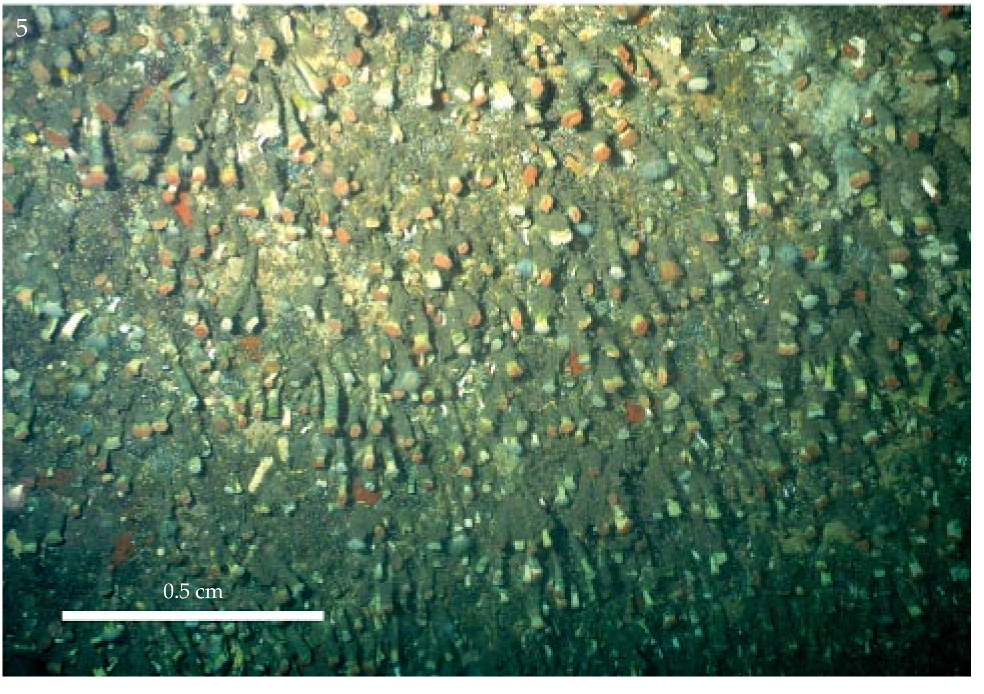

Fig. 4-5. Typical growth forms of *Desmophyllum dianthus*, 32m (S61). Fig. 4: In dense aggregations, specimens of *Desmophyllum dianthus* show elongated growth and may have many epibionts on their basal portion. Fig. 5. On vertical walls, specimens of *D. dianthus* generally show downward growth.

Discussion

Distribution and ecological relevance

The distribution of *Desmophyllum dianthus*, which is the senior synonym of *D. cristagalli* Milne Edwards & Haime, 1848, by Cairns (1994), is cosmopolitan except for off continental Antarctica and northern boreal Pacific. It is described from 35-2460 m (Cairns, 1994) and common on seamounts, guyots and on deep-water coral banks associated with framework building species (Cairns & Stanley, 1982). *Desmophyllum cristagalli* (= *D. dianthus*) was the most commonly observed and collected ahermatypic coral on the JSL expedition, often found growing downward on the underside of overhangs or within cavities, a growth habit also observed for this species in the deep-water canyons off New York (Cairns, 1994). It was the framework coral for a deep-water (334 m) coral bank on the Campbell Plateau, New Zealand (Squirres, 1965). Judging by the quantity (hundreds of specimens) of *D. cristagalli* (= *D. dianthus*) dredged off Chile, it may also form deep-water coral banks there at depths of 300-800 m (Cairns, 1982). All these findings make *Desmophyllum dianthus* one of the most important species for deep-water coral banks. The bathymetric distribution of this species was previously reported to range from 35-2460 m with the shallowest specimens found in New Zealand fjords (Cairns, 1982; Cairns, 1994). The discovery of large populations of *D. dianthus* in depths as shallow as 25 m and of single specimens as shallow as 8 m in Chilean fjords emphasizes its ecological importance and shows that the vertical distribution of this species is broader than originally expected. Former records that have been queried for the shallowness of the site now must be reconsidered.

Population densities and extension of the aggregations increased with depth at all sites where corals were found during this study. We were never able to observe a lower limit of these communities. Thus it is most probable that also in the fjords the population maximum lies below 45 m and the lower distribution limit lies far below this depth. The upper bathymetrical distribution limit of scleractinians in the Chilean fjords coincides with the maximum extension of a surface low salinity layer. Thus it is very probable that the bathymetrical distribution of stony corals in the fjord regions among other factors is restricted to areas that exhibit a more or less stable high salinity.

Despite the ecological importance, studies on the populations of this species are still lacking. One reason for this may be the difficult accessibility of habitats of these populations, such as overhangs or sites within cavities or in canyons, mainly located in major depths. The populations in Chilean fjords offer the opportunity of in situ studies with a minimum of logistic efforts.

Growth forms

The characteristic growth forms of *Desmophyllum dianthus* may indicate that exposure to current is a very important factor for its presence and the growth of specimens. Specimens in the centre of dense accumulations grow very large with comparably small calicular diameters (fig.4). This growth form goes hand in hand with delicate skeletons that consist of spongy-like structures. Comparable to trees in a dense forest, which grow tall due to competition for light, intraspecific competition might force the individuals of *D. dianthus* to sacrifice structural integrity and radial growth in trade off for intensified length growth, which is necessary for optimised exposure to current. Isolated specimens and specimens at the edge of those aggregations show short trumpet-shape growth and have very massive skeleton structures. As exposure to current is no problem for these individuals, maximization of the calicular diameter, and thus maximization of the feeding surface, seems to be the principal factor that determines the shape of the corallum.

During the rainy winters, influx of sediment and organic matter from rivers and from the dense shore vegetation causes considerable sedimentation, especially on the near shore subtidal communities. In summer, sinking organic matter from marine organisms adds further sedimentation on the benthos (own observations). The restriction of specimens of *D. dianthus* to vertical or overhanging walls and an often downward directed growth might indicate sensitivity to this sedimentation (fig. 5). Salmon farms, which produce large amounts of muddy sediment due to fish excrements, food loss and dead fishes, might cause additional stress for these coral communities.

Growth rates

Growth rates for *Desmophyllum cristagalli* (= *D. dianthus*) in the Atlantic were estimated 0.5 – 1 mm/yr length growth (Risk et al., 2002). In comparison to these growth rates, the minimum growth rate estimated for specimens of *D. dianthus* on the fibre hull of a sunken boat was surprisingly high. For several reasons it cannot be excluded that growth rates at other sites are even higher than those estimated for the specimens of *D. dianthus* on the ship hull.

Opinions of local fishermen about the date of the sinking of the vessel average from winter 1991 to winter 1992. For calculations of minimum growth rates, the date 1991 was taken as the base.

It is very improbable that coral growth on the ship hull started before the boat sunk due to the fact that fishermen regularly clean the hulls of their boats and use anti fouling paint, in combination with the fact that surface salinities are significantly lower than those in depths where corals are found. It cannot be determined if larval settlement started immediately after the boat has sunken. Thus the largest corals on the hull might be younger than the wreck.

The conditions for coral growth at this site might have been below optimum because the coral population on the ship hull was found close to the upper limit for this species and the coral populations next to the boat were poorly developed.

Mortality and coral rubble

Many coralla were infested with boring sponges in their proximal portion that is not covered with polyp tissue. The sponges hollow out the inner portion of the corallum and perforate the outer wall. In some coralla, polychaetes bore channels in the base close to the substrate. These activities of bioeroding organisms strongly reduce the rigidity of some coralla at the base where leverage is at maximum. Elongated growth and epifaunal extra load additionally increase forces at the base. On terraces below coral aggregations, large numbers of broken off coralla can be found. In the upper layer of this coral rubble, some coralla still carry living polyps. Most of the broken-off coralla exhibit damages at the base caused by boring polychaetes or more frequently by sponges. All this indicates that activities of bioeroding organisms, especially boring sponges may be a main mortality factor for these corals.

It can be inferred from the growth rate estimates and from the amount of broken off corals found on comparably small terraces that the sea bottom below these communities may bear thick layers of coral rubble.

Acknowledgements

We are very grateful to Stephen Cairns for identification of the corals and comments on previous versions of the manuscript. Many thanks also to Helmut Zibrowius for comments on a previous version of the manuscript. Special thanks to the Huinay Foundation, which supported parts of the studies by providing free work space on the marine biological station in the Comao fjord and free logistics. We also want to thank the many Chilean fisherman and the people of the Pumalin Foundation who helped us to carry out our studies. Many thanks to Wolfgang Stotz, Ernst-Gerhard Burmeister and Gerhard Haszprunar for help with the necessary paperwork. Part of this work was realized with the help of a one year scholarship of the Deutscher Akademischer Austauschdienst (DAAD). The results of this publication are part of the doctoral thesis of Günter Försterra.

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Appendix 1

List of study sites (S51–S97) of VH and GF between Puerto Montt and Puerto Chacabuco; corals found *; latitude/longitude (GPS respectively Microsoft Encarta, 2002 or geographical map of Comao fjord 994 and 938, 1:50000; data from Microsoft Encarta without seconds); site description; dates visited, D: *Desmophyllum dianthus*, C: *Caryophyllia* sp., N: third species.

S 51. 41°35′37,0′′S; 72°42′10,9′′W+-9m, approx. 2 km N Lenca, Seno de Relóncavi. Intertidal. Sandy beach with several large rocks 10-15 m diameter. 21.1.2001.
S 52. 41°38,303′′S, 72°40,116′′W, Punta Chaica, approx. 4 km S Lenca, Seno de Relóncavi. Intertidal. Beach with boulders up to 0.5 m diameter. 24.1.2000. 22.1.2001. 24.3.2001.
S 53*. 41°38,303′′S, 72°40,116′′W, Punta Chaica, approx. 4 km S Lenca, Seno de Relóncavi. 0-38 m. Rocky ground sloping more or less steeply, regions with sand. 24.1.2000. 22./23./24.1.2001. 24.3.2001. D. C.
S 54. 41°39′S, 72°40′W, approx. 5 km S Lenca, Seno de Relóncavi. Intertidal. Gently sloping shore with boulders. 13.12.98.
S 55. 41°39′S, 72°40′W, approx. 5 km S Lenca, Seno de Relóncavi. 0-28 m. Gently sloping beach with boulders, steeply sloping sandy ground with few large boulders up to 1 m diameter below 6 m depth. 13.12.98.
S 56. 41°40.353′S, 72°39.399′W, aprox. 3 km N La Arena, Seno de Relóncavi. Intertidal. Gently sloping beach with boulders close to a small fishermens village, brackish water through terrestrial fresh water input. 14.2.1998. 24.1.2000.
S 57. 41°40.353′S, 72°39.399′W, aprox. 3 km N La Arena, Seno de Relóncavi. 0-18 m. Bottom with boulders, sand and broken shells between two small rocky islands sloping gently, superficial water brackish through terrestrial fresh water input. 14.2.1998. 24.1.2000.
S 58. 41°47′02,0′′S; 73°52′58,8′′W+/- 4m, W Faro Corona, NW tip of Chiloé Island, Canal de Chacao. Intertidal. Extended rocky plateau with many tide pools and surge channels; exposed. 30.1.1998, 17.12.1999, 27.1.2001.
S 59. 41°47′02,0′′S; 73°52′58,8′′W+/- 4m, W Faro Corona, NW tip of Chiloé Island, Canal de Chacao. 0-5 m. Very gently sloping ground out of soft, porous sandstone, covered with many algae (*Ulva* sp.); exposed. 29.1.1998, 17.12.1999, 27.1.2001.
S 60. 41°52′01,8′′S; 74°00′55,1′′W+-5m, Mar Brava, W of Ancud. Intertidal. Gently sloping beach with boulders up to several m diameter with small tide pools and surge channels; covered with the alga *Ulva* sp. and partly with *Lessonia nigrescens*; very exposed. 28./29.1.1998. 19.12.1999. 27.1.2001.
S60a*. 42°20′28′′S; 72°26′54′′W, Punta Llonco, eastern shore of the Comao Fjord. 0-45 m. Steeply sloping rock, extended overhanging rock walls densely covered with corals; superficial water very brackish. 3.12.2002. Feb.- Aug. 2003. D. C.
S60b*. 42°09′35′′S; 72°25′35′′W, N shore of Quintupeu fjord, large boulders. 0-30 m. Jan.- Aug. 2003. D. C. N.

Further study sites in the fjord (S60c-S60h), visited regularly Jan.-Aug. 2003:
S60c*. 42°09′36′′S; 72°26′06′′W, entrance of Quintupeu fjord, N shore, steep rock wall. 0-40 m. D. C.
S60d*. 42°19′40′′S; 72°27′04′′W, vertical to slightly overhanging rock wall densely covered with corals. 0-45m. D. C?.
S60e*. 42°22′28′′S; 72°25′42′′W, rocky ledge N Huinay. 0-30 m. D. C.
S60f*. 42°23′15′′S; 72°27′38′′W, steep rock wall on western shore of fjord, opposite Huinay. 0-40 m. D. C.

S60g*. 42°23'29''S; 72°27'27''W, steep rock wall on western shore of fjord, opposite Huinay. 0-40 m. D. C.

S60h*. 42°23'42''S; 72°25'12''W, rocky slope, boulders. 0-30 m. D.

S60i. 42°24'07''S; 72°24'45''W, close to waterfall of Rio Tambor, rocky slope. 0-30 m.

S 61*. 42°2'46,6''S; 72°37'0,2''W+-4m, large rocky ledge NW Caleta Gonzalo, fiord Reñihue. 0-35 m. Steeply sloping rock with several small terraces with broken shells and corals, extended vertical to slightly overhanging rock walls; superficial water very brackish. 17/18.2.1998. 20.1.2000. 7./8.1.2001. 23.2.2001. D. C.

S 62*. 42°33'S, 72°36'W, small rocky ledge NW of Caleta Gonzalo, fiord Reñihue. 0-35 m. Steeply sloping rock with terraces. 17.1.2000. D. C.

S 63*. 42°33'12,7''S; 72°35'22,3''W+-28m, rocky ledge E Caleta Gonzalo, fiord Reñihue. 0-32 m. Steeply sloping rock. Superficial water very brackish. 8.1.2001. 23.2.2001. D. N.

S 64. 42°33,494'S; 72°36,271'W, Caleta Gonzalo, fiord Reñihue. Intertidal. Steeply sloping rock with small crevices; protected; superficial water brackish through terrestrial fresh water input. 19.2.1998.

S 65*. 42°33,494'S; 72°36,271'W, Caleta Gonzalo, fiord Reñihue. 0-27 m. Steeply sloping rock with small crevices, superficial water brackish through terrestrial fresh water input. 17.1.2000. D. C.

S 66. 42°33'S; 74°09'W, approx. 10 km N Cucao, Chiloé National Park. Intertidal. Exposed sandy beach, small rocky islands offshore with many tide pools and surge channels, covered with algae. 9.2.1998

S 67. 42°51,361'S; 72°47,967'W, beach of Santa Barbara, approx. 12 km N Chaitén. Intertidal. Gently sloping sandy beach, large rocks offshore with small tide pools and surge channels, covered with algae. 20.2.1998. 15.1.2000.

S 68. 42°51,361'S; 72°47,967'W, beach of Santa Barbara. 0-6 m. Gently sloping sandy beach, some boulders partly covered with *Macrocystis* sp. 15.1.2000.

S 69. 42°55'S, 72°43'W, beach of Chaitén. Intertidal. Gently sloping silty beach with few large boulders. 21.2.1998.

S 70. 43°07'34,6''S; 73°38'20,8''W +-5m, beach of Quellón, Chiloé Island. Intertidal. Gently sloping silty beach with few boulders up to 2 m diameter. 3.2.1998. 22.12.1999. 30.1.2001.

S 71. 43°09'S; 73°35'W, NW of Cailín Island, Chiloé Island. 20-24 m. Flat sandy to muddy ground, some boulders up to 0.3 m diameter, strong surge. 7.2.1998.

S 72*. 43°09'02,1''S; 73°35'30,9''W +-9m, NW tip of Cailín Island, Chiloé Island. 5-13 m. Very gently sloping sandy beach, boulders of sandstone, sparse coverage with *Macrocystis* sp. 4.2.1998. 22.12.1999. 26.12.1999. 28.12.1999. 31.1.2001. D.

S 73. 43°10'S; 73°35'W, W of Cailín Island, Chiloé Island. 6-13 m. Steeply sloping muddy ground. 7.2.1998.

S 74. 43°09'02,1''S; 73°35'30,9''W +-9m, Punta Yenecura, S of Quellón, Chiloé Island. 0-9 m. Sandy ground with some boulders up to 2 m diameter, densely covered with *Ulva* sp. and partly with *Macrocystis* sp. 22.12.1999.

S 75. 43°09'S, 73°29'W, Punta Chaiguao, E of Quellón, Golfo Corcovado, Chiloé Island. Intertidal. Gently sloping beach with boulders. 6.2.1998.

S 76. 43°10'58,6''S, 73°38'27,2''W, Piedra Lile, Isla Laitec. 0-30 m. Rocky ground between two islands. 3./4.2.2001.

S 77. 43°35'59,0''S, 72°55, 25,2''W +- 6m, Bahía Bonito, Bahía TicToc. 0-17 m. Protected bay, rocky beach, ground with boulders 0.3-2 m diameter, silt and sand from 14 m depth downward. 19.2.2001.

S 78. 43°36'13,6''S, 72°59'02,9''W+-5m, between islands, Bahía TicToc. 0-14 m. Rocky wall sloping steeply, flat sand bottom at 14 m depth. 18.2.2001.

S 79*. 43°37'01,8''S, 72°52'50,5''W, Puerto Escondido/Cerro Montura, Bahía Tic Toc. 0-25 m. Vertical rock wall, superficial water brackish through terrestrial fresh water input, high sedimentation, silty ground from 25 m downward. 18.2.2001. N.

S 80. 43°38'21,0''S, 72°59'40,5''W +-7m, tip of small island, Bahía TicToc. 0-31 m. Steeply sloping rock wall alternating with more or less flat regions, large boulders. 18.2.2001.

S 81. 43°39’39,4’’S, 72°59’52,9’’W +-5m, protected side of the island, Bahía TicToc. 0-30 m. Terraced rocky ground, boulders sparsely with *Macrocystis* sp. and *Lessonia trabeculata*. 19.2.2001.

S 82. 43°41’46,9’’S, 72°59’35,0’’W, colony of sea lions in a cave, Bahía TicToc. 0-11 m. Rocks sloping steeply, flat ground at 10 m depth covered with sand and coarse. 17.2.2001.

S 83*. 43°47’09,1’’S, 72°55’34,2’’W +-6m, fiord Pittipalena. 0-31 m. Nearly vertical rock wall. 20.2.2001. D. C. N.

S 84. 43°50’50,4’’S, 73°03’36,5’’W +-9m, islands off-shore of Añihue. 0-26 m. Nearly vertical rock wall, sandy ground at 25 m depth. 20.2.2001.

S 85*. 43°58’18,4’’S, 73°07’00,6’’W +-6m, Bahía Santa Domingo, off-shore of Isla Refugio. 0-34 m. Nearly vertical rock wall with small terraces. 20.2.2001. D. C. N.

S 86. 44°22’S, 72°35’W, narrow spot of Seno Ventisquero, 10 km S of Puhuhuapi. Intertidal. Gently sloping beach with boulders, very brackish water. 26.2.1998.

S 87. 44°23’34,5’’S; 72°34’54,9’’W+-6m, approx. 1 km S of narrow spot of Seno Ventisquero. Intertidal. Beach with boulders, adjacent to steep rocky wall. 23.3.1998.

S 88*. 44°23’34,5’’S; 72°34’54,9’’W+-6m, approx. 1 km S of narrow spot of Seno Ventisquero. 0-31 m. Gently sloping ground with boulders up to 1 m diameter, some terraces, adjacent to steep rocky wall, sandy ground at 30 m depth; sunken boat. 27.2.1998. 10.1.2000. 13.2.2001. D.

S 89. 44°31,608’S; 72°32,107’W, approx. 3 km S of narrow spot of Seno Ventisquero. Intertidal. Steeply sloping beach with boulders up to 0.5 m diameter, water very brackish through terrestrial fresh water input. 23.2.1998.

S 90*. 44°31,608’S; 72°32,107’W, approx. 3 km S of narrow spot of Seno Ventisquero. 0-32 m. Steeply sloping ground with boulders up to 1 m diameter, water very brackish through terrestrial fresh water input, sparse coverage with *Macrocystis* sp., 2 layers at 3 m and 20 m, sandy ground from 30 m downward. 23.2.1998. 9./10.1.2000. D.

S 91. 44°43’29,1’’S; 72°41’24,2’’W+-6m, mole of Puerto Cisnes. Intertidal. Steep rocks, water very brackish through terrestrial fresh water input. 1.3.1998.

S 92*. 44°43’29,1’’S; 72°41’24,2’’W+-6m, mole of Puerto Cisnes. 0-26 m. Steeply sloping rocky wall, sandy ground at 25 m depth, superficial water very fresh through terrestrial fresh water input. 1.3.1998. 4.1.2000. D.

S 93. 44°44’S, 72°42°W, beach of Puerto Cisnes. Intertidal. Gently sloping silty beach, some boulders, very brackish. 2.3.1998.

S 94*. 44°49’, 72°52’W, Canal Puhuhuapi. 0-35 m. Vertical rocky wall with terraces. 5.1.2000. D.

S 95. 44°50’, 72°52’W, Canal Puhuhuapi. 0-36 m. Gently sloping beach with sand and coarse; off shore of natural thermal springs. 5.1.2000.

S 96. 45°26’47,9’’S; 72°49’25,8’’W+-7m, approx. 1 km NO of Puerto Chacabuco. 0-30 m. Steeply sloping rocky wall with terraces, high sedimentation because of salmon farming, silty ground from 26 m depth downward, superficial water very brackish through terrestrial fresh water input. 4.3.1998. 31.12.1999. 19.3.2001.

S 97. 45°27’S; 72°48’W, approx. 0.5 km E of Puerto Chacabuco. Intertidal. Gently sloping silty beach with few boulders, superficial water very brackish through terrestrial fresh water input. 4.3.1998.