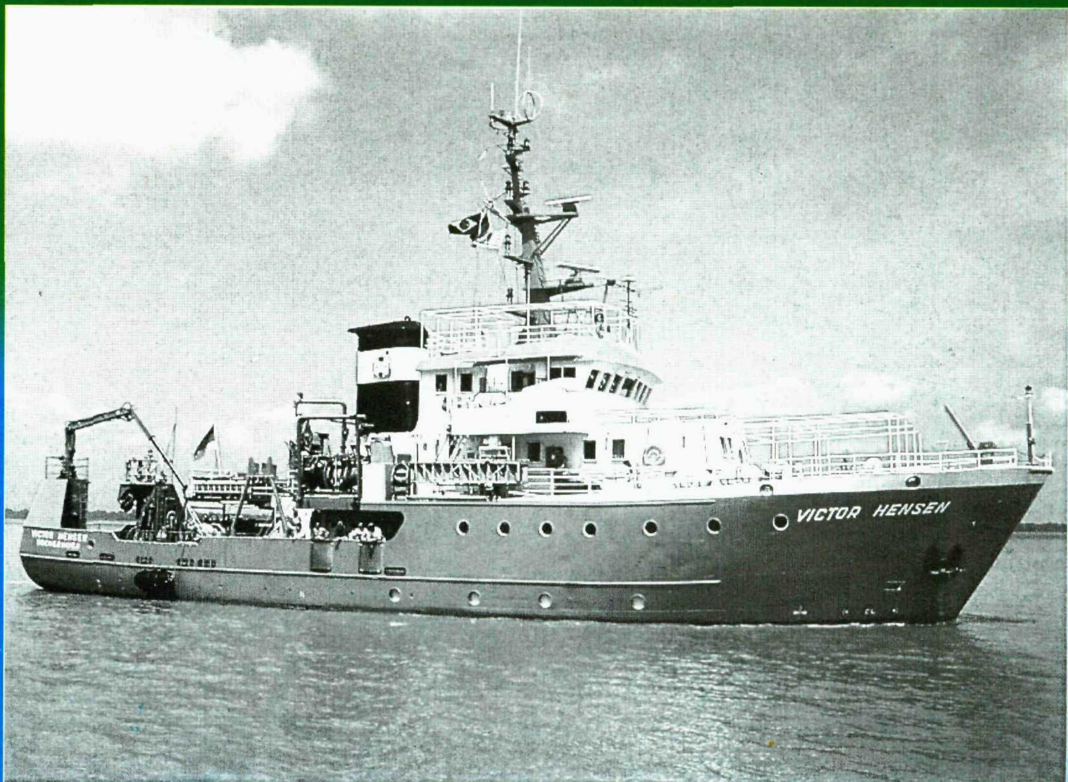
ZMT BREMEN **Contribution 2**

RV *Victor Hensen* Costa Rica Expedition 1993/1994

Cruise Report



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with contributions of the participants

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I. Preface

The Victor Hensen cruise to Costa Rica was carried out as an integral part of a research programme between the Center for Tropical Marine Ecology (ZMT), Germany and the Center for marine and limnological studies (CIMAR), Costa Rica based on a formal agreement between these institutions. In addition, the Universidad Nacional de Costa Rica (UNA) was invited for participation. This programme aims at understanding the functioning of the coastal mangrove ecosystem of the Pacific side of Costa Rica and the processes that link mangrove forests with tidal flats and subtidal nearshore basins.

The research cruise marked the first phase of this programme and was planned and conducted jointly with two other research groups from Bremen University - the Institute for Geological Sciences and the Max Planck Institute for Marine Microbiology. The cruise was divided into 4 legs, of which leg 1 (Dec. 2- Dec. 18, 1993) and leg 4 (Feb. 2- Feb. 19, 1994) were conducted by ZMT, CIMAR and UNA personnel and consisted in the synchronous sampling of data on oceanographical conditions, plankton dynamics, structure of benthodemersal fish and invertebrate assemblages as well as infauna communities. By the employment of the RV Victor Hensen, it was possible to conduct an wide scale sampling programme from shallow waters (20m) near the mangrove edge along transects to the adjacent and deeper fishing grounds to the shelf edge (200 m).

Leg 2 (Jan.5 - Jan 14, 1994) was conducted by scientists of the Max Planck Institute for Marine Microbiology. On January 12, CIMAR scientists joined the cruise to participate in the water sampling for nutrient determination. The investigations were concentrated in the deeper low- and anoxic parts of the Golfo Dulce area (200 m) and were aimed at studying the impact of bottom water anoxia on biochemical processes in water and sediment through chemical and microbiological analysis of water

I. Prefacio

El crucero realizado en el barco oceanográfico Victor Hensen hacia Costa Rica, fue llevado a cabo como parte integral del programa de investigación entre el Centro de Ecología Marina Tropical (ZMT), Alemania, y el Centro de Investigación en Ciencias del Mar y Limnología (CIMAR), de la Universidad de Costa Rica, al amparo del convenio firmado entre las dos Instituciones. Además se invitó la participación de la Universidad Nacional (UNA), Costa Rica. Este programa tiene por objetivo el comprender el funcionamiento de los ecosistemas costeros de manglar del Pacífico de Costa Rica y los procesos que ligan a los manglares con las playas fangosas y ambientes profundos ceranos a la costa.

El crucero de investigación marcó la primera fase de dicho programa y fue planeado y conducido conjuntamente con otros dos grupos de investigadores de la Universidad de Bremen (Instituto de Ciencias Geológicas y el Instituto Max Planck de Microbiología Marina). Este crucero se dividió en cuatro etapas. La primera etapa se realizó del 2 al 18 de diciembre de 1993, y la cuarta etapa fue del 2 al 19 de febrero de 1994. Las investigaciones fueron conducidas por cientificos del ZMT, el CIMAR, y la UNA. Estas consistieron en muestreos sincronizados de parámetros oceanográficos, dinámica de plancton, estructura de grupos de peces asociados al fondo, y estudio de comunidades infaunales. Mediante al uso del barco oceanográfico Victor Hensen fue posible conducir un programa amplio de muestreo para aguas poco profundas (20m) cerca del borde de los manglares y a lo largo de transectos hacia zonas de pesca profundas al borde de la plataforma continantal (200m).

Etapa 2 (5 al 14 de enero de 1994) fue conducida por cientificos del Instituto Max Planck de Microbiología Marina. El 12 de enero participaron cientificos del CIMAR y la UNA en la toma de datos sobre nutrientes. Las investigaciones del Instituto se consentraron en la and sediment samples.

Leg 3 (Jan 17 -Jan 30, 1994) was conducted by the Institute for Geological Sciences and CIMAR scientists and consisted in a sampling programme in the Golfo Dulce and adjacent areas to reconstruct the late quaternary paleoclimate by analysing sediment and coral samples using stable oxygen and carbon isotopes. This sampling was conducted using a 6 m gravity corer and a box corer and covering a depth range from about 20 m to 1500 m.

The research vessel left Bremerhaven on October 28, 1993 and returned to its home port on March 24, 1994, after almost 5 months of navigation.

The scientific programme started on December 2, 1993 in Puerto Caldera, were it was also finalized on February 19, 1994.

On the day prior to the first cruise leg (December 1, 1993) a meeting was held aboard Victor Hensen with representants from the participating Costa Rican universities, the ZMT, the port authorities and the German embassy. On this meeting, the purpose of the cruise was explained and the local authorities were informed about the sampling programme, equipment to be used, required port time etc.

On the last day of the scientific programme (February 18, 1994) Victor Hensen anchored near the Marine Station of the Costa Rican partners in Punta Morales, where a press conference was held with representants from both Costa Rican universities, from the ZMT, two local newspapers and a television channel (channel 15). On this press conference, Dr. Vargas (CIMAR) and Dr. Wolff (ZMT) gave short lectures on the scientific importance of the cruise and the joint research programme respectively. The Vicerectors of the UCR (Dr. Carlos Quesada) and of the UNA (M.Sc. L. San Roman) emphasized the importance of the Costa Rican/German cooperation in marine science and the utility of the marine laboratory in Punta Morales (ECMAR) for the cooperative research programme.

región más profunda y anóxica del Golfo Dulce (200m), y tuvieron como objetivo el estudio del impacto de las condiciones de anoxia en los procesos bioquímicos que tienen lugar en el agua y los sedimentos. Estos procesos fueron evaluados mediante análisis químicos y microbiológicos.

Etapa 3 (17 al 30 de enro 1994) fue conducida en conjunto por cientificos del Instituto de Ciencias Geológicas de Bremen y cientificos del Instituto del CIMAR. Esta etapa consistió en un programa de muestreo en el Golfo Dulce y región de Sierpe - Terraba, dirigido a la reconstrucción del paleoclima de la época del período Cuanternario Tardío. Se utilizó la toma de sedimentos y muestras de coral para el análisis de isótopos estables de carbono y oxígeno. Este muestreo fue conducido utilizando un barreno de 6m de longitud y un muestreador tipo "box corer", y cubrieron un ámbito de profundidad de 20 a 1500m.

El barco de investigación zarpó del puerto de Bremerhaven, Alemania el 28 de octubre de 1993 y retornó al mismo el 24 de marzo de 1994, depués de casi 5 meses de navegación.

El programa de investigación cientifica empezó en Puerto Caldera (Costa Rica), el 2 de diciembre de 1993 y finalizó en el mismo puerto el 19 de febrero de 1994.

El día anterior a la primera etapa (1 de diciembre de 1993) se hizo una reunión, a bordo del Victor Hensen, con representantes de las universidades costarricenses participantes, del ZMT, de las autoridades portuarias, y de personal de la Embajada de Alemania en Costa Rica. En esta reunión se explicó el propósito del crucero, el programa de muestreo, equipo a ser utilizado, y otros detalles.

El último día del programa científico (18 de febrero de 1994) el barco Victor Hensen fue anclado cerca de la Estación de Ciencias Marinas en Punta Morales, Golfo de Nicoya. En la Estación se hizo una conferencia de prensa con representantes de las dos universidades participantes, el ZMT, periodistas locales y el canal de televisión (Canal 15) de la

Thereafter, the group visited the RV Victor Hensen were the scientific equipment was demonstrated and the sampling programme conducted during the four cruise legs was explained. All Costa Rican participants showed great enthusiasm about the research vessel, the cruise and the scientific cooperation between Germany and Costa Rica, which was also reflected by numerous newspaper articles and a television programme that followed the press conference.

A special compliment must be given here to the extraordinary logistical and coordinative work done by the Costa Rican partners - their cars run several thousand miles during the time of the cruise to transport Costa Rican and German scientists to and from the research vessel, to provide the research crew with missing equipment and chemicals, to transport samples to land based cooling containers, to bring food supplies to the ship etc.

All participating scientists carried out their work with great enthusiasm and the captain and his crew cooperated exemplary. Excellent weather conditions during the cruise helped to provide ideal working conditions onboard the Victor Hensen.

However, as on all research cruises some problems occurred that should also be mentioned here. During leg 1, one research day was lost due to a fishing line that got trapped under the ship and that had to be removed by diving. In the Golfo dulce area the bottom trawl got stuck on remains of an ancient coral reef and was heavily damaged. On another station the beam trawl broke. Both bottom trawl and beam trawl could be repaired, however. During leg 4, the plankton multi -net did not work despite all the effort dedicated to it by the scientific and technical personnel of the ship. At one station the spare bottom trawl was completely lost as it was so heavily loaded that it had to be cut off. Last not least, one of the German scientists had to be brought to the nearest hospital in the port of Puntarenas to be operated on his appendix...

Universidad de Costa Rica. En esta conferencia de prensa, el Dr. Vargas (CIMAR) y el Dr. Wolff (ZMT) dieron un breve informe sobre la importancia científica del crucero y del programa de investigación conjunta. Los Vicerrectores de Investigación de la Universidad de Costa Rica (Dr. Carlos Quesada) y de la Universidad Nacional (M. Sc. Lorena San Román) enfatizaron la importancia de la colaboración Costa Rica - Alemania en las ciencias marinas y sobre la utilidad de la Estación de Ciencias Marinas (ECMAR) en Puenta Morales para este programa cooperativo.

Después de dicha actividad, el grupo visitó el barco Victor Hensen donde se les mostró el equipo científico y se explicó el programa de muestreo utilizado durante las cuatro etapas. Los científicos costarricenses se despidieron de sus colegas alemanes y de la tripulación del buque. Los paticipantes mostraron mucho entusiasmo con respecto al buque científico, el crucero y la cooperación científica entre Alemania y Costa Rica, la cual tambien fue reflejada por numerosos articulos en los periódicos y programas de televisión derivaados de la conferencia de prensa.

Debemos expresar un especial agradecimiento al extraordinario trabajo logístico y de coordinación realizado por los ostarricenses; sus vehiculos recorrieron miles de kilómetros durante las 4 etapas del crucero, transportando científicos alemanes y costarricenses hacia y desde el barco; además de equipo, muestras y alimentos.

Todos los científicos condujeron su trabajo con gran entusiasmo y el capitán y su tripulación cooperaron ejemplarmente. Las condiciones climáticas excelentes durante todo el crucero ayudaron a proveer condiciones ideales de trabajo a bordo del Victor Hensen.

Sin embargo, como en todas las expediciones oceanográficas, algunos problemas ocurrieron que son dignos de mencionar aquí. Durante la etapa 1 se perdió un dia comleto debido a una línea de pesca que se atascó en la hélice del buque y tuvo que ser removida por buzos. En el área del Golfo Dulce una

Despite all these circumstances, the first expedition with the RV Victor Hensen to Costa Rican waters can be regarded as very successful and we feel encouraged to continue this scientific research programme.

In the here presented cruise report the raw data and first preliminary results shall be presented in order to provide a basis for a more detailed analysis and discussion.

de las redes quedó atascasa en un arrecife fósil, por lo que sufrió severos daños. En otra estación se rompió otra red. Ambas redes pudieron ser reparadas a bordo. Durante la 4° etapa la red múltiple para plancton no funcionó apropriadamente, no obstante el esfuerzo de los técnicos y científicos del barco. En otra estación, el contenido de la red de fondo excedió la capacidad de levante del barco, por lo que tuvo que ser desechada. Por último, uno de los científicos alemanes tuvo que ser llevado al hospital del Purto de Puntarena para ser operado de su apéndice.

No obstante estas circunstancias, la primera expedición del barco Victor Hensen en aguas costarricenses puede ser considerada un rotundo éxito, y nos sentimos estimulados a continuar con este programa científico.

Presentamos a continuación el informe del crucero y datos ppreliminares cuyo objetivo es servir de base para análisis y discusión más detallados.

Matthias Wolff (Scientific coordinator - ZMT)
Jose A. Vargas (Coordinador cientifico - CIMAR)

II. Study areas

Off the three study areas of the Victor Hensen cruise, the Golfo de Nicoya and the Sierpe-Terraba Forest Reserve (Fig. A,B) represent the most extensive mangrove areas (20379 ha and 17738 ha respectively) of the pacific coast of Costa Rica. The former is a tectonic estuary, extending about 100km from the Tempisque river to the 500m isobath. The upper gulf is shallow (< 25m) and fringed by mangroves and mud flats. The lower gulf deepens sharply towards the mouth, and is surrounded by rocky shores and sandy beaches. Tides are semidiurnal (mean range 2,5m). A dry season from December to April and a rainy season from May to November exert a significant impact on its water characteristics. The gulf is similar to other tropical estuaries as it is subjected to extreme seasonal variations in riverine flow, and differs from most temperate counterparts in that much of the nitrogen entering the system is from offshore deep water. The estuary is the most important fishing ground (finfish and peneid prawns) of Costa Rica, and the main ports are located within it. Coastal zone development, particularly agriculture and tourism has increased in recent years (Vargas, 1992). Because of its importance for the country, and the wide variety of ecosystems found, the Gulf has been the subject of a long-term research programme. More than 80 papers have been published to date, making the Gulf one of the best known tropical estuaries worldwide (Vargas, 1994)

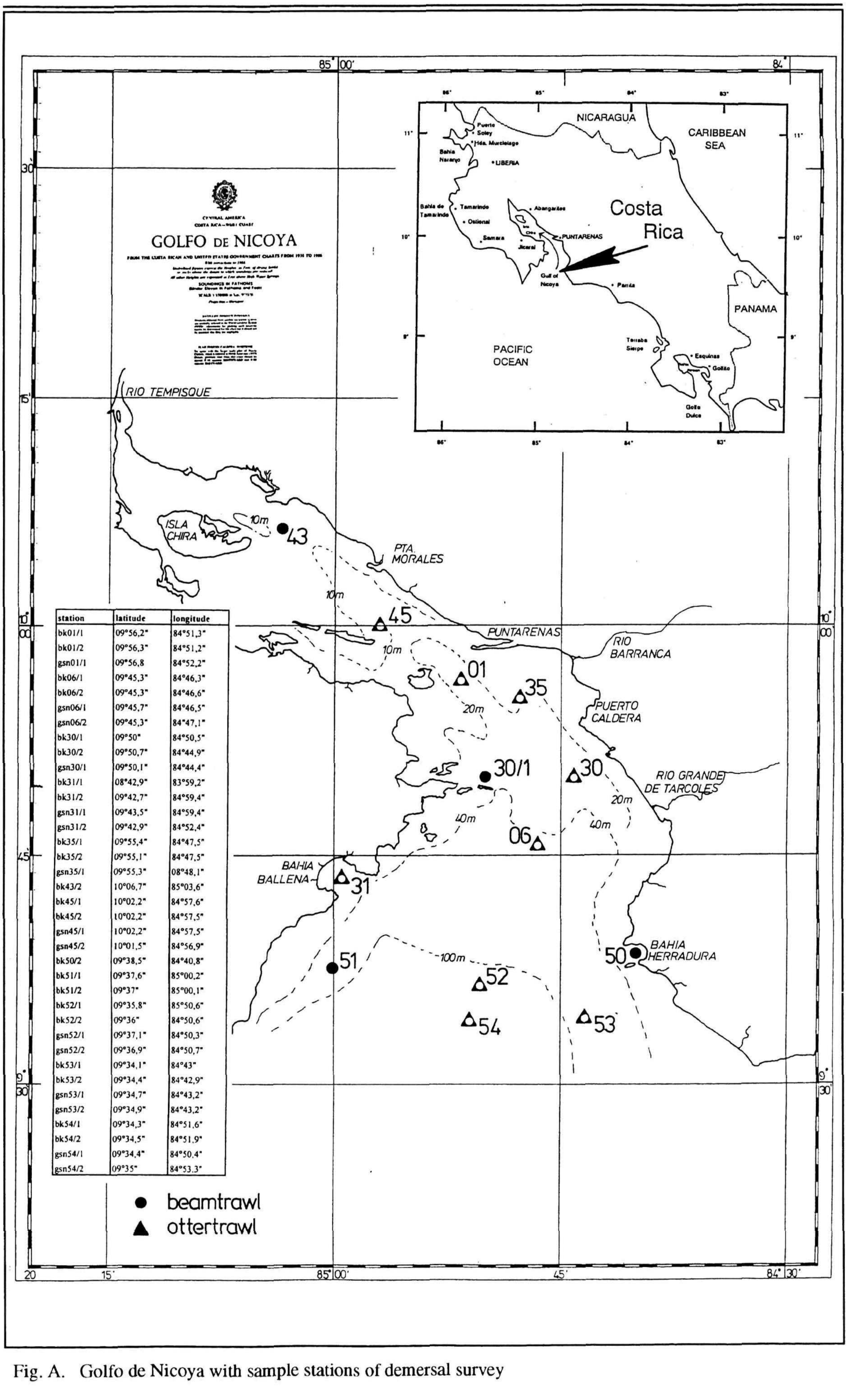
The Sierpe Terraba Forest Reserve is influenced by the Terraba and Sierpe rivers. The mangrove forest differs markedly from that in the "Golfo de Nicoya" in that the mangroves cover a wider area. People from the Sierpe-Terraba area are allowed to cut mangrove trees on a small scale to produce charcoal from the wood and tannins from the bark for the local market. Other sources of income are the collection of the bivalve Anadara tuberculosa, finfishing, and tourism (Coto, 1992). In contrast to the Golfo de Nicoya, very few investigations have been focussed on this area

The third study area, "Golfo Dulce" (Fig.C), is the only anoxic basin in the Pacific coast of the Americas. As such, it may be considered as a unique "tropical fjord". The inner part of the gulf is deeper (200m) than the Golfo de Nicoya, and is surrounded by steep mountains covered by rain forest. A sill of about 60m closes the mouth of the gulf. Water circulation is reduced because of the gulf's topography and is apparently governed by the local wind regime (Richards et.al, 1971). Two principal rivers are responsible for the input of fresh water into the system: Rio Rincon and Rio Esquinas. Mangroves are also found at many sites, as well as patches of coral reefs. Some big lumbering projects are taking place in the lands surrounding the coast, which may cause a serious impact on the gulf.

These factors, together with the enclosed nature of the gulf, and its anoxic condition, make it particularly vulnerable to human impact. However, very little research has been conducted in Golfo Dulce.

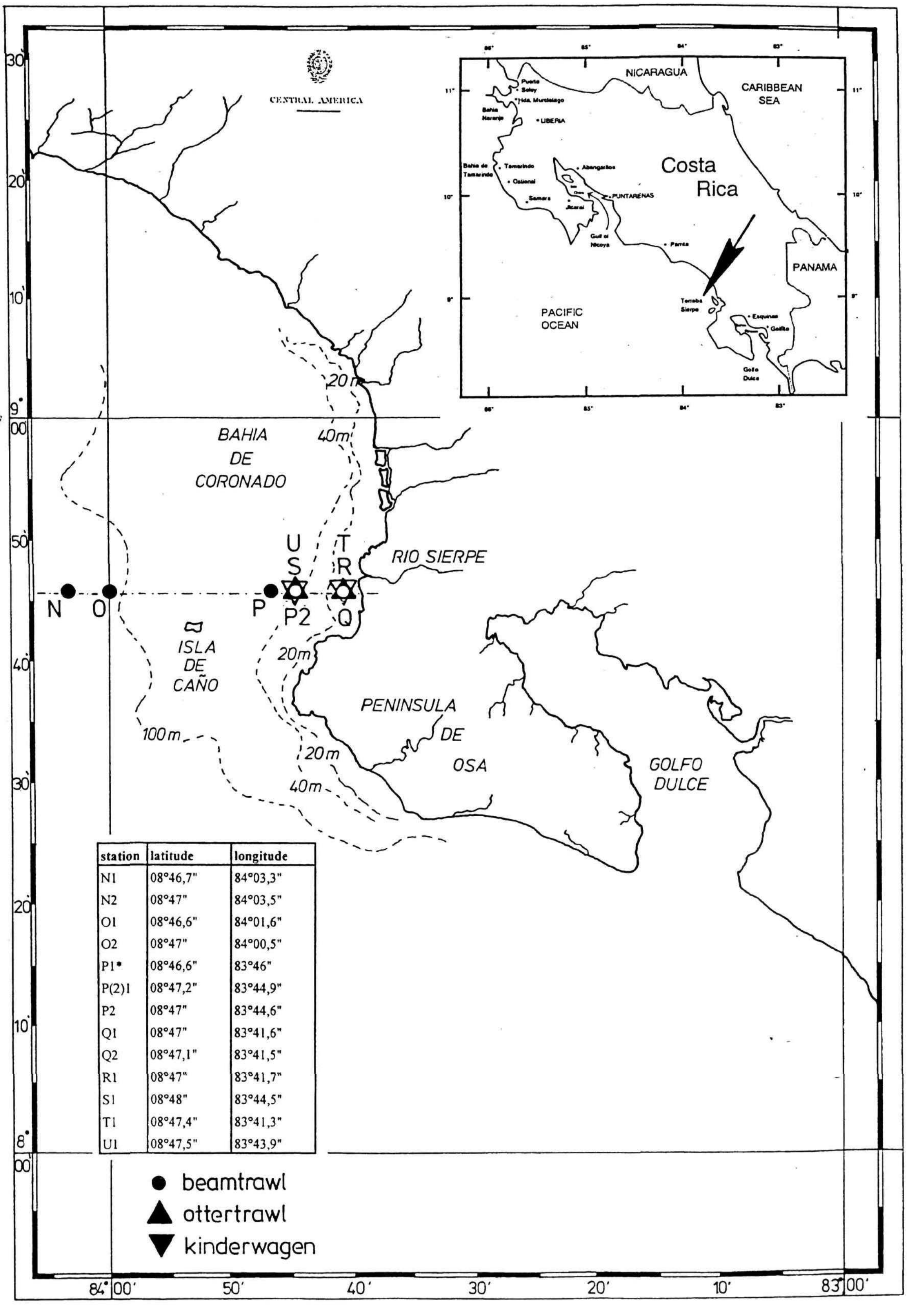
The vital importance of the mangrove areas in the Golfo de Nicoya and Sierpe- Terraba, and Golfo Dulce regions for the local populations requires management policies aimed at the maintenance or increase of the economic benefit on a sustainable basis. In order to achieve this, the research strategy needs to comply with an ecosystem approach and an evaluation of human impact.

The three areas have received uneven scientific attention over the past 15 years. In spite of this problem, available knowledge on the biota can be used and collections (e.g. fish species) can be referred to. Field stations from CIMAR and UNCR allow basic work on-site. A literature list of publications referring to the study areas can be obtained from Dr. Vargas.



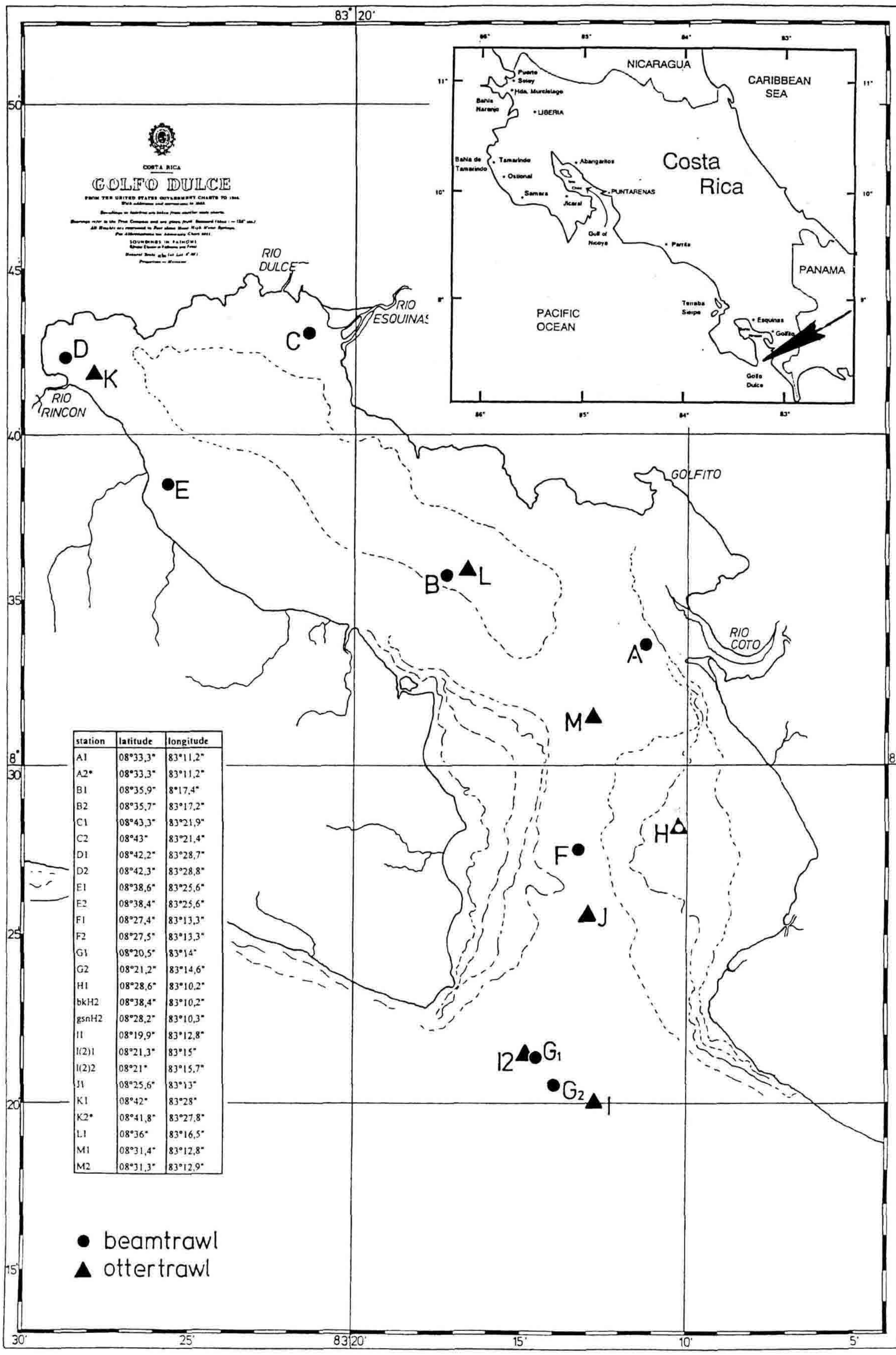
station	latitude	longitude
bk01/1	09°56,2"	84°51,3"
bk01/2	09°56,3"	84°51,2"
gsn01/1	09°56,8	84°52,2"
bk06/1	09°45,3"	84°46,3"
bk06/2	09°45,3"	84°46,6"
gsn06/1	09°45,7"	84°46,5"
gsn06/2	09°45,3"	84°47,1"
bk30/1	09°50"	84°50,5"
bk30/2	09°50,7"	84°44,9"
gsn30/1	09°50,1"	84°44,4"
bk31/1	08°42,9"	83°59,2"
bk31/2	09°42,7"	84°59,4"
gsn31/1	09°43,5"	84°59,4"
gsn31/2	09°42,9"	84°52,4"
bk35/1	09°55,4"	84°47,5"
bk35/2	09°55,1"	84°47,5"
gsn35/1	09°55,3"	08°48,1"
bk43/2	10°06,7"	85°03,6"
bk45/1	10°02,2"	84°57,6"
bk45/2	10°02,2"	84°57,5"
gsn45/1	10°02,2"	84°57,5"
gsn45/2	10°01,5"	84°56,9"
bk50/2	09°38,5"	84°40,8"
bk51/1	09°37,6"	85°00,2"
bk51/2	09°37"	85°00,1"
bk52/1	09°35,8"	85°50,6"
bk52/2	09°36"	84°50,6"
gsn52/1	09°37,1"	84°50,3"
gsn52/2	09°36,9"	84°50,7"
bk53/1	09°34,1"	84°43"
bk53/2	09°34,4"	84°42,9"
gsn53/1	09°34,7"	84°43,2"
gsn53/2	09°34,9"	84°43,2"
bk54/1	09°34,3"	84°51,6"
bk54/2	09°34,5"	84°51,9"
gsn54/1	09°34,4"	84°50,4"
gsn54/2	09°35"	84°53,3"

Fig. A. Golfo de Nicoya with sample stations of demersal survey



station	latitude	longitude
N1	08°46,7"	84°03,3"
N2	08°47"	84°03,5"
O1	08°46,6"	84°01,6"
O2	08°47"	84°00,5"
P1*	08°46,6"	83°46"
P(2)1	08°47,2"	83°44,9"
P2	08°47"	83°44,6"
Q1	08°47"	83°41,6"
Q2	08°47,1"	83°41,5"
R1	08°47"	83°41,7"
S1	08°48"	83°44,5"
T1	08°47,4"	83°41,3"
U1	08°47,5"	83°43,9"

Fig. B. Sierpe- Terraba area with sample stations of demersal survey



station	latitude	longitude
A1	08°33,3"	83°11,2"
A2*	08°33,3"	83°11,2"
B1	08°35,9"	8°17,4"
B2	08°35,7"	83°17,2"
C1	08°43,3"	83°21,9"
C2	08°43"	83°21,4"
D1	08°42,2"	83°28,7"
D2	08°42,3"	83°28,8"
E1	08°38,6"	83°25,6"
E2	08°38,4"	83°25,6"
F1	08°27,4"	83°13,3"
F2	08°27,5"	83°13,3"
G1	08°20,5"	83°14"
G2	08°21,2"	83°14,6"
H1	08°28,6"	83°10,2"
bkH2	08°38,4"	83°10,2"
gsnH2	08°28,2"	83°10,3"
I1	08°19,9"	83°12,8"
I(2)1	08°21,3"	83°15"
I(2)2	08°21"	83°15,7"
J1	08°25,6"	83°13"
K1	08°42"	83°28"
K2*	08°41,8"	83°27,8"
L1	08°36"	83°16,5"
M1	08°31,4"	83°12,8"
M2	08°31,3"	83°12,9"

Fig. C. Golfo Dulce with sample stations of demersal survey

III . Scientific programme

Leg.1 and 4 :Macroscale evaluation

Chief scientists: Dr. M. Wolff (ZMT), Dr. J. Vargas (CIMAR)

Introduction

During the first leg (Dec. 2-Dec. 18, 1993) and the fourth leg (Febr.2- Febr. 18) a macroscale evaluation of biological and oceanographical conditions in the water column and at the sea bottom along inshore - offshore transects (20m-200m) in the Golfo de Nicoya, Sierpe Terraba and Golfo Dulce areas of the Pacific coast of Costa Rica was conducted. This evaluation consisted in the synchronous sampling of data on 1) oceanographical conditions (CTD - recordings of temperature, salinity and oxygen concentration, secci-depth), 2) structure of bentho-demersal fish, 3) infauna communities, 4) ichthyoplankton and 5) zooplankton dynamics, The results of 1) to 5) will be presented separately by the corresponding scientific groups.

1. Overview on oeanographical conditions

1.1. CTD - Temperature, salinity and oxygen profiles (M. Wolff)

Objectives

The main scientific objective of the recordings of oceanographical data in the study area was to provide baseline data on the abiotic environment of the living communities sampled during the study programme. Emphasis was given to temperature and salinity stratification according to water depth in the study areas and to the oxygen conditions in the water column and at the seafloor.

Methods

At 33 of 47 sample stations, a conductivity-temperature-density sensor (CTD) was lowered at a conduction wire from the sea surface to the seafloor at a constant velocity of 0.8 m/sec and the recordings of water depth, temperature, salinity and oxygen were registered on a computer. Each CTD- profile was saved and plotted for subsequent analysis. These profiles are presented here separately for the areas of Golfo de Nicoya (GN), Sierpe -Terraba (ST) and Golfo Dulce (GD).

Preliminary results and discussion

The following Figures 1.1, 1.2, 1.3. exhibit the CTD profiles of leg1 and a map of the corresponding sampling sites in the study areas Golfo de Nicoya, Sierpe -Terraba and Golfo Dulce.

For all except one profile (GN, St. 35) the oxygen concentration shows a pronounced maximum of > 120% saturation around 5m - 7 m water depth, which can only be explained by assuming a measurement artifact. The further shape of the oxygen curves seem reasonable, however and will be compared here. On the shallow water stations (< 50m water depth) in the GN area, the oxygen concentration drops very smoothly towards the bottom. At around 50m water depth, oxygen saturation is still > 60%. At the deeper stations, oxygen saturation rapidly drops from > 60 % at 50m water depth to < 20% around 75 m. From this depth downwards to 270m (deepest station (54) in the GN area) oxygen concentration decreases at a small gradient, reaching about 10 - 12% at 100 m water depth, 5 -7% at 200m and still over 1% at 270m. The same pattern repeats in the ST area (see Fig. 1.2). The GD area shows a somewhat different picture: at the shallow water stations (D and K), oxygen saturation decreases rapidly to about 15% at 50m; at the deepest stations (L,B) in the inner part of the golf, oxygen saturation is almost 0% at 100m and seems to be 0% in the bottom water. At the same water depth outside the GD area (St.I/G) oxygen saturation exceeds 1%, however, as in the GN and ST areas.

At the stations 01,35 and 30 of the central part of the GN area, surface temperature is about 28° C and decreases only to a small extend towards the bottom indicating little or no temperature stratification and a well mixed water body. This is also corroborated by the relatively straight salinity and density profiles at these stations. At station 06 at the central southern part of the bay, a light thermocline is observable around 30 m water depth. Temperature drops from about 26°C at 45 m to about 20° C at 60 m. At the deeper stations of the outer part of the GN area, a surface water layer of 30-40m depth with relatively homogeneous temperature conditions is followed by a transition zone (to about 75m) where the temperature decreases from about 27° C to about 16° C. Towards the deeper waters, temperature decreases only little to reach values of about 14° C at 100m to 12° C at 270m water depth. These deeper waters have a fairly homogeneous density. A similar pattern can be observed in the area of ST.

At the shallow stations of the GD area (Stations D,K), temperature and salinity decrease steadily to about 50m, with no stratification. Surface salinity is the lowest (about 21ppt) at these two stations reflecting the strong influence of the river "Rio Rincon". At the deeper stations within the golf (Stations L,B) the temperature profile follows the oxygen profile. Temperature, oxygen, salinity and density remain fairly constant below 100 m water depth. Bottom temperature is about 16°C at 200 m within the golf, significantly higher than at the same depth outside the golf and in the other study areas (around 12°C).

From the foregoing the GD area can be considered as oceanographically distinct from the other two study areas: firstly, oxygen saturation decreases much more rapidly from the surface to bottom waters, were (at least in part) anoxic conditions prevail. Water temperature is significantly higher in the deeper parts (below 100m) compared to the other study areas. These features suggest that the water entering the golf from the open ocean has a rather long duration time in the golf when compared with the other areas.

Living communities with moderate to high oxygen requirements (>7% saturation) should do well in the GN and ST areas up to a water depth of about 150m, while in the GD area an oxygen restriction can be expected for these communities below 50 - 70m water depth.

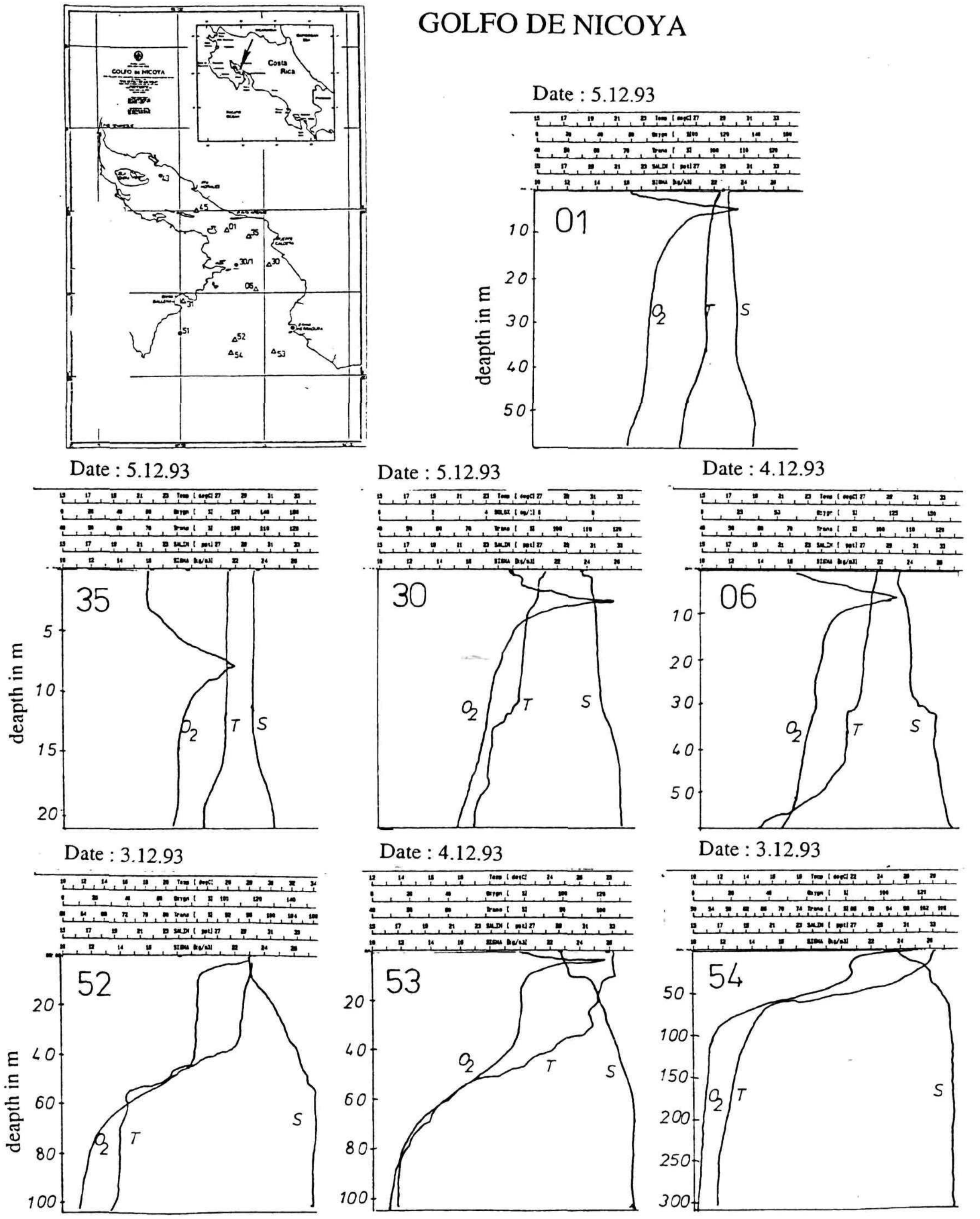


Fig. 1.1 T (°C), S(°/°°) and O_2(%) - profiles in the area of Golfo de Nicoya

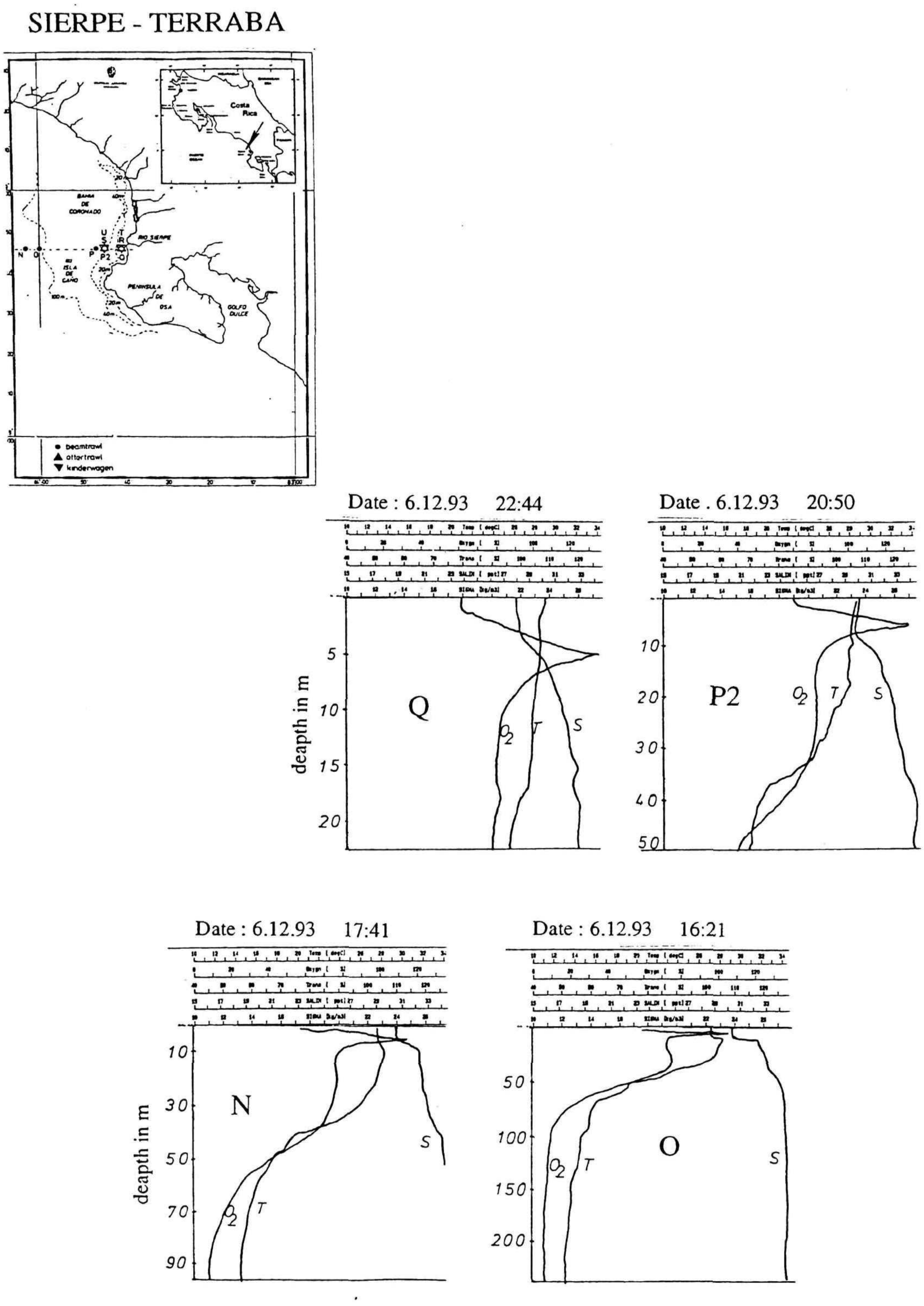


Fig. 1.2 T (°C), S(°/°°) and O_2(%) - profiles in the area of Sierpe-Terraba

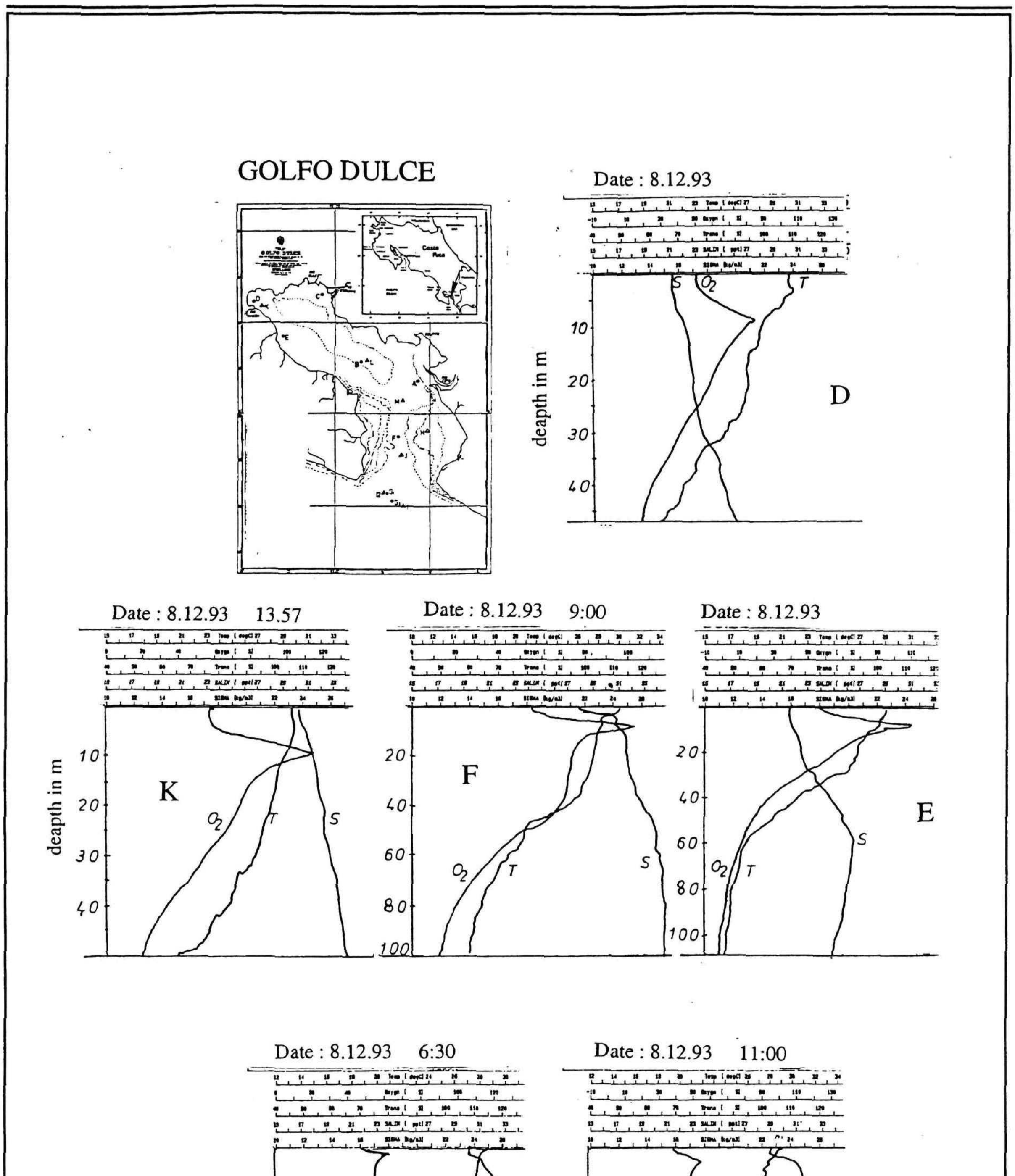


Fig. 1.3 T (°C), S (°/°°) and O_2(%) - profiles in the area of Golfo Dulce

Literature

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1.2. Nutrient profiles (J. Chaves, M. Birkicht, S. Leon & A. Madrigal)

Introduction

Research on the plant nutrient dynamics and distribution on the Pacific coast of Costa Rica began with an early survey along the Costa Rica Dome by Broenkow (1965). This work was prompted by the interest generated by this upwelling area, which is part of the eastern Pacific tuna fishery ground. Other studies that followed in shallower coastal environments include a comprehensive chemical survey of the Golfo Dulce (Richards, et. al. 1971),which was shown to be anoxic in most parts (see chapter II for further description).
In the Golfo de Nicoya (Fig.A, chapter II) the first nutrients survey was done in the late 70´s by Epifanio, et. al. (1983). The authors found higher nutrient loads in the upper gulf, with levels varying seasonally by an order of magnitude The lower gulf was characterized by low nutrient concentrations at the surface. The most remarkable finding was that, contrary to most temperate estuaries, much of the nitrogen entering the bay, is from offshore waters.
Located 150 km southeast of the Golfo de Nicoya is the Sierpe-Terraba estuary, Costa Rica´s largest deltaic system (see Fig.B, chapter II). Most of the studies available about this area are related with the mangrove forests that cover several islands located in the mouth area of the river. However, a FAO fisheries survey during 1987 (Strømme and Sætersdal, 1988), reported high catches of both pelagic and demersal species. In the realm of hydrographic surveys, no data is available so far. Fig. 1.4 presents this and the other two areas with the sampling stations of the cruise.

Objectives and Scientific Questions

The main objective was to assess the plant nutrient distribution within the above study areas

Important questions adressed were:

- To which extent are the nutrient levels of the upper Nicoya Gulf influenced by the entrainment of oceanic deep water into the gulf, especially during times of lower nutrient loads from the runoff in the dry season ?

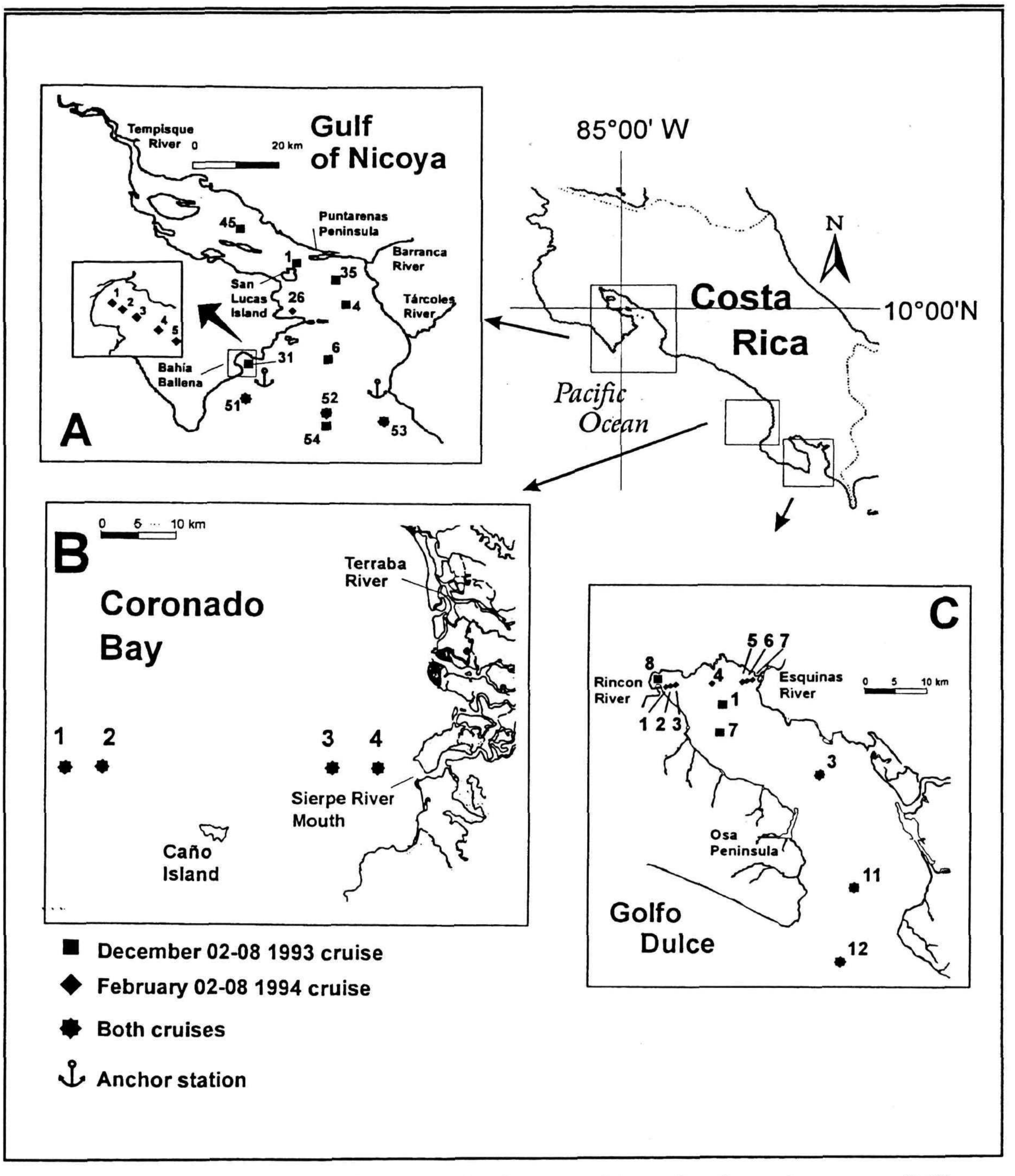

Fig.1.4: Pacific coast of Costa Rica, Central America. Location of the stations for nutrient survey: A) Nicoya Gulf, B) Coronado Bay, C) Golfo Dulce

- To what degree have the nutrient loads of the Nicoya gulf increased during the last few years? An increase can be expected since water from the Caribbean basin has been deverted into the Nicoya Gulf through a major irrigation project that began in the early 80´s. Those waters enter the gulf from the north through the Tempisque river. In addition, part of the sewage from the city of Puntarenas is now directed to a treatment plant which discharges into the gulf.

- How is the nutrient distribution across the Golfo Dulce?

Methods

Two cruise legs were done on board of R/V Victor Hensen (02-08 December 1993 and 02-08 February 1994) covering the Golfo de Nicoya, the adjacent shelf to the Sierpe-Terraba rivers and Golfo dulce (Fig.1.4). At the Nicoya Gulf the number of sampling stations during the first and second leg were ten and eleven respectively. During the second leg, two anchor stations over a semidiurnal tidal cycle were included at the west and east sides of the lower gulf, as these are the areas where the main water exchange between the ocean and the Nicoya Gulf takes place (Voorhis, et. al. 1983). Additionally, a five station transect was conducted in Bahía Ballena, a small bay at the west side of the lower gulf (see Fig.1.4).
In the Coronado Bay (Sierpe-Terraba), four stations were sampled in both legs along a 40 km transect perpendicular to the coast. It extended from the Sierpe river to the 200 m isobath.
Five sampling stations were distributed in Golfo Dulce along its longitudinal axis during the first leg and one lateral station at the inner basin was included. During the second leg, samples were taken at three stations, outside, over and inside the sill. Another transect of seven sample stations was done transversally across the gulf between the Rincon and Esquinas rivers (Fig.1.4).
Sampling was done with Niskin bottles. During the first leg samples were taken at three or two depth levels. In shallow water (10-20m) samples were taken from the surface and bottom waters respectively. In deeper water a third sample was taken from the region of the thermocline as determined with a CTD. During the second cruise samples were taken at closer levels.
Ammonium was spectrophotometrically analyzed onboard immediately after collection of the water sample, using prepared Merck-Spectroquant reagents. Samples for nitrite, nitrate, ortophosphate and silicate were stored and frozen in 500 ml polyethylene bottles for later analysis in the Marine Chemistry Laboratory at the Universidad Nacional, Costa Rica. Triplicate analysis were carried out spectrophotometrically following the procedures of Strickland and Parsons (1972).

Preliminary Results and Discussion *

Golfo de Nicoya:

During the first leg higher nutrient levels were found in the upper gulf (Figs.1.5). A strong vertical mixing process over the depression in the mid-gulf area is evident. Levels of nitrite and ortho-phosphate change markedly in this area. Variation in nitrate between the upper and lower gulf appears to be less marked during dry season. Higher concentrations (up to 27 μmol $l^{-1)}$ were found in deep waters (200 m) of the lower gulf during the December leg. Epifanio et. al. (1983) reported nitrate concentrations as high as 20 μmol l^{-1} at the bottom, at a 65 km distance to the mouth of the Tempisque river. At this distance, we measured only about 7 μmol l^{-1} (Fig.1.5, upper left). However, over a semidiurnal tidal cycle this picture changes drastically. Nitrate levels measured at the west side anchor station at a depth of 60 m (Fig. 1.7a). some 75 km from the Tempisque rivers were as high as 28 μmol l^{-1}, descending to 18 μmol l^{-1} during low tide (anchor station results are discussed below). This sug-

* Ammonium data for both cruises and silicate data for the first are not included in this first report.

gests that the intrusion of nutrient rich water into the upper gulf is a tidally driven process, rather then result of permanent upwelling, as suggested by Epifanio et . al. (1983). Lateral distribution across the lower gulf (stations 51,52, 53) during the February cruise (Fig. 1.6), shows a rising of the isopleths towards the west side of the gulf indicative for stronger input of nutrient rich deep water through this area. Results from the anchor stations measurements show an opposite behavior of nutrient fluxes in response to tidal phase at both sampled sites. At the west side of the lower gulf (Fig.1.7 a-d), water above the thermocline was always low in nutrients with no major changes during the tidal cycle. At deeper levels, a strong input of nutrient-rich water was evident with a peak during high tide, particularly with nitrate

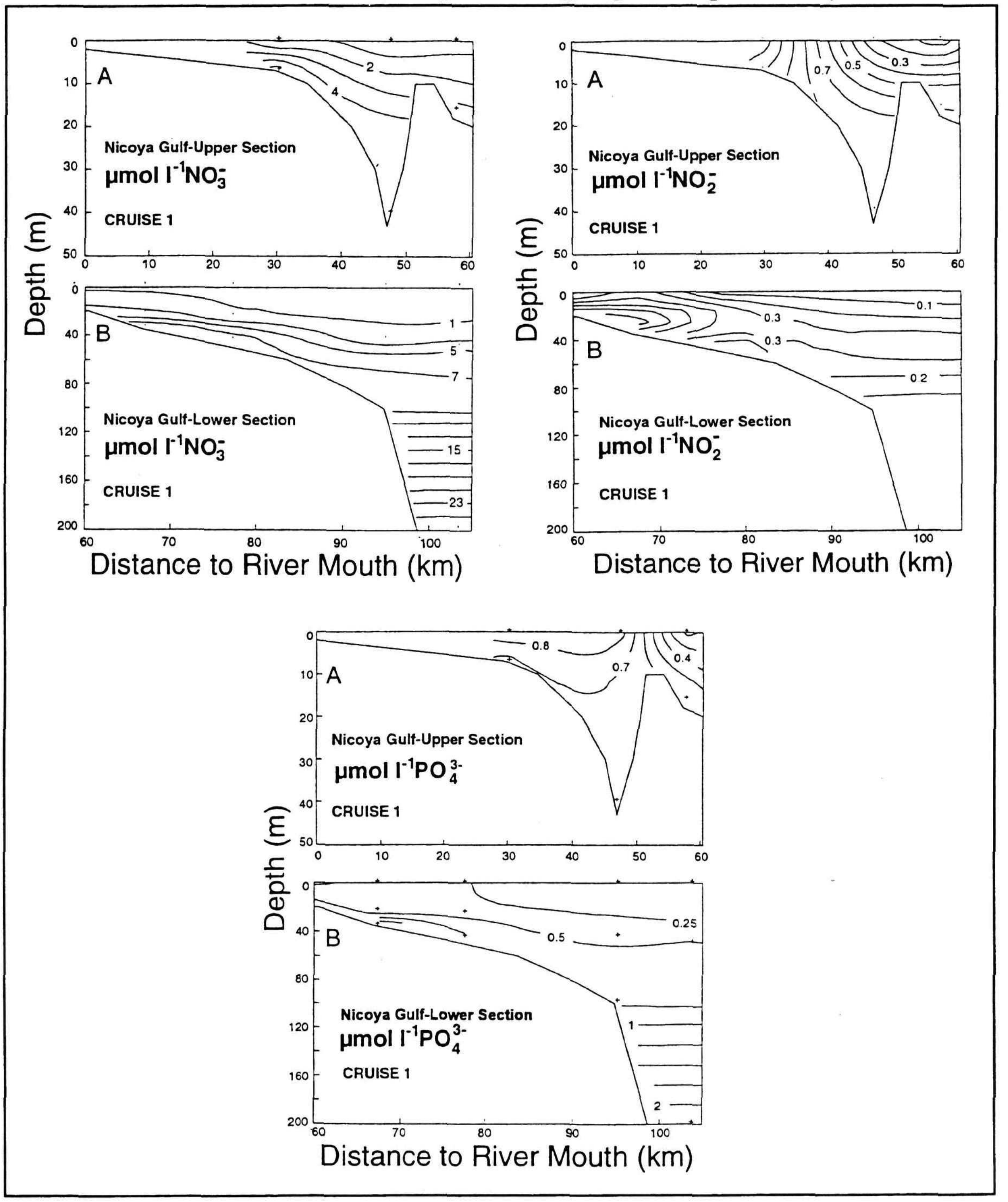

Fig. 1.5. Golfo de Nicoya. Vertical distribution of nitrate (upper left), nitrite (upper right) andortho-phosphat (lower part) (μmol^{-1}) along ots main axis at the upper (st.45,1,35) and lower gulf (st.4,6,52,54) during the first leg (2-8/12/93)

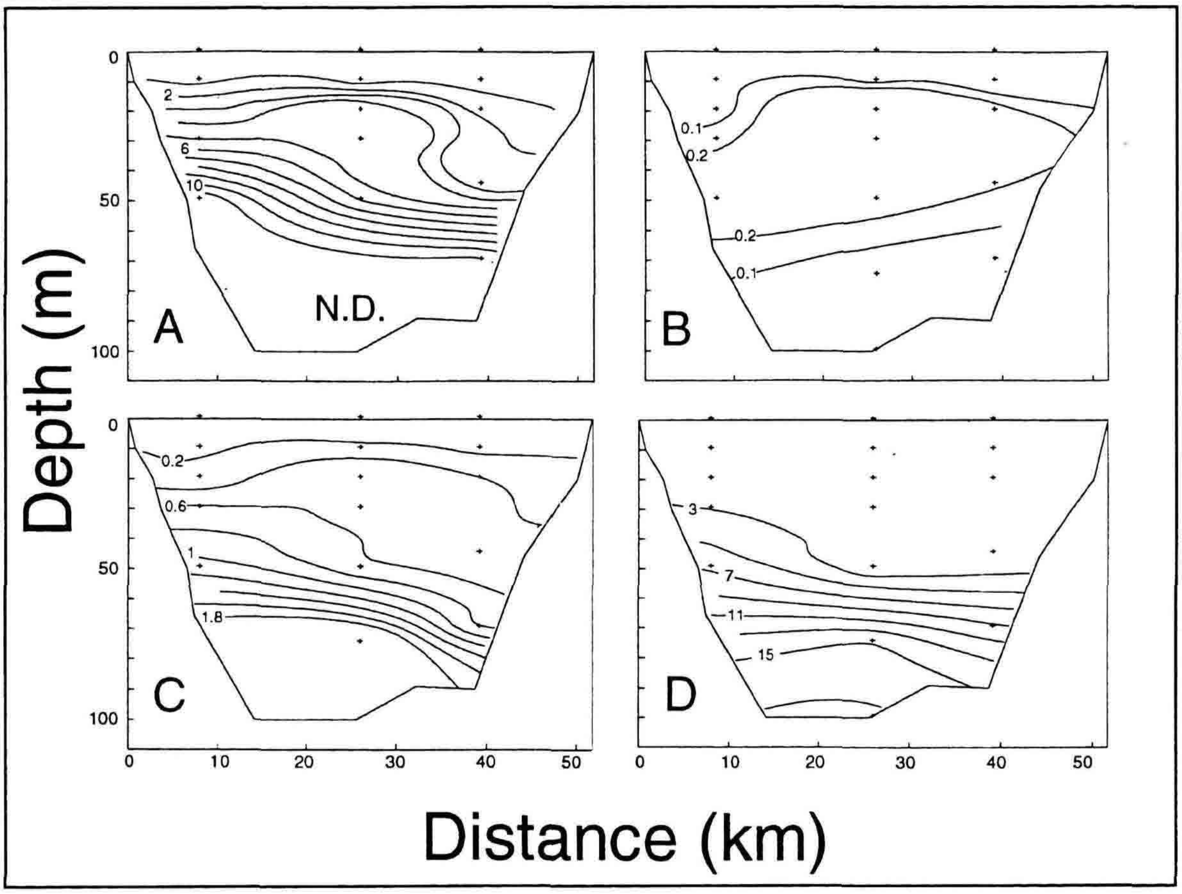

Fig. 1.6 Golfo de Nicoya. Vertical distribution of nutrients (μmol l^{-1}) at thje lower gulf (stat. 51,52,53). A) Nitrate,--N.D: no data fro deeper levels--, B)nitrite, C) ortho-phosphate, D) silicate, during cruise leg 2 (2- 8/2/94)

and ortho-phosphates. Nitrite showed no changes and silicate presented lower levels during high tide. At the anchor station on the eastern side (Fig. 1.7 e-h), nutrient levels rose in the entire water column around the low tide. The picture is in accordance with the tidaly averaged circulation pattern proposed by Voorhis et . al. (1983): inflow of oceanic water at all depth at the western side of the lower gulf and along the bottom at the eastern side. Outflow takes place at shallower depth at the eastern side. The water leaving the gulf passes through the constriction between San Lucas Island and Puntarenas and flows southward along the eastern side. Thus, the eastern lower gulf exhibits increased nutrient levels especially during low tide.
Vertical nutrient distribution along the transect at Bahía Ballena (Fig. 1.8 a), suggests that the shallow bay receives strong nutrient input at the bottom. Levels of nitrate up to 18 μmol l^{-1} - outside in the lower gulf only found at deeper levels- were detected at 30 m in this bay. Suggesting enhanced productivity at Bahía Ballena. This process could account for the rich benthic fauna found here (Maurer & Vargas, 1988 and see section 2.2 and 2.3 of this report).

Sierpe-Terraba:

No differences were found between the December and February legs in Coronado Bay (Figs. 1.9, 1.10),. Vertical distribution of nutrients showed not to be different from that of the contiguous Eastern Tropical Pacific oceanic waters as reported by

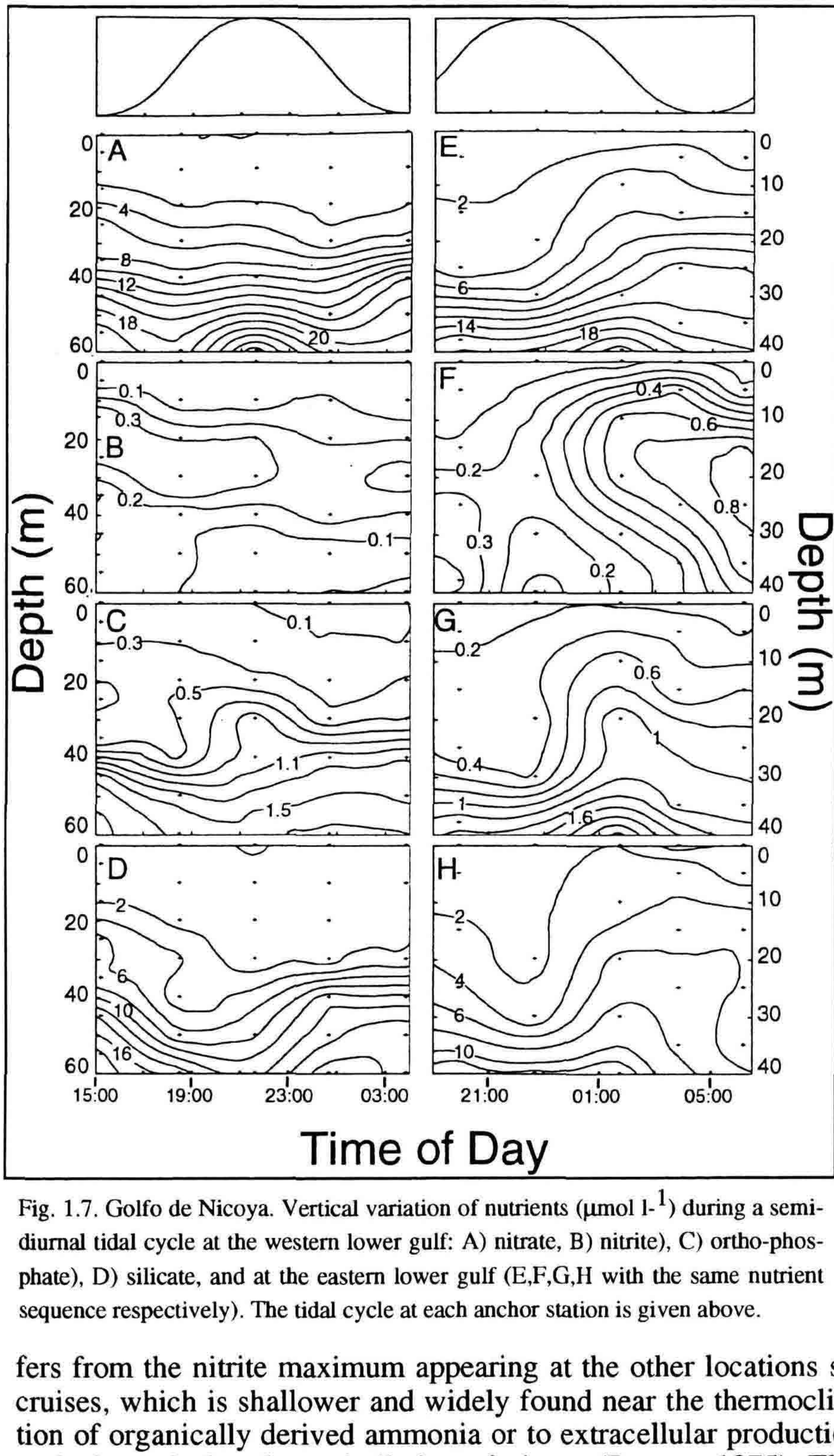

Fig. 1.7. Golfo de Nicoya. Vertical variation of nutrients (µmol l-1) during a semi-diurnal tidal cycle at the western lower gulf: A) nitrate, B) nitrite), C) ortho-phosphate), D) silicate, and at the eastern lower gulf (E,F,G,H with the same nutrient sequence respectively). The tidal cycle at each anchor station is given above.

NOAA (1975). No influence of the Sierpe and Terraba rivers was detected.

Golfo Dulce:

The distribution of the sample stations at Golfo Dulce proved to be inadequate to resolve the chemical complexity of this anoxic basin. The following discussion corresponds to the data collected at the transect between the rivers Rincon and Esquinas. Data from the other stations are listed in the data appendix.

Both nitrate and nitrite distribution evidences the denitrification processes occuring in Golfo Dulce. Nitrate appears to be exhausted from 180 m to the bottom. A secondary nitrate maximum is evident around a depth of 120 m. This maximum differs from the nitrite maximum appearing at the other locations sampled during both cruises, which is shallower and widely found near the thermocline due to the oxidation of organically derived ammonia or to extracellular production of nitrite by phytoplankton during the assimilation of nitrate (Deuser, 1975). The deeper secondary maximum found at Golfo Dulce is caused by the activity of denitrifying bacteria.
Silicate concentration at the deep levels inside the basin were significantly lower than those reported by Richards et. al. (1971). These authors reported concentrations ranging from 50 -70 µmol l^{-1}. Concentrations we found were comparable to those outside the sill at the same depths (see appendix). Low silicate concentrations at deep waters of the inner basin were associated by the above authors with events of new water entering the deeper layers of the basin.

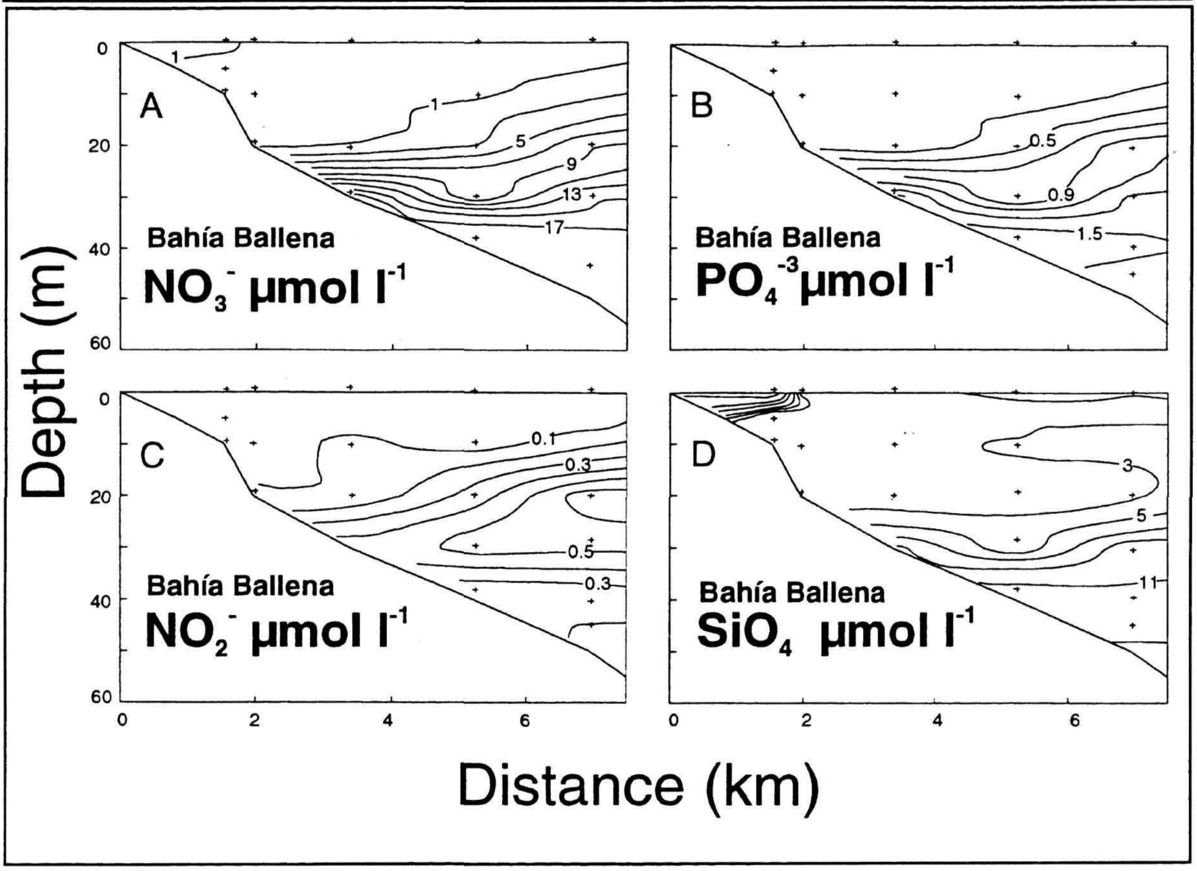

Fig.1.8 Nicoya Gulf. Vertical distribution of nutrients (μmol l^{-1}) at a transect in Bahía Ballena, A) nitrate, B) ortho-phosphate, C) nitrite, D) silicate.

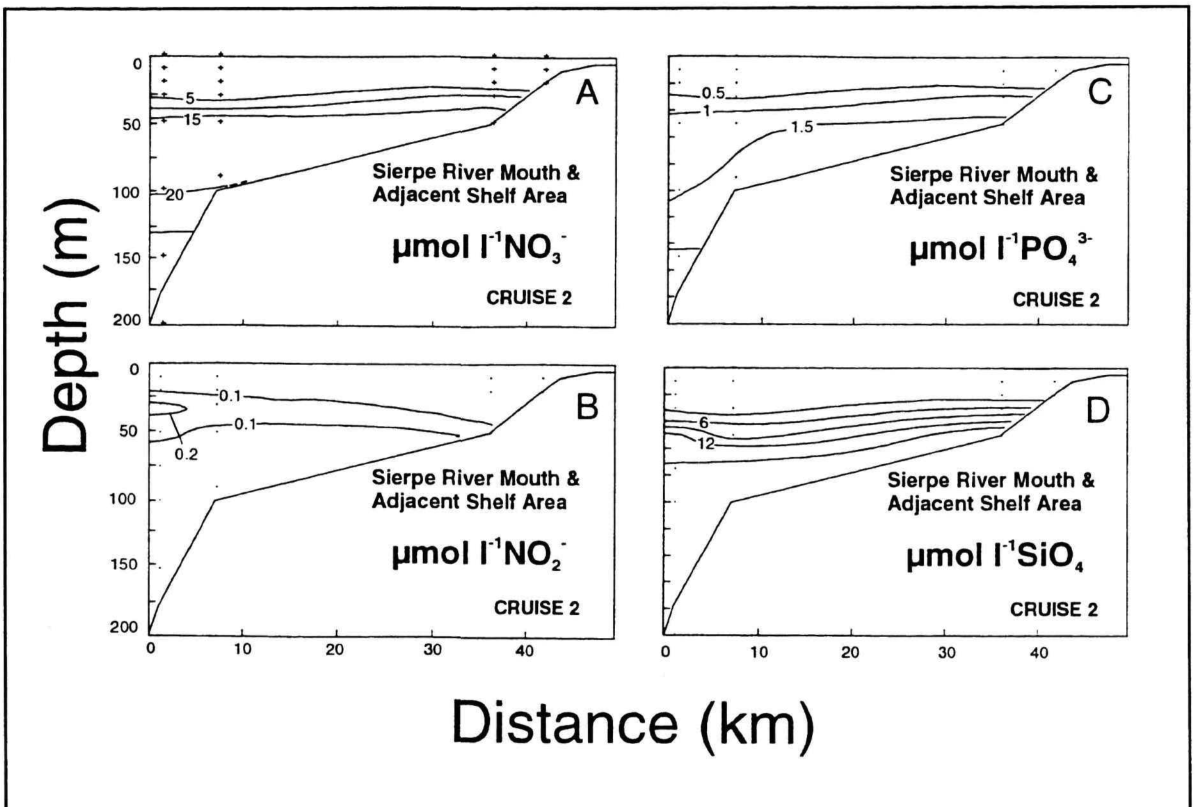

Fig. 1.10 Coronado Bay. Vertical distribution of nutrients (μmol l^{-1}) at a transect from Sierpe river´s mouth ti the 200 m isobath during cruise 2 in February 02-08 1994. A) nitrate, B) nitrite, C) ortho-phosphate D) silicate.

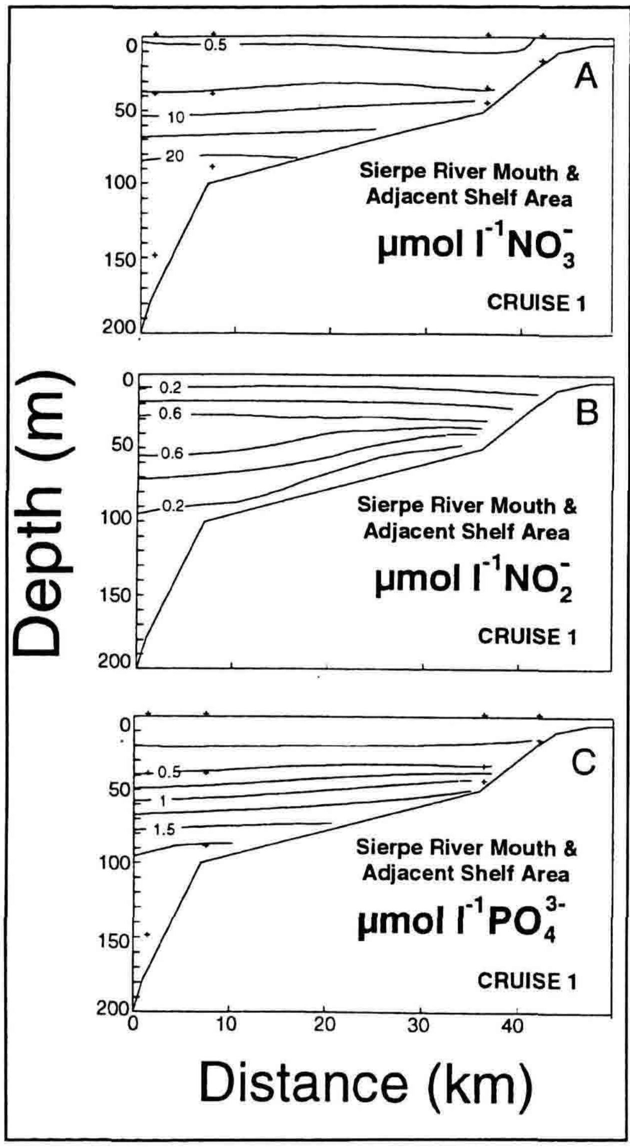

Fig. 1.9 Coronado Bay. Vertical distribution of nutrients (µmol l^{-1}) at a transect from the river Sierpe to the 200m isobath during leg 1 (8/12/93).

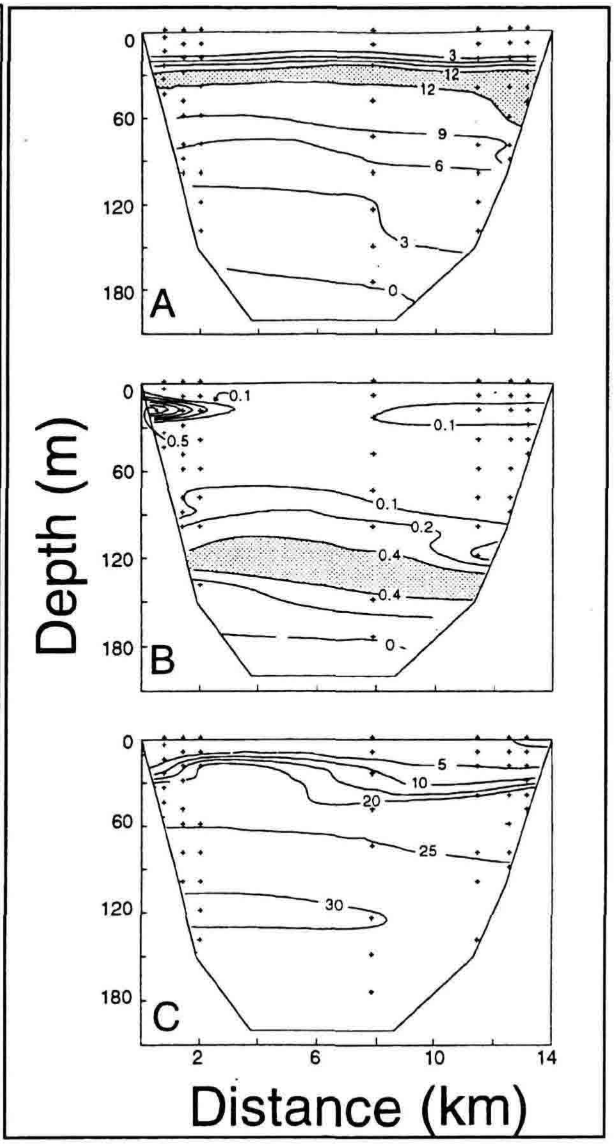

Fig.1.11 Golfo Dulce. Vertical distribution of nutrients (µmol l^{-1}) at a transect between Esquinas and Rincon rivers during cruise 2 in February 02-08 1994. A) nitrate, B) nitrite C) silicate.

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2. Demersal Fish and macrofauna - Trawl surveys

2.1. Report on the fish collections (W. Bussing & M. Lopez)

Objectives

Our objectives were twofold: (1) to identify all species taken on board in order to insure accurate sample data by the fisheries biologists and (2) to take tissue samples of as many species as possible to be preserved in saline buffer solution for future mtDNA analysis. This latter analysis can be used for a variety of future studies such as the identification of pelagic larvae, phylogenetic studies, comparisons with fish stocks from other regions of the Eastern Pacific, etc.

Preliminary results and discussion

We achieved both goals, although a number of specimens remain to be confirmed to species. Tissue samples were taken from more than 250 species of fishes.

The December `93 and February `94 cruises, for the first time, permitted a comparison between the benthic faunas of both the Golfo Dulce and Golfo de Nicoya utilizing the same sampling procedures at the same time of the year. The ichthyological results reveal a striking contrast between the depauperate Golfo Dulce and the far more productive Golfo de Nicoya. It is probable that the differences would have been even more significant were it not that the Golfo de Nicoya has been overfished for many years and fish stocks can be considered way below "normal".

We were present on two of three cruises aboard the R/V Skimmer in the Golfo de Nicoya during 1979-1980. Collections were made with a small otter trawl with a mouth of 12m. At that time, only 14 years ago, the number of species and biomass, especially of sciaenids, was far greater (Bartels et al. 1983, 1984). Some of these differences may reflect the fact that the Skimmer also sampled at night, whereas that was not possible on the Victor Hensen. Otherwise sampling stations were roughly similar.

Two specimens of an eel, Ophichthus sp., were collected which represent a species new to science. Several other specimens of known, but undescribed, species were also taken. Two specimens of Gobiesox milleri, a diminutive species with a ventral sucking disc, were the first specimens of the species taken since the original description 40 years ago and are the first for the Museo de Zoologia.

A list of the fish species already identified onboard Victor Hensen is given in Appendix IV.

2.2. Report on non-crustacean invertebrate collections

2.2.1. Mollusc collections (R. Cruz)

Objectives

Except for a report of Maurer et al. (1988) on the benthic fauna in the Gulf of Nicoya and some taxonomic information on the gastropods and bivalves along the Pacific shores of Central America by Keen (1971), there are no species lists available for the areas investigated during the cruise of RV Victor Hensen (Golfo de Nicoya (GN), Sierpe-Terraba (ST) and Golfo Dulce (GD)). For this reason, the objective of this report is to present a species list of gastropods and bivalves collected during the research cruise and to compare the species of these three areas.

Material and methods

All specimens collected during the two legs of RV Victor Hensen were preserved in 10% formalin and identified using the literature (Olsson, 1981; Keen, 1971; Skodlund, 1991,1992). (Further details on the sampling see next chapter C: quantitative assessment)

Preliminary results and discussion

The list of gastropods and bivalves found at the various sample stations in the three study areas is given in Table 2.1 A total of 166 species was identified, of which 119 belong to the groups gastropods, 46 to bivalves and 1 to scaphopods.

Of the gastropods, 56,8 and 9 species were found exclusively within the GN, GD and ST - areas respectively. 22 species were found in all of these areas, 9 in the GN-and GD-areas and 17 in the ST and GN-areas.

This species record adds 81 species to the area of GN, where Maurer et . al (1988) had reported only 25 species.

Among the most abundant gastropods were Polystira oxitropis and Strombina fusinoidea in the GD-area, Oliva polpasta in the ST-area and Fusinus panamenis in the GN-area.

Of the 45 bivalves collected, 24,5 and 6 were found only within the GN, ST and GD-areas. Only two species were found in the three areas. Nicols-Driscoll (1976) reported 4 bivalve species in the GD-area compared to 11 found during this survey and Maurer et. al (1984) reported 2 species for the GN-area compared to 27 found during this survey.

At station 51 (Golfo de Nicoya, about 60 m) the highest species number of gastropods was found (48), followed by station P (Sierpe-Terraba, about 50m) with 30 species, station 52 (Golfo de Nicoya, about 100 m) with 22 species and stations 31 (Bahia Ballena, 22 m) and station F (Golfo Dulce, 73 m) with 21 species.of gastro-

Table 2.1. Mollusc species/station list as derived from demersal survey during leg 1 and leg 4

Stations	Golfo Dulce											Sierpe Térraba							Gulf of Nicoya											
Species	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	31	51	54	52	53	6	50	30	35	1	45	43
Gastropods																														
Admetula deroyae												x																		
Amaea ferminiana					x									x								x								
Architectonica nobilis		x											x	x					x	x		x			x					
Butonaria caplata																									x					
Butonaria nana				x			x													x				x			x			
Calliostoma veleroae														x								x								
Cancellaria bulbulus																								x						
Cancellaria cremata				x																										
Cancellaria decussata														x								x								
Cancellaria gemnulata				x																										
Cancellaria jayana																						x								
Cancellaria ovata																						x								
Cancellaria strunzi												x																		
Cancellaria urceolata																						x				x				
Cantharus gatesi					x								x	x								x		x						
Cantharus panamicus																				x										
Cantharus rehderi					x		x												x			x								
Carinodrillia adonis				x																x										
Cassis centiquadrata																											x			
Catenopsis mendozana				x															x	x										
Cerithium gersmatum																			x											
Chicoreus peratus				x										x						x										
Ciphona emarginatum																				x										
Cochlespira cedonulli				x	x		x					x		x						x	x									
Compsodrillia bicarinata				x																										
Compsodrillia gracilis												x																		
Conus archon														x					x											
Conus arcuatus				x										x								x								
Conus fergusoni				x																x										
Conus perplexus								x					x	x	x					x							x			
Conus regularis								x					x	x	x					x										
Conus tornatus														x													x			
Coralliophila squamosa																				x										
Cosmioconcha modesta		x																				x	x	x		x			x	x
Cotonopsis turrita																														x
Crassispira balleanensis				x																										
Crucibulum scutellarum																				x										
Cruziturricula arcuata														x						x		x								
Cymatium amictoidum																				x										
Cymatium constricta																								x						
Cymatium wiegmanni																														x
Distorsio constricta				x									x	x					x	x		x	x							
Distorsio decussata														x					x						x					
Ficus ventricosa																				x				x			x			
Frigonostoma funiculatum																				x										
Fusinus panamensis					x		x						x							x	x	x	x	x						
Fusiturricula armilda				x								x		x							x			x						
Glyphostoma bayeri																						x								
Harpa crenata														x						x										
Hexaplex brassica																	x			x		x	x				x			
Hexaplex regius																														
Hindsiclava resina			x	x		x						x		x					x											
Imaclava pilabry																			x											
Jenneira pustulata																			x						x					
Knefastia walkeri				x										x																
Latirus gemnatus																			x											
Latirus hemiphilli																			x						x					
Linatella wiegmanni																														x
Malea ringens														x						x										
Metula amosi																				x	x			x						
Mitra swainsoni												x								x		x	x		x					
Murex recurvirostris			x					x											x	x	x			x						
Nassarius angulatus														x																
Nassarius angulicostis														x																
Nassarius catallus				x										x								x								
Nassarius guaymasensis																				x										
Nassarius shaskyi																				x										
Natica broderipiana																			x								x			
Natica caneloensis																				x		x					x			
Natica colima																					x			x		x				
Natica elenae												x								x										
Natica grayi				x																										
Northia northiae																				x										
Oliva polpasta		x				x								x	x				x	x										
Phos articulatus																										x				
Phos crassus																				x				x		x				
Phos reticulatus																										x				
Phos veraguensis		x	x											x										x						
Polinices uber		x																	x	x				x					x	x
Polystira nobilis				x	x							x								x			x	x						
Polystira oxytropis				x	x							x		x	x				x	x		x	x	x						
Polystira picta		x													x				x											
Prunum curtum																				x	x									
Pteropurpura centrifuga												x										x								
Pteropurpura deroyana												x								x	x	x	x							
Sinum cymba																				x	x									

Species	Golfo Dulce C	D	E	F	G	H	I	J	K	L	M	Sierpe Térraba N	O	P	Q	R	S	T	Gulf of Nicoya 31	51	54	52	53	6	50	30	35	1	45	43
Gastropods																														
Solenosteira mendozana																				x										
Stenorysis dianae												x								x										
Strombina fusiformis		x																												
Strombina fusinoidae		x		x										x																
Strombina recurva																				x										
Strombina turrita																														x
Strombinoturris crockeri																				x										
Stromboli bebeei																				x										
Subcancilla attenuata														x	x			x	x											
Subcancilla calodinotas															x															
Subcancilla cumingii															x												x			
Subcancilla hindsii																		x									x			
Sveltia cantrota												x																		
Synum grazi																							x							
Terebra armillata																								x			x			
Terebra glauca														x																
Terebra hancocki																											x			
Terebra ornata																			x											
Tiaturris spectabilis				x										x						x										
Trajana perideeis					x															x										
Trigonostoma bullatum																					x									
Trigonostoma funiculatum																				x										
Tripsyche tulipa																				x									x	
Truncaria filosa																							x							
Turritella clarionensis			x																											
Turritella leucostoma							x								x									x			x			
Typhis cumingii															x															
Vasum caestum																				x										
species number	**0**	**8**	**4**	**21**	**8**	**3**	**5**	**3**	**0**	**0**	**0**	**14**	**6**	**30**	**10**	**0**	**1**	**3**	**21**	**48**	**10**	**22**	**10**	**18**	**6**	**6**	**13**	**0**	**3**	**6**
Bivalves																														
Adrana crenifera															x			x		x										
Anadara biangulata												x																		
Anadara concinae												x		x																
Anadara nux																			x											
Anonia peruviana																														x
Arca pacifica				x									x																	
Aroinella californica																											x			
Arcopsis solida																											x			
Chione gnidia																											x			
Chione kelletii												x																		
Chione nariae																			x											
Clementia solida																											x			
Corbula tumaca				x																										
Cyclinella zakata																			x											
Cyclocardia spurca bebeei				x																										
Eucrassatella gibbosa																		x	x											
Glovivenus isocardia																				x										
Glycineris strigilata																			x	x										
Harvella elegans																										x				
Leporimetris dorbei																														x
Macoma mediamericana														x							x	x								
Macoma seliqua		x			x																x					x			x	
Megapitaria squalida																			x											
Mulinia palida																					x								x	
Nemocardium annette								x					x					x	x											
Nuculana marella				x																										
Oppenheimopecten perulus																			x											
Pacipecten tumbizensis																				x										
Papyridea cockeri																				x										
Pholas chiloensis								x																						
Pitar callicomatus																		x												
Pitar mexicanus								x																x						
Pseudomussinum fasciculatum												x																		
Spondylus princeps				x																										
Tagelus burgeoisiae																										x				
Tagelus peruvianus						x																								
Tellina burneti																											x			
Tellina ecuadoriana		x			x																									
Tellina inscuepta																			x											
Tellina nicoyana																					x									
Tellina ochracea																			x											
Tellina prumeti																											x			
Trachycardium belchesi																			x	x										
Trachycardium consore																									x					
Trachycardium senticosum																											x			
Transennella modesta																			x											
Trigonocardia granifera																			x											
species number	**0**	**2**	**0**	**5**	**2**	**1**	**0**	**3**	**0**	**0**	**0**	**4**	**2**	**2**	**1**	**0**	**0**	**4**	**13**	**6**	**4**	**1**	**0**	**1**	**1**	**3**	**7**	**0**	**2**	**2**
Scaphopods																														
Dentalium oerstedi																								x			x			

pods.

Bivalve species richness was highest at station 31 (Bahia Ballena, 22 m) with 13 species, followed by station 35 (Golfo de Nicoya, 15 m), station 51 (6 species) and station F (5 species).

Except for station F, all Golfo Dulce stations exhibited rather low species richness of gastropods and bivalves.

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2.2.2. Quantitative notes (V. Koch)

Objectives

The objective of this contribution is to give an overview on the biomass distribution of collected (non -crustacean) invertebrates in the three study areas Golfo de Nicoya, Sierpe-Térraba and Golfo Dulce and to look for similarities and differences between areas and depth ranges.

Preliminary results and discussion

Invertebrate biomass values were in general higher in the Gulf of Nicoya than at Sierpe Térraba and Golfo Dulce (Table 2.2). Some groups such as squids, sea urchins, anemones and sea cucumbers were exclusively found in the Gulf of Nicoya. Sea stars were much more abundant here, but also occurred- at lower biomasses- in the other two regions. In the GN- area, the shallow stations showed the highest values (depth range: 10 - 44m), but on station 52 (118m) some sea stars were found too. Highest biomass and abundance of squids was found in the Gulf of Nicoya where the greatest concentrations occurred in depths between 60 - 110m. Only one juvenile squid was caught in the Golfo Dulce. Highest octopod biomass was reported in the Golfo Dulce, but only on those stations (G, I, M) located at the outer shelf and in the region of the sill which closes the Gulf to the ocean. Gastropod biomass was highest in the Gulf of Nicoya, especially on stations 51 and 52 with Fusinus panamensis being the dominant species. At most stations dead shells predominated, living gastropods were most frequently found in areas with coarse sediment or stones. Living bivalves were rare in all three regions, Tellina ecuadoriana was the dominant living bivalve (stat. C in Golfo Dulce and bt06/2 in the Gulf of Nicoya). Sea urchins were found in the Gulf of Nicoya in depths from 10 - 80m, but did occur only at three stations (43, 51, 53). Ophiurids were not caught in Golfo Dulce whereas at the 20m station (Q) in Sierpe Térraba some specimens were found. In the Gulf of Nicoya ophiurids were caught at three shallow stations, of which two had low biomass values (31 and 50). The highest biomass was reported in the upper Gulf near Isla Chira at a depth of 10m. No ophiurids were caught at depths below 32m. Anemones in the Gulf of Nicoya were found at four stations (ot06, bt06, 30 and 52). Highest biomass occurred at the first three stations at a depth range from 31 - 44m. Sea cucumbers were found at two stations in the Gulf of Nicoya (31 and 06), at depths of 22m and 44m respectively. In terms of biomass, squids were the dominant invertebrate group in the Gulf of Nicoya, representing 40% of the total catch, followed by sea stars (27%), sea urchins (11%), gastropods (10%), anemones(7%), ophiurids(3%), sea cucumbers (1,4%), octopods (0,5%) and bivalves (0,1%).In Golfo Dulce the catch was clearly dominated by gastropods (49%) and octopods (45%). Seastars and bivalves represented only 3% each, the percentage of squids was below 0,2%. In Sierpe Térraba invertebrate biomass was strongly dominated by gastropods (87%), sea stars and ophiurids represented approx. 6% each and ophiurids accounted for 1% of total catch.

The low invertebrate biomass found in the Golfo Dulce area suggests a general lower benthic productivity when compared to the Gulf of Nicoya. This can probably be attributed to the low oxygen content of the bottom water of the inner Golfo dulce during most time of the year, inhibiting settlement and growth of most invertebrates but might also be the result of a general lower nutrient input and a lower primary productivity. In the Sierpe Térraba area, invertebrate biomass seems to be somewhat higher than in the Golfo dulce. Here the oxygen saturation of the bottom water is more favourable and high nutrient input from the large river Sierpe and the surrounding mangrove swamps may improve the conditions for megabenthic invertebrates. The

Table 2.2. Invertebrate biomass /abundance in the study areas Golfo de Nicoya, Sierpe-Terraba and Golfo Dulce

					biomass (g) /Abundance (n)									
	station	*depth (m)*	*Temp. (°C)*	*Ox. (%)*	*Squids*	*Octopods*	*gastropods*	*bivalves*	*sea urchins*	*sea stars*	*ophiurids*	*anemones*	*sea cucumbers*	*total (g)*
Golfo dulce	C2	48	20	22				36/ 49						36
	D2	25	24	35				10/ 15						10
	E2	40	20	12			15							15
	F2	75	15,5	15			800							800
	G2	200	13	2		800/ 18	500/ 26							1300
	otI/2	235	13	2		400/ 7								400
	otM/ 2	82	16	8	8/ 1	6/ 1	14	30		78				136
		total biomass (g)			**8**	**1206**	**1329**	**76**	**0**	**78**	**0**	**0**	**0**	**2697**
Sierpe Térraba	N2	186,5	13	2		10/ 1								10
	O2	103,3	14,5	8			972							972
	P2	48	15,5	10		120/ 22	1000			146				1266
	Q2	21	26	75							24/ 65			24
		total biomass (g)			**0**	**130**	**1972**	**0**	**0**	**146**	**24**	**0**	**0**	**2272**
Gulf of Nicoya	bt01/2	33	27	65						900/ 86				900
	bt06/2	43	19,5	50			390/ 105	42/ 30				300/12		732
	ot06/2	44	19,5	50	500/ 62		300/ 9			450/ 40		1200/ 40	300/ 12	2750
	bt30/2	31	22	50								1000/ 39		1000
	bt31/2	22	26	80							66/ 68			66
	ot31/2	22	26	80	80/ 14								250/ 1	330
	ot35/2	19	25	55						600/ 37				600
	bt43/2	10	27	60					1000/ 55	600/ 65	1000/ 530			2600
	bt45/2	15	27	50						2500/170				2500
	ot45/2	18	29	50	300/47					5000/ 333				5300
	bt50/2	32	24	55	35/ 22	60/ 11				87/ 8	50/ 50			232
	bt51/2	64	16	40	1000/ 123		1500		1800/ 66					4300
	bt52/2	118	14,5	10			1500/ 59			200		100		1800
	ot52/2	109	14,5	10	3500/ 410									3500
	ot53/2	80	14,5	18	9200/1375				1500/ 5					10700
	bt54/2	228	12	2		120/ 4	100/ 3							220
	ot54/2	239	12	2	1000/ 123									1000
		total biomass (g)			**15615**	**180**	**3790**	**42**	**4300**	**10337**	**1116**	**2600**	**550**	**38530**

high biomass of squids in the Gulf of Nicoya may be indicative for a high pelagic productivity in this area. The much higher biomass and abundance of detritus and filter feeders such as sea urchins, ophiurids, sea cucumbers and anemones in the Gulf of Nicoya is probably reflecting a much higher benthic productivity in this area when compared to the other two areas as a result of the shallow nature of the bay and the high nutrient input (see chapter 1). In general the benthos of the Gulf of Nicoya seems to also be more divers than in the other two areas. These findings coincide with those for demersal fish and crustaceans (see next chapter) which also exhibit highest biomass and diversity in the Gulf of Nicoya.

2.3. Quantitative assessment of fish and crustaceans (M. Wolff, S. Jesse)

Objectives

In the three study areas of Golfo de Nicoya , Sierpe Terraba and Golfo dulce, beamtrawl and ottertrawl hauls were conducted along a depth gradient from about 20 m to 200 m in order to sample the demersal fish and macrofauna in these areas and to find out 1) if there are areas with commercially important concentrations of fish and invertebrate species, 2) if there are certain areas/stations that can be characterized by assemblages of a particular set of species, 3) if and how the two golf systems (Golfo de Nicoya and Golfo dulce) and the Sierpe-Terraba estuary differ in their species richness, -composition, abundances and biomass and how differences relate to oceanographical conditions in the different areas and water depths. As the Golfo dulce area had not been surveyed on a macroscale before, it was expected to find some new as yet not described species.

Material and methods

Sampling

Two types of trawls (beam trawl and otter trawl) were employed to sample the smaller fish and macroinvertebrates as well as the bigger fish.

At the stations (seen in Figs. A,B,C), 15 min beamtrawl hauls (meshsize 1cm) were conducted at an average towing speed of about 1.5 knots. The catch was then separated into fish and invertebrates, and the total weight of all specimens of each species was registered (in some rare occasions subsamples had to be taken). The length frequencies of the abundant species (> 10/sample) were recorded. Most taxonomic identification of the fish species was done already on board by Dr. William Bussing. Unidentified species (the majority represented by invertebrates) were numbered for later identification and preserved in 4% formalin.

On those sampling stations where coral pieces, tree trunks or stones appeared in the beam trawl, the otter trawl was not employed thereafter because of the danger of damage - otherwise the sampling stations of the beamtrawl were repeated with the ottertrawl (meshsize 2.5 cm), that was towed for 30 min at an average speed of 2.5 knots. The catch was then analysed as described for the beamtrawl.

The beamtrawl (opening width: 3m) swept an area of approx. 2084 m^2, while the ottertrawl (opening width: 35 m, head rope:27.5m;foot rope: 34m) swept an area of approx. 81 025 m^2 per tow.

During the first leg, the ottertrawl was heavily destroyed on a coral reef in the Golfo dulce area (st. I, see Fig. C), but sampling was continued using a second trawl. At another occasion (st. 51, Fig.A) the beam of the beamtrawl broke and had to be repaired.

During the second leg, the second ottertrawl was lost completely in the Golfo dulce (st.E, see Fig.C) as it was so heavily loaded that it had to be cut off. In the meanwhile the other ottertrawl had been repaired and could be employed up to February 16, when it again was so heavily destroyed (Golfo de Nicoya, St. 54) that it could not be used any longer. For this reason , the number of samples taken by the ottertrawl was lower (11) then during the first leg (18).

Data processing

For the preliminary data analysis of the fish and crustacean data presented here the following steps were done:

1. For each sample (station), a species list was elaborated containing biomass (Bm^{-2}) number (N^{m-2}), and a descriptor (P) which combines biomass and number. This descriptor is given by: $P = (B/A)^{0.73} * A$ (Warwick & Clarke, 1993).

In case of the crustaceans, the species list is still incomplete because of identification difficulties. Therefore, the unidentified species were grouped into families or even higher taxonomic categories for further elaboration.

2. A station/species matrix was constructed for the beamtrawl and ottertrawl samples for both cruise legs separately and a similarity matrix using the Goodman-Kruskal gamma coefficient was computed by the use of the SYSTAT software. For this matrix the descriptor "P" (s. above) was used.

In case of the crustaceans, only data of the fourth cruise leg are presented here, as the data of the first leg have as yet not been elaborated.

3. The ward linkage algorithm was then used to construct station clusters from the similarity matrix.

4. A "station parameter table" was constructed for the data of all beamtrawl and all ottertrawl samples taken during leg 1 and leg 4. To do so, for each station (sample), bottom temperature (°C), oxygen (% saturation) species richness (number, except for the crustaceans), biomass (g m^{-2}), abundance and dominance index "d" (except for the crustaceans) was calculated. The dominance index "d" was calculated after Whittaker (1965): $d = \Sigma (ni/N)^2$, where ni the value (biomass, abundance or production) for each species and N is the sum of the values of all species.

5. This station parameter table was then standardized to put the measurements on a common scale. By the standardizing routine the data of the variables are replaced by their sample standard scores.

6. From the so standardized table a similarity matrix was constructed as described above.

7. A 2- dimensional multidimensional scaling (MDS) -plot was then established in order to fit the sample points in space such that their distances correspond as closely as possible to the set of the 6 station descriptors used (see above).

8. A 3 D-MDS plot was done with the samples of the beamtrawl and ottertrawl separately for both cruise legs using a station/species matrix in which the species numbers were significantly reduced to those species that account for 90%-95% of the species biomass (about 30% of all species/station).

In case of the crustaceans, no further species reduction was necessary, as the data had to be grouped into higher taxonomic categories right from the beginning (s.a.)

For the MDS-plots, the stress (Shepard diagram) was used as a goodness of fit criteria as described in the SYSTAT handbook.

Preliminary results and discussion

1. Fish assemblages

The appendix A contains the species list for both cruise legs. Table 2.3. shows the oceanographical and biological station descriptors for the beamtrawl and ottertrawl samples.

Fig. 2.1. shows the station clusters for the beamtrawl and ottertrawl samples of both legs derived from the station/species matrix using the biomass/abundance descriptor "P".

The beamtrawl cluster of the first leg shows three groups, the first being composed of the stations of the inner and central part of the Golfo de Nicoya (35,30,06,45 and 01), the second group is divided into the deep water stations of the Golfo dulce, Sierpe-Terraba and Golfo de Nicoya areas (G,N,52,54) and the other stations of the Sierpe-Terraba area (O,T,P,Q) and the shallow stations of the western side of Golfo dulce (D and E). The third group contains the other stations of the Golfo dulce area (F,C,A and B) and the stations of the Golfo de Nicoya area located at the edges of the outer part of the gulf (53,51,31). A somewhat different but similar pattern is repeated for the beamtrawl samples of the second leg: here the deep water stations of all areas (54,G, N,O) and those stations that are near to the openings of both gulf systems (31,51,F and H) form the first group. The second group is divided into the stations of the inner part of the Golfo de Nicoya (43,45,01) and two of the central stations of the Golfo dulce area (B,C). The last group is made of stations of the central part of the Golfo de Nicoya (30,35,06,50) and the nearshore stations D,E of the Golfo dulce area and the 50m station P of the Sierpe -Terraba estuary.

In the ottertrawl clusters, some of the above station grouping are repeated, some are not: the stations of the central and outer part of the Golfo de Nicoya (30,06,52,53,54) are grouped as are the stations of the Golfo dulce K,L and M. The deep water stations I and I.2 are grouped together with station 31 (Bahia Ballena) of the Golfo de Nicoya in the cluster of the first leg. For the second leg the deep stations I.2 and 54 are also grouped. The grouping of the nearby stations 45 and 01 (Golfo de Nicoya, inner part) are repeated in all clusters, except the ottertrawl cluster of leg 2. Here, station 45 is quite distant to the other stations.

Fig. 2.2. shows the 2D-MDS-plots based on the station parameter table 2.3. for the combined beamtrawl and ottertrawl samples of both legs (upper part) and the 3D-MDS-plots established from the reduced station/species matrices for the beam- trawl and ottertrawl catches of each leg.

The beamtrawl stations show a clear pattern: the stations of high biomass and species richness are concentrated in the upper part of the plot, with the stations of the inner, warmer and shallower part of the Golfo de Nicoya (43.2,35.1,35.2,45.1,31.1, 01.1, 31.2) being clumped together in the upper right corner, whereas the deep and cold water stations located in the outer parts of the Golfo de Nicoya (54), Sierpe-Terraba (N2) and Golfo dulce area (G1 and G2) are within the left upper part of the plot. The two stations of the deep basin within the Golfo Dulce (B1 and B2) are clumped together in the lower part of the plot. These 2 stations, in addition to having very low species biomass and richness are separated from other stations of low biomass by their anoxic conditions.

The plot for the ottertrawl catches shows a somewhat similar pattern: again the anoxic deep basin station "L" within the Golfo dulce is at the lower part of the plot and the shallow water stations of high biomass and high species richness are clumped in the upper right corner of the plot.

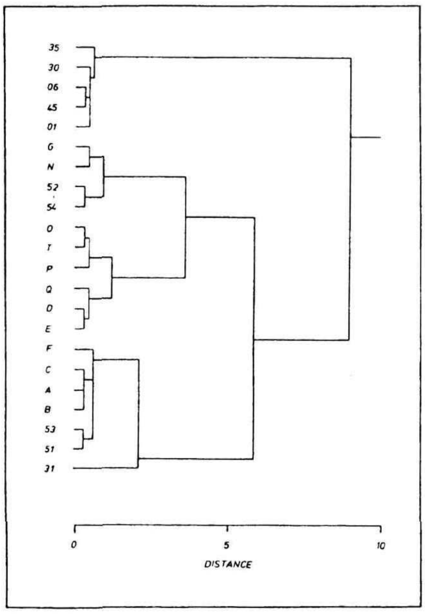
Table 2.3. Sample stations and station parameters (B: biomass; A: abundance; P: production; cA, cP: dominance for abundance and production respectively, see text for further explanation)

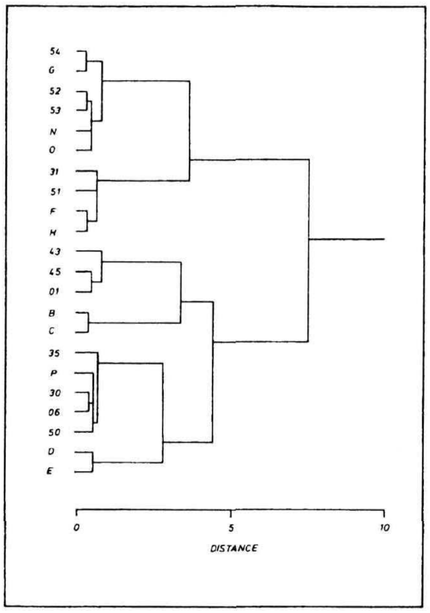
station parameters

				Beamtrawl					
station	water depth [m]	temperature [°C]	oxygen [%]	species richness	B [g/m2]	A [n/m2]	P [g/m2]	cA	cP
A1	107,0	17	2	3	0,1368	0,0466	0,0943	0,3923	0,3619
B1	191,4	16	0	6	0,3053	0,4843	0,3366	0,9823	0,9069
B2	192,0	16	0	2	0,0872	0,0010	0,0222	0,4920	0,9146
C1	42,0	20	22	6	0,6811	0,0965	0,2735	0,5548	0,2146
C2	48,0	20	22	2	0,0254	0,0024	0,0133	0,5199	0,5000
D1	32,5	23	35	10	0,4632	0,0250	0,1741	0,3107	0,2616
D2	25,0	24	35	11	1,0052	0,0240	0,3132	0,1144	0,3036
E1	50,0	19	20	11	0,1869	0,0158	0,0778	0,1901	0,1608
E2	40,0	20	12	2	0,0468	0,0010	0,0148	0,4999	0,7763
F1	73,0	15	13	13	1,1322	0,0293	0,2258	0,2771	0,2778
F2	75,0	15,5	15	2	0,0240	0,0024	0,0124	0,5199	0,5311
G1	200,0	16	2	21	3,1990	0,3715	1,3577	0,3534	0,2379
G2	200,0	13	2	22	1,9940	0,1550	0,9786	0,1433	0,1471
H1	12,3	27	75	17	0,2570	0,0011	0,0485	0,1625	0,1890
bkH2	15,0	27	100	7	1,4620	0,0198	0,2266	0,5551	0,4510
N1	164,0	14	8	23	1,2921	0,0802	0,5211	0,1189	0,0955
N2	186,5	13	2	20	2,4324	0,0945	0,9240	0,1424	0,1734
O1	109,9	14,5	10	8	0,2381	0,0182	0,0765	0,1828	0,3855
O2	103,3	14,5	8	20	0,8051	0,0811	0,3742	0,1718	0,1385
P(2)1	50,2	15,5	10	15	0,9880	0,0931	0,4110	0,2090	0,1608
P2	48,0	15,5	10	12	1,1135	0,1275	0,5559	0,2612	0,2158
Q1	21,1	26	80	10	0,3857	0,0341	0,1439	0,3152	0,1596
Q2	21,0	26	75	12	0,5611	0,0725	0,2116	0,2971	0,2227
bk01/1	36,3	27	65	13	1,2346	0,0212	0,2937	0,1271	0,1571
bk01/2	33,0	27	65	19	0,3910	0,0293	0,1445	0,1432	0,0951
bk06/1	43,0	19,5	50	3	0,0053	0,0034	0,0038	0,5509	0,5098
bk06/2	43,0	19,5	50	16	0,8671	0,1200	0,4269	0,2875	0,1844
bk30/1	28,9	22	50	11	0,1483	0,0182	0,0711	0,2908	0,2817
bk30/2	31,0	22	50	4	0,1013	0,0182	0,0603	0,5396	0,5951
bk31/1	21,7	28	90	12	1,1147	0,0456	0,3856	0,4854	0,3382
bk31/2	22,0	26	80	11	0,4348	0,0240	0,1800	0,3768	0,4049
bk35/1	14,8	26	70	18	1,0869	0,0667	0,4735	0,1207	0,1328
bk35/2	19,0	25	55	14	1,0874	0,0653	0,4553	0,1940	0,2409
bk43/2	10,0	27	60	25	11,4650	0,1044	2,3031	0,1035	0,1535
bk45/1	13,2	29	75	7	3,0391	0,0062	0,4219	0,1716	0,7734
bk45/2	15,0	27	50	9	0,1544	0,0120	0,0732	0,2544	0,3129
bk50/2	32,0	24	55	18	0,5068	0,1512	0,3394	0,1837	0,1741
bk51/1	58,5	17	40	11	0,0866	0,0211	0,0469	0,2293	0,4225
bk51/2	64,0	16	40	20	0,6345	0,1497	0,3581	0,4651	0,1589
bk52/1	117,6	15	10	3	0,0022	0,0014	0,0018	0,3333	0,5017
bk52/2	118,0	14,5	10	15	0,6100	0,0014	0,0029	0,2769	0,2640
bk53/1	85,0	14	10	6	0,0130	0,0048	0,0084	0,2400	0,2184
bk53/2	83,0	14,5	18	9	0,0893	0,0187	0,0513	0,2715	0,1917
bk54/1	228,0	12	5	9	0,0910	0,0005		0,1712	0,2636
bk54/2	228,0	12	2	15	0,9721	0,0994	0,4897	0,2935	0,2745

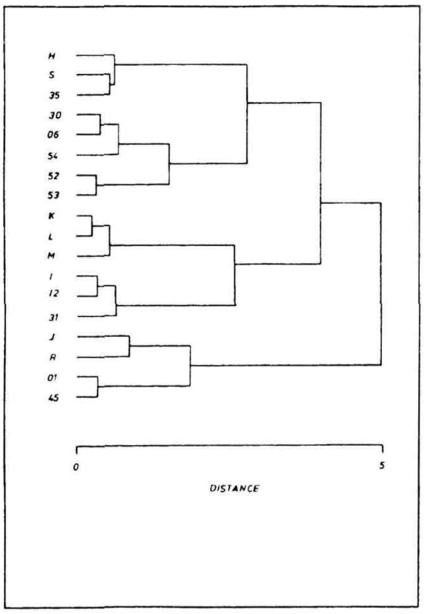
				Ottertrawl					
station	water depth [m]	temperature [°C]	oxygen [%]	species richness	B [g/m2]	A [n/m2]	P [g/m2]	dA	dP
gsnH2	23,0	27	100	20	0,6692	0,0019	0,1088	0,1472	0,1082
I1	261,5	13	3	16	0,0791	0,0018	0,0232	0,1195	0,2648
I(2)1	235,0	13	2	9	0,8518	0,0244	0,3031	0,2816	0,1568
I(2)2	210,0	13	2	21	0,0360	0,0006	0,0098	0,3313	0,3211
J1	52,5	20	45	21	0,7552	0,0020	0,1069	0,1562	0,3944
K1	53,8	20	28	8	0,2031	0,0101	0,0889	0,7416	0,7768
L1	194,0	16	0	6	0,0575	0,0072	0,0249	0,3059	0,2332
M1	122,8	16	5	13	0,2961	0,0127	0,1199	0,3356	0,4635
M2	82,0	16	8	15	0,1781	0,0004	0,0294	0,1105	0,1975
R1	20,1	26	80	15	0,0364	0,0003	0,0077	0,0865	0,1795
S1	21,3	26	80	19	0,2373	0,0009	0,0464	0,0852	0,1439
gsn06/1	43,7	19,5	50	20	2,8793	0,0136	0,4996	0,1611	0,5176
gsn06/2	44,0	19,5	50	22	0,9941	0,0053	0,1425	0,1470	0,1751
gsn30/1	31,5	22	50	23	1,8418	0,0117	0,2642	0,1291	0,1831
gsn31/1	22,7	28	90	34	0,3418	0,0071	0,0882	0,2292	0,1014
gsn31/2	22,0	26	80	39	2,1915	0,0126	0,3635	0,3172	0,0676
gsn35/1	14,5	26	70	19	1,6863	0,0128	0,3905	0,1608	0,1650
gsn45/1	13,2	29	75	33	18,0702	0,1185	2,2856	0,2457	0,1968
gsn45/2	18,0	7	50	29	0,6006	0,0277	0,1480	0,6423	0,1482
gsn52/1	97,7	15	10	27	0,6569	0,2100	0,2067	0,2967	0,1143
gsn52/2	109,0	14,5	10	19	0,1178	0,0045	0,0438	0,2153	0,4752
gsn53/1	80,0	14	10	27	0,3091	0,0369	0,0662	0,2111	0,1842
gsn53/2	80,0	14,5	18	30	0,2698	0,0049	0,0637	0,2462	0,1667
gsn54/1	199,0	12	5	8	0,1505	0,0088	0,0645	0,8449	0,5619
gsn54/2	239,0	12	2	25	0,5086	0,0040	0,1187	0,1946	0,4408

A. Beamtrawl station cluster. left: leg 1, right: leg 4





B. Ottertrawl station cluster. left: leg 1, right: leg 4



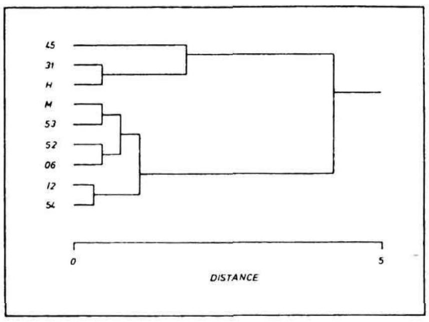
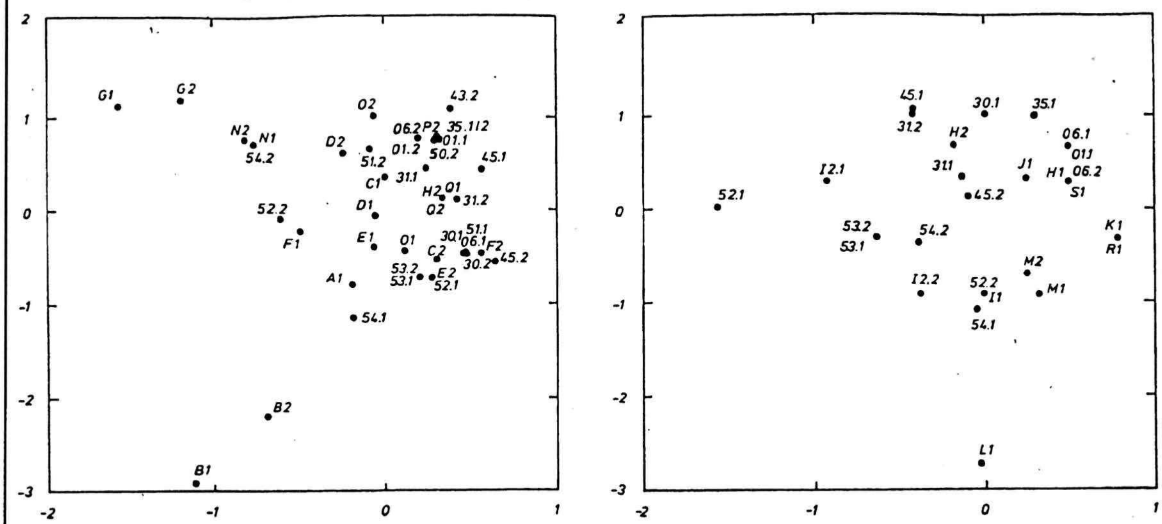
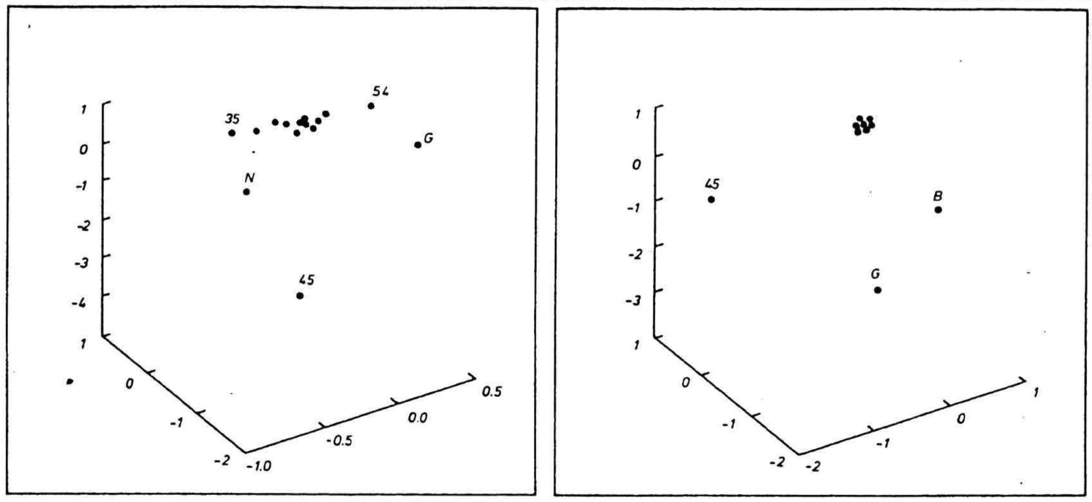


Fig.2.1. Fish. Beamtrawl (A)- and Ottertrawl (B) station clusters (left: leg 1, right: leg 4)

A: 2D-MDS - plots. left: beamtrawl stations, right: ottertrawl stations



B: 3D-MDS - plots. Beamtrawl stations (left: leg 1, right: leg 4)



C: 3D-MDS - plots. Ottertrawl stations (left: leg 1, right: leg 4)

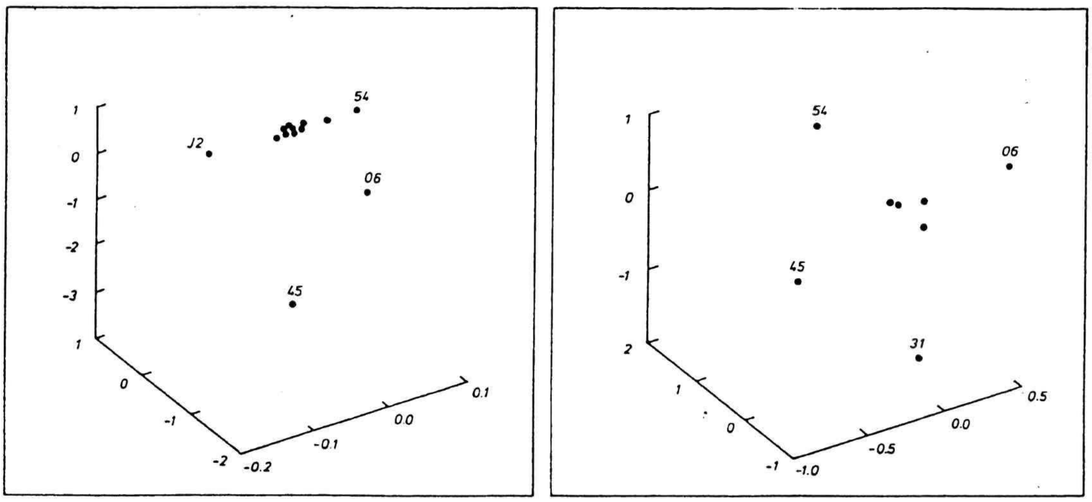


Fig.2.2 Fish. A: 2D - MDS- plots for beamtrawl (left) and ottertrawl (right) stations asa derived from the station parameter table 1; B: 3D- MDS-plot of the beamtrawl stations (left:leg 1; right: leg 4); C: 3D-MDS-plots of the ottertrawl stations (left:leg 1; right :leg 4)

The 3D- MDS plots established from the reduced station/species matrix from the beamtrawl and otter trawl samples exhibit the following pattern:

(1) station 45 (inner part of Golfo de Nicoya) is separated from the other station points in all plots; (2) the deep water stations outside the golf systems (54, G, I2) are also separated in all plots; (3) the anoxic station B (Golfo Dulce) is separated from the other points in the beamtrawl plot of the fourth leg. In both ottertrawl plots, station 06 (center part of Golfo de Nicoya) is also separated from the rest.

Characteristic species for station groupings

When looking for characteristic species of high biomass and abundance of these station groupings (consulting appendix A), the following table can be derived: It is shown, that some species are abundant in all or most of the station groups (e.g. Symphurus spp., Cynoscion spp.) while others are rather characteristic for just the stations grouped (Hemanthias spp. and Pontinus sierra for the deep stations, Arius spp. for the shallow stations of the Golfo de Nicoya and Bollmania spp. for the shallow stations in the Golfo dulce and Sierpe-Terraba areas).

Table 2. 4. Characteristic fish species of station groups derived from cluster analysis and MDS-plots (see text)(species in bold seem to be very typical for the group)

group A	*group B*	*group C*	group D	group E
deep: St. 54, G, N, I	anoxic basin: B,L	shallow Golfo de Nicoya: st.43,45,01	central Golfo de Nicoya: 35,30,06	Golfo dulce, Sierpe-Terraba: C,D,K,E,A,M,H,F,J.O. P.S.R.
Symphurus spp.	Cynoscion spp.	Dasyatis longus	Cynoscon spp.	Symphurus spp.
Hemanthias signifer	Porychthys spp.	**Arius spp.**	Diapterus spp.	Cynoscion spp.
Pontinus sierra		Neopisthopherus tropicus	Selene peruviana	Diplectrum spp.
		Paralonchurus dumerilli	Trachinotrus paitensis	Dasyatis longus
		Pomadasys leuciscus	Symphurus spp.	**Bollmania spp.**
		Rhinobathis leucorhynchus	Anchoa spp.	Porychthys spp
		Cynoscion spp.	Cyclopsetta querna	Mustrellus danulatus
		Anchoa spp.	Synodus spp.	Cyclopsetta spp.

Additional comments

Our collections referred to above are bottom trawl collections and most fish and invertebrate species caught are demersal. However,when the trawls were lowered to the sea bottom and lifted after sweeping the bottom, some pelagic fish and invertebrates were caught as well, which means that not all species caught can be considered as demersal.

In the Golfo dulce area, were the fish biomass was clearly much less than in the Golfo de Nicoya area, extensive shoals of very dense pelagic tuna-like fish were seen at the surface, representing an enormous fish biomass that was not quantified during the survey.

2. Crustacea *

Due to the lack of appropriate identification keys and time constraints, only the penaeid shrimps were identified down to species level. The caridean shrimps were grouped to the family level. The brachyuran and anomuran crabs were pooled within the category "crabs" as their further identification to lower taxonomic levels was as yet not possible. As a preliminary step towards the data analysis, the above mentioned groups (penaeids as species, caridean shrimps together and brachyuran and anomuran crabs as another group) were used for cluster analysis and MDS as described above. For the further data elaboration, only the groups shrimps, stomatopods and crabs were used. According to (Warwick, 1988) such coarse taxonomic levels for sample groupings in the multivariate analysis of macrofauna might sometimes give better results than finer taxonomic resolution and might well be justified.

1. Beamtrawl

A total of 7053 specimens (0,1539 n/m^2), weighing 20,44 kg (0,4459 g/m^2), was collected in the three study areas.

Table 2.5. Relative abundance (A), biomass (B) and production (P) of the groups shrimps, crabs and stomaotopods in the areas Golfo de Nicoya, Sierpe-Terraba and Golfo dulce (all stations/ area combined)

Study area	shrimps (%)			crabs(%)			stomatopods(%)		
	A	B	P	A	B	P	A	B	P
Golfo Dulce	35	41,1	40	64.8,	56,3	59,1	0.4,	2.6	1.4
Sierpe-Terraba	53,9	39,8	43,2	41,7	44,1	47,5	4.5	16,2	9,3
Golfo de Nicoya	79,1	62,2	66,5	18,9	34,2	30,4	2.0,	3.6	3,1

Golfo Dulce (GD)

A total of 2197 specimens (0,1757 n/m^2) weighting 9,789 kg (0,7831 g/m^2) was collected in the Golfo Dulce area. When station G is excluded because of its location outside the gulf, only 414 individuals (0,0331 n/m2) with a biomass of 6,169 kg (0,4935 g/m2) remain. Within the gulf, crabs represent the group of the highest number of individuals (0,1137 n/m2), followed by shrimps (see Table 2.5). The stomatopods which were found only at two sampling sites showed the lowest relative abundance (0,36 %) and biomass (2,63 %). The "production" values calculated show the same pattern.

When comparing the sampling sites, highest relative abundance of crabs occur at station G (83,1 %) outside the gulf followed by station D with 10,4 % (Table 2.6). The other stations remain under 5 %. The shrimps show a similar pattern, but on station C shrimps were more abundant then on station D. Stomatopods were only found at station D and F in similar quantities. The distribution of relative biomass corresponds to that of abundance at station G. At station D, only 2,81 % of the crab biomass and 2,28 % of the shrimp biomass was measured due to the occurrence of smaller and younger portunids and pinnotherids and the shrimp species *Sicyonia* sp., *Solenocera* sp. and *Trachypenaeus* sp. (hatchery area?). 10,46 % of all shrimp biomass was located at station C where a bulk of *Solenocera agassizii* was identified. Stomatopod biomass shows the same pattern as abundance.

*a preliminary crustacean species list derived from leg 1 is given by Mauricio Castro (UNA) in appendix III

For production again highest values for crabs (86,56 %) and shrimps (94,82 %) were present at station G. Production at station D seems to be similar for crabs (4,09 %) and shrimps (3,51 %) due to the same relationship of biomass and abundance. A higher production value for shrimps was found at station C, which corresponds to the high biomass of Solenocera agassizii.

Sierpe Terraba estuary (ST)

A total of 970 specimen (0,1164 n/m^2) weighing 2,967 kg (0,356 g/m^2) was found which is similar to the per-square-metre-value for the Golfo Dulce. In contrast to the GD-area, shrimps contain most individuals (53,91%) but not the highest biomass (39.8%), which is represented by the crabs instead (41,6 %). The high crab biomass is explained by the presence of some big specimen of Calappa sp. Stomatopods as a group are only little represented (4,5 %). However, their abundance is about twice as high as in the GD -area and its biomass proportion was the highest of all three study areas (16,2 %) (Table 2.5).

The comparison of the relative abundance at the various sample stations (along the depth gradient) does not reveal a clear pattern. Relative abundance of shrimps was highest at the stations O (100 m, 37,6 %) and P (50m, 41,98 %). N, the deepest open ocean station (200m) contained 9,16 % of the shrimps in this area , a similar quantity as the shallowest station Q (11,26 %). For further interpretation, the species structure must be analyzed. The values for N and Q were comparable to those of stations C and D within the GD area. Highest relative abundance of crabs was found at station N, followed by P (see Table 2.6). Q exhibits the lowest value with 3,97 %. Station O which lies between N and P on the depth gradient has only 12,16 % of relative abundance. Except for this station, an increase in the relative abundance of crabs along the depth gradient from the shallower to the deeper stations seems evident. Stomatopods occur only at station P and N with a clear preference for P (81,4 %).

The relative biomass of shrimps differs from the relative abundance: a linear increase in shrimp biomass along the depth gradient is apparent with a peak at station P(68,36 %). At this station, Penaeus californiensis and Sicyonia disdorsalis account for most of the biomass. Relative crab biomass increased continuously from station Q to N. The stomatopod biomass is almost equally distributed between station N (54,36 %) and station P (45,27 %). The production values reflect the distribution pattern of relative biomass for shrimps and crabs.

Golfo de Nicoya

A total of 3886 specimens (0,1554 n/m^2, which is five times as high as in GD excluding station G), weighting 7,68 kg (0,3072 g/m^2, which is a little beyond the value for GD) were collected. Shrimps represent the most important group in terms of relative abundance (79,13 %), biomass (62,19 %) and production (66,49 %). Crabs contain 18,86 % of all specimen in the gulf and their biomass proportion is even higher (34,22 %). The lowest percentage was calculated for the stomatopods with 2,01 % of relative abundance which is five times the GD-value and half of the ST-value. Relative biomass was twice as high as in GD but only one third of ST (Table 2.5).

The highest relative abundance of shrimps occurred at station 01, closely followed by the deeper stations 54 and 06. A second group in the inner and nearshore part of the gulf can be defined within the range 6 -12 %. Lowest values were found at the inner-most station 43 near Isla Chira, were the sea bottom continually falls dry, in Bahia Ballena and in the outer part of the gulf. Highest relative abundance of crabs occur at

Table 2.6. Distribution of biomass (B), abundance (A) and production (P) at all sample sites in the three study areas Golfo de Nicoya (GN), Sierpe-Terraba (ST) and Golfo Dulce (GD)

Golfo dulce - beamtrawl

	shrimps									crabs									stomatopods								
station	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)
C	58	0,0278	7,6	422	0,2025	10,46	247	0,1185	9,8																		
D	99	0,0475	12,9	92	0,0442	2,28	88	0,0424	3,5	148	0,071	10,4	155,7	0,0056	2,8	153,6	0,0737	4,1	4	0,0019	50	113,36	0,0544	53,22	46,0	0,0221	52,37
E	3	0,0014	0,4	0,46	0,0002		1	0,0004		28	0,0134	2,0	11,7	0,0072	0,2	14,8	0,0071	0,4									
F										53	0,0254	3,7	15,1	2,5711	0,3	21,3	0,0102	0,6									
G	602	0,2889	78,4	3517	1,6879	87,20	2176	1,0445	86,6	1181	0,5668	83,1	5356,8	0,0016	96,6	3561,3	1,7093	94,8	4	0,0019	50	100	0,048	46,95	41,9	0,0201	47,63
H	6	0,0029	0,8	1	0,0007	0,04	2	0,0009	0,1	11	0,0053	0,8	3,4	0,0016	0,1	4,8	0,0023	0,1									
total	768			4033			2514			1421			5543			3756			8			213			87,9		
% total	35,0			41,2			39,5			64,7			56,6			59,1			0,36			2,18			1,38		
mw	128			672			419			237			924			626			1,33			36			14,7		
stdv	236			1403			866			466			2376			1439			2,07			55,25			22,74001		

Sierpe Terraba - beamtrawl

	shrimps									crabs									stomatopods								
station	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)
N	48	0,0230	9,2	215	0,1033	18,2	135,2	0,0649	16,4	186	0,0893	46,2	675,79	0,3244	51,7	476,9	0,2289	52,7	8	0,0038	18,6	261,66	0,1256	54,63	103,1	0,0495	43,77
O	197	0,0946	37,6	134	0,0643	11,3	130,6	0,0627	15,9	49	0,0235	12,2	432,3	0,2075	33,1	240,2	0,1153	26,5									
P	220	0,1056	42,0	808	0,3878	68,4	527,8	0,2533	64,1	152	0,073	37,7	192,96	0,0926	14,8	180,8	0,0868	20,0	35	0,0168	81,4	216,85	0,1041	45,27	132,5	0,0636	56,23
Q	59	0,0283	11,3	25	0,0119	2,1	30,0	0,0144	3,6	16	0,0077	4,0	5,84	0,0028	0,5	7,7	0,0037	0,9									
total	524			1182			824			403			1307			906			43			479			235,6		
% total	54,0			39,8			41,9			41,6			44,0			46,1			4,43			16,13			11,99		
mw	131			295			206			101			327			226			11			120			58,9		
stdv	90			351			220			81			291			194			17			139			69,07368		

Golfo de Nicoya - beamtrawl

	shrimps									crabs									stomatopods								
station	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)
O1	659	0,3163	21,4	178	0,0852	3,7	253,8	0,1218	6,6	70	0,0336	9,6	178,56	0,0857	6,79	16,9	0,0081	7,86	9	0,0043	11,54	78,36	0,0544	0,0376	63,1	0,021	24,28
O6	470	0,2256	15,3	458	0,22	9,6	459,4	0,2205	11,9	26	0,0125	3,6	0,5	0,0002	0,02	9,0	0,0043	1,0	13	0,0062	16,67	113,27	0,0131	41,49	24,8	0,0303	35,03
30	266	0,1277	8,7	328	0,1576	6,9	308,4	0,148	8,0	6	0,0029	0,8	10,49	0,005	0,40	48,1	0,0231	0,5	19	0,0091	24,36	27,25	0,0002	9,98	0,4	0,0119	13,76
31	4	0,0019	0,1	1,49	0,0007	0,0	1,9	0,0009	0,1	47	0,0226	6,4	48,49	0,0233	1,84	66,3	0,0318	2,7	1	0,0005	1,28	0,37	0,0058	0,14	10,8	0,0002	0,23
35	376	0,1805	12,2	399	0,1913	8,3	389,8	0,1871	10,1	44	0,0211	6,0	76,96	0,0369	2,93	387,5	0,186	3,8	8	0,0038	10,26	12,11	0,0195	4,44	36,3	0,0052	6,01
43	170	0,0816	5,5	136	0,0654	2,9	144,4	0,0693	3,7	80	0,0384	10,9	694,53	0,3333	26,40	165,8	0,0796	22,0	27	0,013	34,62	40,58	0,0005	14,86	1,0	0,0174	20,12
45	199	0,0955	6,5	169	0,0809	3,5	176,1	0,0845	4,6	121	0,0581	16,5	186,23	0,0894	7,08	330,0	0,1584	9,4									
50	128	0,0614	4,2	133	0,0638	2,8	122,9	0,059	3,2	171	0,0821	23,4	420,72	0,2019	15,99	215,4	0,1034	18,7	1	0,0005	1,28	1,07	0	0,39	0,0	0,0005	0,58
51	48	0,023	1,6	24	0,0115	0,5	24,6	0,0118	0,6	88	0,0422	12,0	300,15	0,1441	11,41	146,9	0,0705	12,2									
52	241	0,1157	7,8	832	0,0007	17,4	572,8	0,2749	14,8	40	0,0192	5,5	237,64	0,1141	9,03	3,8	0,0018	8,3									
53	7	0,0034	0,2	1,47	1,0161	0,0	2,3	0,0011	0,1	3	0,0014	0,4	4,02	0,0019	0,15	235,9	0,1132	0,2									
54	508	0,2438	16,5	2117	1,0161	44,3	1405,1	0,6744	36,4	36	0,0173	4,9	472,51	0,2268	17,96	1764,3	0,8468	13,4									
total	3076			4777			3861			732			2631			3529			78			273			360,4		
% total	79,2			53,3			66,5			18,8			29,3			30,39			2,01			3,55			3,1		
mw	256			398			322			61			219			271			6,5			23			27,7		
stdv	209			591			594			49			219			465			9			37			50,36		

Golfo dulce - ottertrawl

	shrimps									crabs									stomatopods								
station	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)
H	2	0,000025	7,7	2,4	0,000030	1,3	2,3	0,000029	2,2	1,0000	0,000012	1,0	57,0	0,000704	1,2	19,1	0,000236	1,2	1	0,000012	100,0	14,9	0,000184	100,0	7,2	0,000089	100,0
I2	21	0,000259	80,8	145,7	0,001798	78,5	86,0	0,001062	81,1	77	0,000950	74,8	4689,6	0,057878	95,4	1546,0	0,019080	93,6									
M	3	0,000037	11,5	37,4	0,000462	20,2	17,7	0,000219	16,7	25	0,000309	24,3	167,0	0,002061	3,4	87,1	0,001075	5,3									
total	26			185,56			106,14			103			4913,56			1652,2			1			14,9			7,211225		
% total	20,0			3,6			6,0			79,2			96,1			93,6			2			0,9			1,2		
mw	9			62			35	0		34			1638			551	0		1			14,9			7,2	0	
stdv	11			75			45			39			2643			863											

Golfo de Nicoya - ottertrawl

	shrimps									crabs									stomatopods								
station	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)	A	A (n/m2)	rel. A (%)	B	B (g/m2)	rel. B (%)	P	P (g/m2)	rel P (%)
O6	144	0,001777	7,1	241	0,002978	4,6	356,8	0,004404	2,9	25	0,000309	6,5	431,05	0,00532	2,3	199,8	0,002466	9,1	29	0,000358	42,0	122	0,001505708	28,8	82,9	0,001023	34,3
31										15	0,000185		336,61	0,004154		145,3	0,001793										
45	309	0,003814	15,3	1405	0,017344	26,5	9249,0	0,114150	75,0	98	0,00121	25,3	949,17	0,011715	5,1	514,0	0,006344	23,3	31	0,000383	44,9	111	0,001369948	26,2	78,6	0,00097	32,5
52	117	0,001444	5,8	342	0,00422	6,5	229,9	0,002837	1,9	93	0,001148	24,0	15860,2	0,195744	85,2	737,3	0,00910	33,5	4	4,94E-05	5,8	45	0,000555384	10,6	23,6	0,000291	9,7
53	82	0,001012	4,0	222,31	0,002744	4,2	146,0	0,001802	1,2	12	0,000148	3,1	278	0,003431	1,5	119,0	0,001469	5,4	2	2,47E-05	2,9	23	0,000283863	5,4	11,9	0,000147	4,9
54	1374	0,016958	67,8	3085	0,038081	58,3	2357,9	0,029101	19,1	144	0,001777	37,2	765	0,009442	4,1	487,4	0,006016	22,1	3	3,70E-05	4,3	122	0,001505708	28,8	44,9	0,000554	18,6
total	2026			5296,4			12340			387			18620			2202,9			69			423			241,9		
% total	81,4			52,6			62,2			15,6			43,2			34,1			2,8			4,2			3,7		
mw	405			1059			2468			65			3103			367			14			85			48		
stdv	549			1236			3900			55			6255			250			15			47			32		

Bahia Herradura. The inner gulf stations and the hard-bottom-station 51 seem to form a group within a range of 9 to 16 %. Stomatopods were most abundant at stations 01, 06, 30 and 43, were relative abundance attains values up to 34 %. These stations were located along a longitudinal transect through the gulf. Stomatopods were not found in waters deeper then 40 m (Table 2.6). Highest relative shrimp biomass was found at the deep station 54 (44,32 %) followed by the nearby station 52 (17,42 %). Between 5 and 10 % of the biomass was found on the central stations, and less than 5% in the upper and lower part of the area. Highest crab biomass was found at the innermost station 43 near Isla Chira. Between 9 and 17 % of the crab biomass is distributed over the outer stations 50, 51, 52, 53 and 54, which as a group can be separated from the central stations which do not attain values > 7 %. The distribution of stomatopod biomass showed a somewhat irregular pattern. Highest values were found for the station 06 (41,49 %) followed by stations 01, 43 and 30 which represented the central and inner part of the gulf. The other stations showed values below 5 %. The stomatopods seemed to be generally widely distributed but no correlation to oceanographical conditions are apparent.

Production values for shrimps confirm the distribution pattern of biomass and abundance. Values were highest for shrimps at station 54 (36,39 %). Again the central and eastern stations fell in the range of 6 to 14 %, while the inner stations 43, 45, Bahia Ballena and the deeper near shore stations 50, 51, 53 in the lower part of the gulf contain > 5 % of the production values for shrimps. Production of crabs was highest at the innermost station 43 and at Bahia Herradura. The central part can be separated (below 5 %) from the rest of the stations. These results are contrary to those for the shrimps. The values for stomatopod production show the same pattern as for the biomass data.

2. Ottertrawl

A total of 2612 specimens (0,0036 n/m^2) weighing 15,21 kg (0,021 g/m^2) were collected in the three study areas. Referring to the total catch of ottertrawl and beamtrawl, only 0,1 to 9 % of biomass and abundance respectively are comprised by the otter trawl catches. Taking the beamtrawl as 100 %, the ottertrawl attained values between 0.3 and 3,2 % for abundance and 2.7 to 6,7 % for biomass at the various sample stations.

Comparing the shrimp catches of the ottertrawl with that of the beamtrawl in the GD, ST and GN areas, only 1,6 to 2.2 % of the specimens and biomass is represented by the ottertrawl in the first area, while 24,7 % of the specimen and 35,5 % of the

Table 2.7. Proportion (%)of biomass (B) and abundance(A) of crabs, stomatopods and shrimps in ottertrawl (Ot) and beamtrawl (Bt) catches in the study areas Golfo Dulce, Sierpe-Terraba and Golfo de Nicoya.

	Shrimps		Crabs		Stomatopods	
Area	Ot	Bt	Ot	Bt	Ot	Bt
Golfo Dulce						
Abundance (%)	2,2	97,8	3,9	96,1	8,5	91,5
Biomass(%)	2,7	97,3	38,9	61,1	4,9	95,1
Golfo de Nicoya						
Abundance (%)	24,7	75,3	20,9	79,1	30,5	69,5
Biomass(%)	35,5	64,5	45	55	43,4	56,6
Sierpe-Terraba						
Abundance (%)	0,6	99,4	5,8	94,2	0	100
Biomass(%)	3	97	11,2	88,8	0	100

biomass in the latter. This indicates larger average sizes of shrimps in the GN area when compared to the GD areas.

The same holds for the stomatopods. In the GD only 3.3 to 5.8 % of the specimen were caught by the ottertrawl. In the GN-area approximately one third of specimens and of the biomass was collected by the ottertrawl (see Table 2.7)

For crabs a different picture emerges: In the GD area 3.4% of the abundant specimen are sampled but more than one third of the biomass. In GN 20,9 % of specimens and up to half of the biomass is caught by the ottertrawl.

Multivariate analysis

3D - MDS - plots were drawn with the Crustacean data from the station parameter table 1 but are not included here, as they did not show any reasonable station groupings. This can be attributed to the fact that the station descriptors 'species richness'

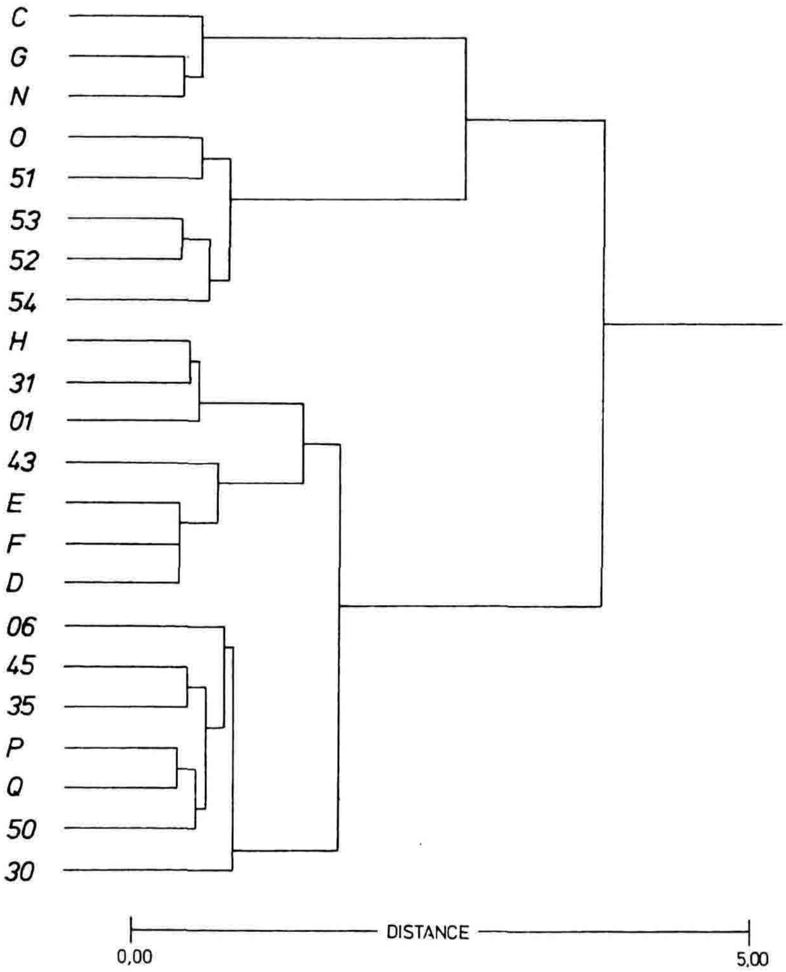


Fig. 2.3. Crustacea. Station clusters for beamtrawl (C) catches as derived from a species/station matrix

and 'dominance' (used for fish) could not be calculated for the crustacean data. The cluster diagram for the beamtrawl collections as derived from the species-station matrix is shown in Fig. 2.3.

The beamtrawl tree-diagram shows two big cluster, the first being composed of the deeper GN-sand shelf -edge stations, the second of the inner and central GN-stations, the nearshore GD-stations and the estuarine ST-stations.

The first cluster is subdivided into the following three groups: 1) the 3 deep GN- stations (>80m) 52,53,54 which share the shrimps species Sicyonia picta, Solenocera mutator, some palaemonid shrimps and some majid crabs; 2) the shelf edge station G outside the GD-area, the deep (200m) station N of the ST-area and station C from inside the GD. The position of the latter shallow station C in this group is surprising, but when looking at the species collected, it is shown that the shrimp Solenocera agassizii was common on all of the three stations. Siconya picta and Munida sp. are other species characteristic for this group. 3) the 100m- station O of the ST-area and the station 51 of the GN-area. Here, Sicyonia picta, Sicyonia disdorsalis, some majid crabs and many anomuran crabs are abundant. This species composition resembles that of the first group, but the biomasses of Sicyonia sp. and majid crabs is much lower.

The second cluster can also be divided into three groups: the first being composed of the central stations of the GN-area (06,45,35 and 30), Bahia Herradura (50) and the nearshore ST-stations P and Q. On these stations, which according to Epifanio et..al (1980) are characterized by high concentrations of nutrients and strong water currents, shrimps (Sicyonia disdorsalis and Trachypenaeus sp.) are abundant as well as stomatopods (except for st. Q) and portunid and majid crabs.

The second group is made of the st. 43 (innermost st. of GN), the GD inner st. D and E and the st. F. The grouping of the latter station is difficult to understand as neither its oceanographical characteristics nor its species composition resembles much that of the other stations of the group. The other stations of this group are all strongly influenced by riverine water and had high abundances of the shrimps Sicyonia disewardsii (GD) and Trachypeneus sp. St. 43 had -compared to the other stations-, a very high biomass of crabs.

The third group is made of the GN station 01 (central part), the shallowest GD station H and the st. in Bahia Ballena (GN). The interpretation of this group is difficult until the species are identified. Only in this station group occurred the shrimp Trachypeneus faoe, but also the widely distributed Sicyonia disdorsalis.

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3. *Infaunal communities (R. Cordoba & J. Vargas)*

Intoduction and objectives

Benthic research in the Gulf of Nicoya has focused primarily on the description of structural aspects of communities (variation in space and time of the number of inividuals and species). Some findings from previous subtidal research are: a total of 56000 individuals belonging to 98 species was collected in trawl samples from 17 stations. Decapod crustaceans were the dominant taxon, with 54 species (Maurer et al., 1984). Smith-McIntyre grab samples taken at 42 stations yielded 4684 individuals annd 205 species of macrofauna, of which polychaete worms were represented by 120 species, followed by crustaceans (46 spp.), and molluscs (22 spp.). Maximum density was 8744 individuals per meter square, and maximum diversity (H`) was 3.09, which was not as high as expected for a tropical estuary (Maurer & Vargas, 1984). Recent efforts have focused in intertidal mud flats, and in taxonomic studies, particularly on relatively small groups such as cumaceans, brachiopods, and sipunculans (Vargas, 1994). The Gulf of Nicoya is also an estuary under fast coastal zone development. Thus, the need to conduct a detailed evaluation of the benthic communities, to serve as a comparison with that conucted in 1979-1980 (Maurer & Vargas, 1984), increased in importace over the years, and was included in the FS Victor Hensen cruises.

In marked contrast with the information available for the benthic communities in Gulf of Nicoya, there is only a published report on the subtidal benthos of Golfo Dulce. This study, conducted by Nichols-Driscoll (1976), clearly established that below 100 meters, sediments were azoic. The fauna of shallower waters was dominated by the polychaete Paraonis lyra. The total number of species collected with a Van Veen grab was closed to 75. This grab produces a shock wave and operates poorly in hard sediments. These facts might have influenced the low number of species found. Thus, the opportunity to use a box-corer, which collects relatively undisturbed samples in all kinds of sediments, was regarded as unique to conduct a detailed evaluation of the Golfo Dulce benthic community, and to compare the results with Nichols-Driscoll (1976) survey.

Mangrove ecosystems are a key component of the coastal vegetation in both the Gulf of Nicoya and Golfo Dulce. However, the most extense mangroves are located on the Sierpe-Térraba region. Thus, it was considered appropriate to evaluate the compositon and distribution of benthic communities along an offshore transect originated at the mouth of the Térraba river, perpendicular to the coast, and passing north of Caño Island, also a place of bilogical interest due to the existence of fringing coral reefs. No previous information is available on the nature of the benthic communities of the Sierpe Térraba transect, except for a basic description of meiofauna near Caño Island.

Table 3.1. Box-corer sampling for macrofauna in the Gulf of Nicoya (GN), Golfo Dulce (GD) and the Sierpe-Térraba sites (ST).

STATION	LAT./LONG.	DATE OF SAMPLING		SAMPLING DEPTH (m)	NUMBER OF BOX-CORER	NUMBER OF SUBSAMPLES
GD-01	08°42N / 083°24W	Dec. 08-93		200	3	15
GD-03	08°35N / 083°16W	Dec. 08-93		200	3	15
GD-07	08°39N / 083°24W	Dec. 08-93		100	3	15
GD-08	08°43N / 083°29W	Dec. 08-93		50	3	15
GD-09	08°39N / 083°26W	Dec. 08-93		43	3	15
GD-11	08°27N / 083°13W	Dec. 07-93		75	3	15
GD-12	08°21N / 083°14W	Dec. 09-93		200	2	10
GD-24	08°20N / 083°14W	Jan. 24-94	(2416)*	200	3	18
GD-26	08°23N / 083°14W	Jan. 24-94	(2417)	100	3	21
GN-01	09°57N / 084°53W	Dec. 05-93		50	3	15
GN-06	09°45N / 084°46W	Dec. 04-93		50	3	15
GN-26	09°52N / 084°53W	Feb. 03-94		13	3	15
GN-30	09°51N / 084°46W	Dec. 05-93		35	3	15
GN-31	09°43N / 084°57W	Dec. 02-93		28	3	15
GN-35	09°56N / 084°46W	Dec. 05-93		18	3	15
GN-45	10°03N / 085°00W	Dec. 05-93		8	3	15
GN-46	10°02N / 084°57W	Feb. 02-94		15	2	15
GN-50	09°38N / 084°41W	Feb. 05-94		45	1	12
GN-51	09°38N / 085°00W	Dec. 03-93		72	3	15
GN-52	09°36N / 084°50W	Dec. 03-93		100	3	15
GN-53	09°34N / 084°43W	Dec. 04-93		87	3	15
GN-54	09°33N / 084°50W	Dec. 03-93		260	3	15
ST-01	08°47N / 084°04W	Dec. 06-93		200	3	15
ST-02	08°47N / 084°01W	Dec. 06-93		100	3	15
ST-03	08°47N / 083°46W	Dec. 06-93		50	3	15
ST-04	08°47N / 083°42W	Dec. 06-93		20	3	15
ST-23	08°31N / 083°54W	Jan. 23-94	(2414)	200	3	21
ST-24	08°30N / 083°57 W	Jan. 23-94	(2415)	500	3	21
ST-28	08°29N / 084°01W	Jan. 25-94	(2419)	1150	3	21
ST-29	08°47N / 084°12W	Jan. 25-94	(2420)	510	3	21
ST-30	08°47N / 084°17W	Jan. 26-94	(2421)	1000	1	7
1. Gulf of Nicoya: Bahia Ballena transect (TBB)						
TBB-10	09°44 N/085°00W	Feb. 04-94		10	1	16
TBB-20	09°44 N/085°00W	Feb. 04-94		20	1	12
TBB-30	09°43N/084°59W	Feb. 04-94		30	1	6
TBB-40	09°43N/084°59W	Feb. 04-94		40	1	12
TBB-50	09°42N/084°58W	Feb. 04-94		50	1	16
2. Golfo Dulce: Bahía Rincón-Río Esquinas transect (TGD)						
TGD-R	08°42N/083°28W	Feb. 08-94		50	1	25
TGD-R	08°42N/083°28W	Feb. 08-94		100	1	14
TGD-R	08°42N/083°27W	Feb. 08-94		150	1	7
TGD-R	08°42N/083°25W	Feb. 08-94		200	1	7
TGD-E	08°42N/083°24W	Feb. 08-94		150	1	7
TGD-E	08°43N/083°21W	Feb. 08-94		100	1	7
TGD-E	08°43N/083°21W	Feb. 08-94		50	1	7
3. Golfo Dulce: in front of Corcovado National Park (GCD)						
GCD-27	08°24N/83°35W	Jan.24-94	(2418)	200	2	14
TOTAL		44 stations			101	632

Material and methods

The present study was executed during the dry season (December, January, February) of 1993 and 1994. The study focused on the collection of sediment samples in three different environments on the Pacific coast of Costa Rica: the Gulf of Nicoya estuary, the Sierpe-Térraba offshore transect, and the Golfo Dulce anoxic basin.

The first cruise was conducted in the Gulf of Nicoya, and comprised a total of fourteen stations. The second set of samples was collected along a transet perpendicular to the Sierpe-Térraba forest reserve in the Osa Peninsula, and comprised nine stations. The third set of samples was collected in Golfo Dulce, and comprised eleven stations (Table 3.1).

Samples were collected using a 50cm x 50cm x 50cm box-corer operated with the ship´s crane. Whenever possible, three box-corers were take at each station and a minimum of five subsamples collected from each one. Once on board, the box-corer was opened and subsamples taken with a plastic cylinder of 17,7cm^2 to a depth of 15cm into the sediment, in order to facilitate comparisons with previous benthic sampling in the region (Vargas, 1988).

Samples were stored in sealable polyester bags, preserved with 10% buffered formalin in sea water stained with Rose Bengal. Sediment samples, for granulometric characteristics and organic matter content were also collected with the plastic cylinder and kept frozen until analyses.

In the gulf of Nicoya the stations were deployed, in waters shallower than 60m, based on Maurer and Vargas (1984) sampling scheme. Additional stations were deployed at depths greater than 60m.

For the Golfo Dulce embayment the stations were deployed based mainly on Nichols-Driscoll (1976) scheme.

In the Sierpe-Térraba region, a transet was chosen as described above, and running from 20 to 1150m depth.

The location of sampling stations are included in Figure 1. the station code data of sampling depth, and number of subsamples taken are included in Table 1.

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4. Zooplankton (B. Hossfeld, H. Molina, & A. Morales)

Introduction

Among the biological components of aquatic ecosystems, the planktonic comunities play a major role in the cycling of biological matter. The term "Plankton" refers to an assemblage of organisms which are drifters rather than powerful swimmers; their horizontal distribution is determined by currents, not by their own swimming. The zooplankton represents the animal component of the plankton. It inhabits all layers of the ocean down to the greatest depth ever sampled (Vinogradov, 1970).

As a link between the lower (phytoplankton) and higher production levels (fish) the zooplankton fulfills a very important role within the trophic dynamics of the ocean (Vidal, 1980). Zooplankton is made up of many different taxa of at least two kingdoms: Protista and Animalia. The best known and most abundant group is represented by the crustaceans, mostly copepods. However, every major invertebrate phylum is represented, either as holoplanktonic animals (which spend their entire life cycle in the plankton) or the early stages of organisms that are benthic or pelagic as adults (most fish and invertebrates). The total amount (abundance and weight) of zooplankton may have drastic variations over seasonal and geographical scales and these fluctuations may have a great effect on the secondary production and trophic dynamics (Raymont, 1983). In order to understand such dynamics, knowledge about the species composition and population structure of the zooplankton is required.

On the Pacific coast of Costa Rica, the Gulf of Nicoya and the Golfo Dulce are sheltered, low-energy, depositional estuarine environments of similar size, orientation and geographical outline. Whereas numerous studies have been carried out in the Gulf of Nicoya on its oceanography (Voorhis et. al., 1983), nutrients (Epifanio et. al., 1982), benthos (Maurer et al., 1984; de la Cruz & Vargas, 1987; Vargas, 1987, 1988) and fish (Price et al., 1980; Bartels et. al., 1983,1984), the coastal plankton has as yet received only little attention. Scattered reports are available on the phytoplankton distribution (Hargrave & Viquez, 1985), as well as on local phenomena of red tides (Hargrave & Viquez, 1981) and their impact on the distribution of dissolved oxygen in the bay (Gocke et al., 1990). In addition, studies about the copepods and chaetognaths composition in the Costa Rica Dome (Suarez & Gasca, 1989; Segura et al., 1992; Gasca & Suarez, 1992) and the zooplankton seasonality around Caño Island (Guzman & Obando, 1988) have been published.

Meroplankton has been studied as well. Epifanio & Dittel (1984) reported differences in the dominance of brachyuran larvae in the inner and outer parts of the Gulf. Taxonomy, distribution, abundance and composition of ichthyoplankton within the Gulf of Nicoya have been referred to in several studies (Lopez & Arias, 1987; Ramirez et al., 1989,1990), as well as in open waters off the Nicoya Peninsula (Rojas et al., 1991).

No studies on the holozooplankton have been published to date. However, Morales & Vargas (in press) provide a list of the copepods of the Gulf of Nicoya with notes about the distribution of the species within the eastern Pacific.

The publication record for the Golfo Dulce is by far worse; the only oceanographic account dates back to Richards et al., (1971). Cortes (1992) reports the situation of the coral reefs and recently Hartmann (in press) gives a complete review of the Golfo Dulce marine environment. Morales & Vargas (in prep.) discuss the copepod composition within the bay and give some notes on the its distribution in the eastern Pacific.

In this report we present preliminary data about the zooplankton composition in the areas of Gulf of Nicoya, Sierpe-Terraba and Golfo Dulce. In addition we give data on the zooplankton wet volume for different size fractions of the plankton.

Objectives

The objectives of the plankton survey were twofold: 1) to determine the abundance and biomass of the plankton groups (a) Copepods (200µ-fraction) , (b) Chaetognaths (300µ-fraction) and (c) Ichthyoplankton (500µ and 1000µ-fractions) in the three study areas Golfo de Nicoya, Sierpe-Terraba and Golfo Dulce along a depth gradient from shallow (20m) to deeper offshore (200m) waters; 2) to describe and compare the plankton communities in the study areas in relation to oceanographical conditions and water depth.

Material and methods

Zooplankton surveys were conducted during leg 1 (December 2-9, 1993) and leg 4 (February 2-9, 1994) along the Pacific coast of Costa Rica. Each leg included the three study sites: Gulf of Nicoya, Sierpe-Terraba and Golfo Dulce (Table 4.1, Fig. 4.1).

The station locations followed previous studies of Voorhis et al. (1983) for the Gulf of Nicoya, and Richards et al. (1971) for Golfo Dulce. No previous plankton studies had been done in the Sierpe-Terraba region. Here, a 4-station transect was set perpendicular to the coast (see Fig.4.1).

At each station, 2 bongo (60 cm net opening, 250 cm net length) hauls were performed with a pair of nets; one set was done with 300µ and 200 µ nets (for copepod and chaetognath samples respectively) and the other with 500µ and 1000µ nets for ichthyoplankton of different size ranges. A "Hydrobios" flowmeter was attached to the mouth of each net.

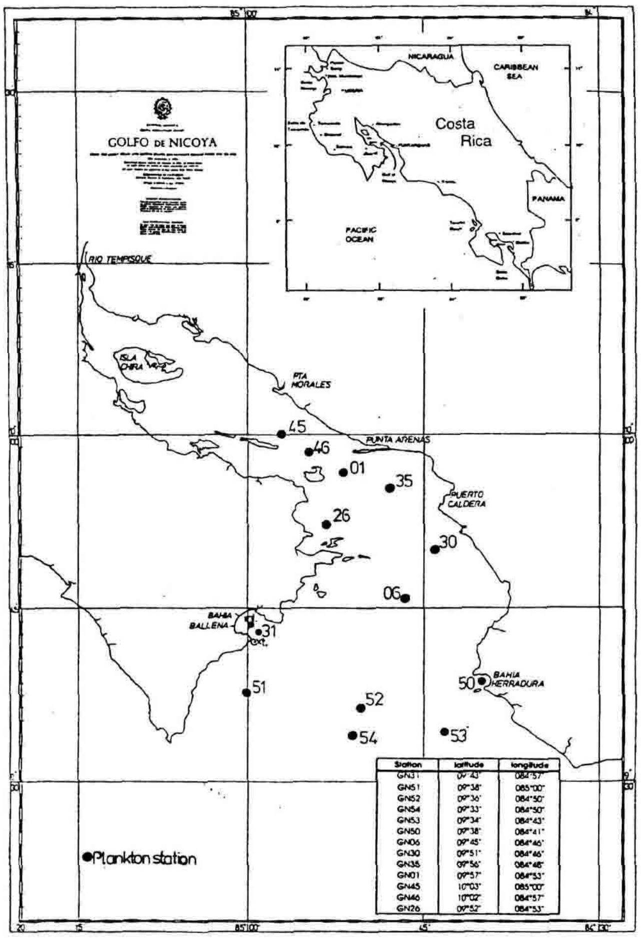
Oblique hauls were done from the surface to the ground at a towing speed of approx. 1.5 knots. Towing time varied between 5 and 10 min, depending on the water depth. The towing depth (and the required length of wire) was determined by a clinometer.

After each haul, the plankton net was washed with seawater to concentrate the plankton into the bucket at the cod end of the net. Thereafter, the plankton was washed with seawater out of the bucket into a strainer before it was transferred into a 1-l kautex bottle.

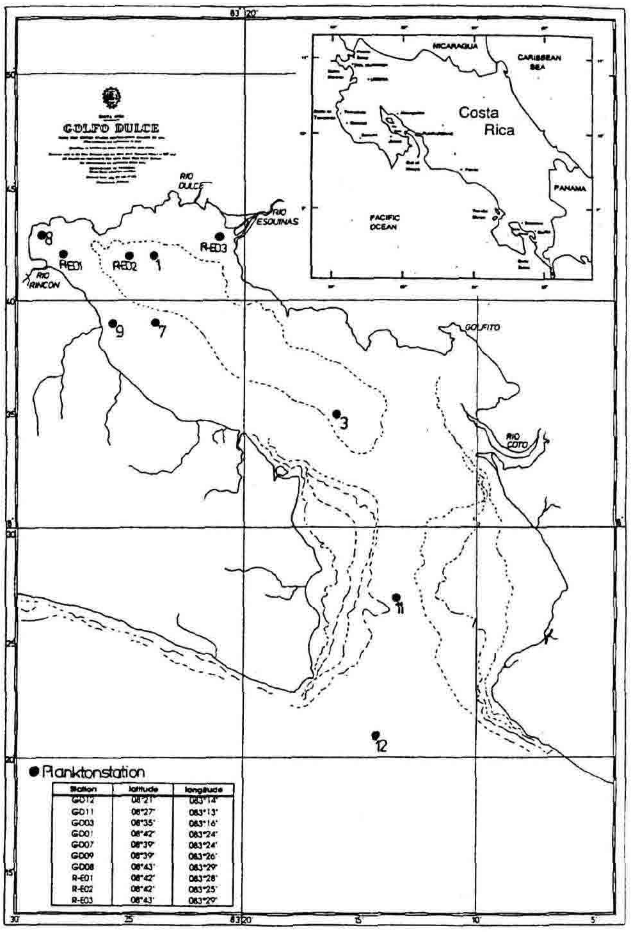
For fixation, 100ml of comercial formaldehyde (40%), buffered with borax (2g at 98 ml formaldehyde), was added to the 3/4 filled Kautex bottle, which was then filled to the top with sea water to arrive at a concentration of 4% formaline.

After three months, the samples were transferred into a preservation solution descri-

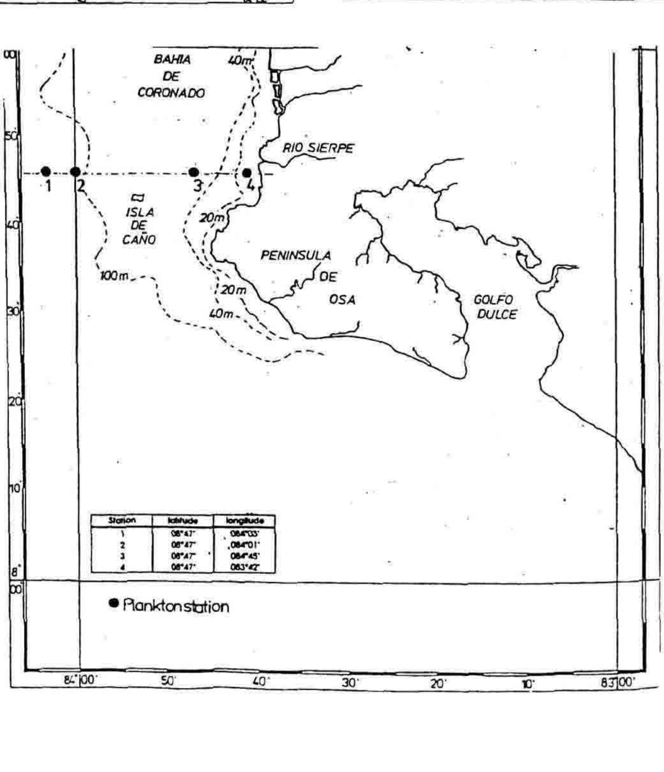
Fig. 4.1. Plankton stations during the Victor Hensen survey (for details see Table 4.1)



Station	latitude	longitude
GN31	09°43'	084°57'
GN51	09°38'	085°00'
GN52	09°36'	084°50'
GN54	09°33'	084°50'
GN53	09°34'	084°43'
GN50	09°38'	084°41'
GN06	09°45'	084°46'
GN30	09°51'	084°46'
GN35	09°56'	084°48'
GN01	09°57'	084°53'
GN45	10°03'	085°00'
GN46	10°02'	084°57'
GN26	09°52'	084°53'



Station	latitude	longitude
GD12	08°21'	083°14'
GD11	08°27'	083°13'
GD03	08°35'	083°16'
GD01	08°42'	083°24'
GD07	08°39'	083°24'
GD09	08°39'	083°26'
GD08	08°43'	083°29'
R-E01	08°42'	083°28'
R-E02	08°42'	083°25'
R-E03	08°43'	083°29'



Station	latitude	longitude
1	08°47'	084°03'
2	08°47'	084°01'
3	08°47'	084°45'
4	08°47'	083°42'

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
GN31	09°43N / 084°57W	02.12.1993	13:33	35	54	8	high	SW 1/2
GN51	09°38N / 085°00W	03.12.1993	09:31	50-55	62	11	high	E 3
GN52	09°36N / 084°50W	03.12.1993	13:05	80	100	10	high	SE 3
GN54/8	09°33N / 084°50W	03.12.1993	15:31	200	250	8	high	SSE 2/still
GN54/9	09°33N / 084°50W	03.12.1993	15:56	150	270	8	high	SSE 2/still
GN53	09°34N / 084°43W	03.12.1993	06:00	60	80	9		N 2
GN06	09°45N / 084°46W	03.12.1993	17:10	30-35	45	4	high	1./2
GN30	09°51N / 084°46W	04.12.1993	06:31	25-30	35	5	low	SO 1/2
GN35	09°56N / 084°48W	04.12.1993	09:10	13	17	6	low	S 2
GN01	09°57N / 084°53W	04.12.1993	11:35	30	48	2	low	S 2
GN45	10°03N / 085°00W	04.12.19933	14:21	3,0	6	1	high	1

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
ST01	08°47N / 084°03W	06.12.1993	06:05	110	165	20	low	SW 2
ST02	08°47N / 084°01W	06.12.1993	09:34	80	100	17	low	SW 2
ST03	08°47N / 084°45W	06.12.1993	12:35	40	53	9	low	W 1
ST04	08°47N / 083°42W	06.12.1993	14:40	18	20	5	high	W 1/2

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
GD12	08°21N / 083°14W	07.12.1993	07:05	145	200	7	high	1
GD11	08°27N / 083°13W	07.12.1993	14:22	35	65	5	mid	SW 3
GD03	08°35N / 083°16W	07.12.1993	16:47	145	190	4	high	W 3
GD01	08°42N / 083°24W	08.12.1993	08:24	150	200	8		still
GD07	08°39N / 083°24W	08.12.1993	11:19	80	94	4,5		still
GD09	08°39N / 083°26W	08.12.1993	13:40	30	48		low	2
GD08	08°43N / 083°29W	08.12.1993	07:39	65	100	7,5		still

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
GN46	10°02N / 084°57W	02.02.1994	11:33	10	16		low	NE 4
GN26	09°52N / 084°53W	02.02.1994	13:39	10	14	2,5	mid	S 3/4
GN35	09°55N / 084°47W	03.02.1994	06:27	10	14		high	S 4
GN31 int.	09°43N / 085°00W	03.02.1994	06:43	10	15	8	high	W 2
GN31 ext.	09°42N / 084°58W	04.02.1994	12:36	40	50	9	low	E 2
GN 51	09°38N / 085°00W	05.02.1994	06:53	50	65		high	NE 5/6
GN52	09°36N / 084°50W	05.02.1994	09:28	70	110		high	NE 5
GN54	09°33N / 084°50W	05.02.1994	10:39	180	300		low	1
GN50	09°38N / 084°41W	06.02.1994	06:43	35	44		high	1
GN53	09°34N / 084°43W	06.02.1994	08:09	70	84	9,5	high	1

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
ST01	08°47N / 084°04W	07.02.1994	07:18	120	280	17,5	high	1
ST02	08°47N / 084°01W	07.02.1994	08:57	85	100	20	high	still
ST03	08°47N / 083°46W	07.02.1994	11:50	48	55	24	low	1
ST04	08°47N / 083°42W	07.02.1994	12:53	19	27		low	1

Station	Position lat. / long.	Date	Time LT	Depth of haul (m)	Echo-Depth (m)	Secchi-depth (m)	Tide	Wether Wind/Sea
GD12	08°21N / 083°14W	08.02.1994	06:26	140	205	5,5	high	NW 1
GD11	08°27N / 083°13W	08.02.1994	08:28	55	70	10,5	high	N 2
GD03	08°35N / 083°16W	08.02.1994	10:44	160	190	10	high	1
R-E001	08°42N / 083°28W	08.02.1994	13:29	30	40	6	low	SE 3
R-E002	08°42N / 083°25W	08.02.1994	16:53	160	199		low	E 1/2
R-E003	08°43N / 083°21W	09.02.1994	10:01	45	57		high	still
GD08	08°43N / 083°29W	09.02.1994	06:16	25	41		high	still

Table 4.1. Description of plankton stations during the Victor Hensen survey

bed in Steedman (1970).

The wet volume of the plankton samples was determined in 1000-ml sedimentation funnels.

Copepods and ichthyoplankton samples are still further processed at CIMAR, UCR, and the Chaetognaths at the ZMT /Bremen

Preliminary results and discussion

4.1. Chaetognaths (size fraction 300µ)

Gulf of Nicoya

During the December survey (leg 1), chaetognath number and plankton volume were higher at the stations of the inner gulf (6,30,35,1,45) than outside the gulf (51,52,54,53 (see Fig. 4.2). The highest numbers and biomasses were found at stations 35 and 1 (up to 250 ind/m^3). At the innermost station 45 (6m) only about 20% of the chaetognath number of st.35 was found, although plankton volumes were similar. In February (leg 4), the plankton volume at the outer stations was much higher than in December and exceeds that of the inner gulf stations. This can be attributed to the large numbers of salps and medusae found. Chaetognath number at the outer gulf stations did, however, not differ significantly from that in December. Towards the inner gulf, chaetognaths increase in numbers, a maximum of 308 ind/m^3 (the highest number of all stations in all areas) was found at station 46.

Sierpe -Terraba

Plankton volume was much smaller in December than in February. At the offshore st. 1(200m) plankton volume was lowest (0.37ml/m^3 in December and 0.65 ml/ m^3 in February). Towards the coast, plankton volume increases with highest values at st. 3 (0.69ml / m^3 in December and 3.45 ml/m^3 in February). The number of chaetognaths varies from 11 to 19 (ind/m^3) with no significant differences between the 4 stations. An Exception is st. 4 in February, when a high number of chaetognaths was found.

Gofo Dulce

During December, plankton volume was < 0.5ml/m^3 at all, except station 11. Interestingly, at st. 9 and 8 near Rincon Bay plankton volume was low but numbers of chaetognaths were high (63 and 50 ind/m^3 respectively). The chaetognaths are very small and seem to differ from those found at the st. 12 and 11 (which are much bigger (probably Sagitta enflata).At the deep anoxic station 3, very low numbers of Chaetognaths were found (<1 ind./m^3), but the plankton volume is higher than at st. 9 and 8). In February, the amount of plankton in the inner gulf is much higher than in December. Again, at the deep stations of the gulf (3,1,R-EO2), chaetognaths appear in very low quantities (1-8 ind./m^3). At the stations of Rincon Bay (R-EO1; 8) chaetognaths are more abundant (around 80/m^3).

It can be summerized from the foregoing that high chaetognath numbers (>100/m^3) were found in shallow coastal waters, with highest numbers of 248 and 308/m^3 . At the oceanic stations, chaetognaths appear at lower concentrations with numbers around 40 ind./m^3.

Further analysis to follow

Wet weight will be determined for the plankton samples and for the sorted chaetognaths of each subsample to get information about the zooplankton biomass and the chaetognath proportion of it. After finishing the identification of species, dry weight will also be determined. In addition, the abundance and distributiuon of chaetognaths in the three research areas will be presented in a map. The maturity stage will be determined for the different species and will be related to body length.

4.2. Ichthyoplankton (size fraction 500µ and 1000µ)

Gulf of Nicoya

The central and inner waters of the gulf (St. GN 035, GN 004, GN 045) contained great amounts of organic matter. The abundance of zoeas, megalopas, small shrimps, hydromedusae, as well as ichthyoplankton of the families Engraulidae, Sciaenidae and Gobiidae, suggests that this particular area is more influenced by estuarine waters. However, at St. GN 035 big amphipods were also found, wich may indicate the presence of oceanic waters as well.

The outer stations (GN 051, GN 052 and GN 053), were characterized by several species of amphipods (including Phronima), as well as fish larvae of a great variety of groups: Anguillifrom leptocephali (Ophichthidae and other families), Carangidae, flatfish larvae (Symphurus and species of other families, Trichiuridae, Bregmacerotidae (Bregmaceros batymaster). Gobiscocidae, Sphaeroides, and other groups not identified yet.

Sierpe- Terraba Region

The larval fish of the open waters of this area were typical oceanic forms. In these samples, the great abundance of Anguilliform leptocephali and Trichiurid larvae was the most common feature.

Golfo dulce

Concerning the ichthyoplankton assemblage, many of the Golfo Dulce stations anali-

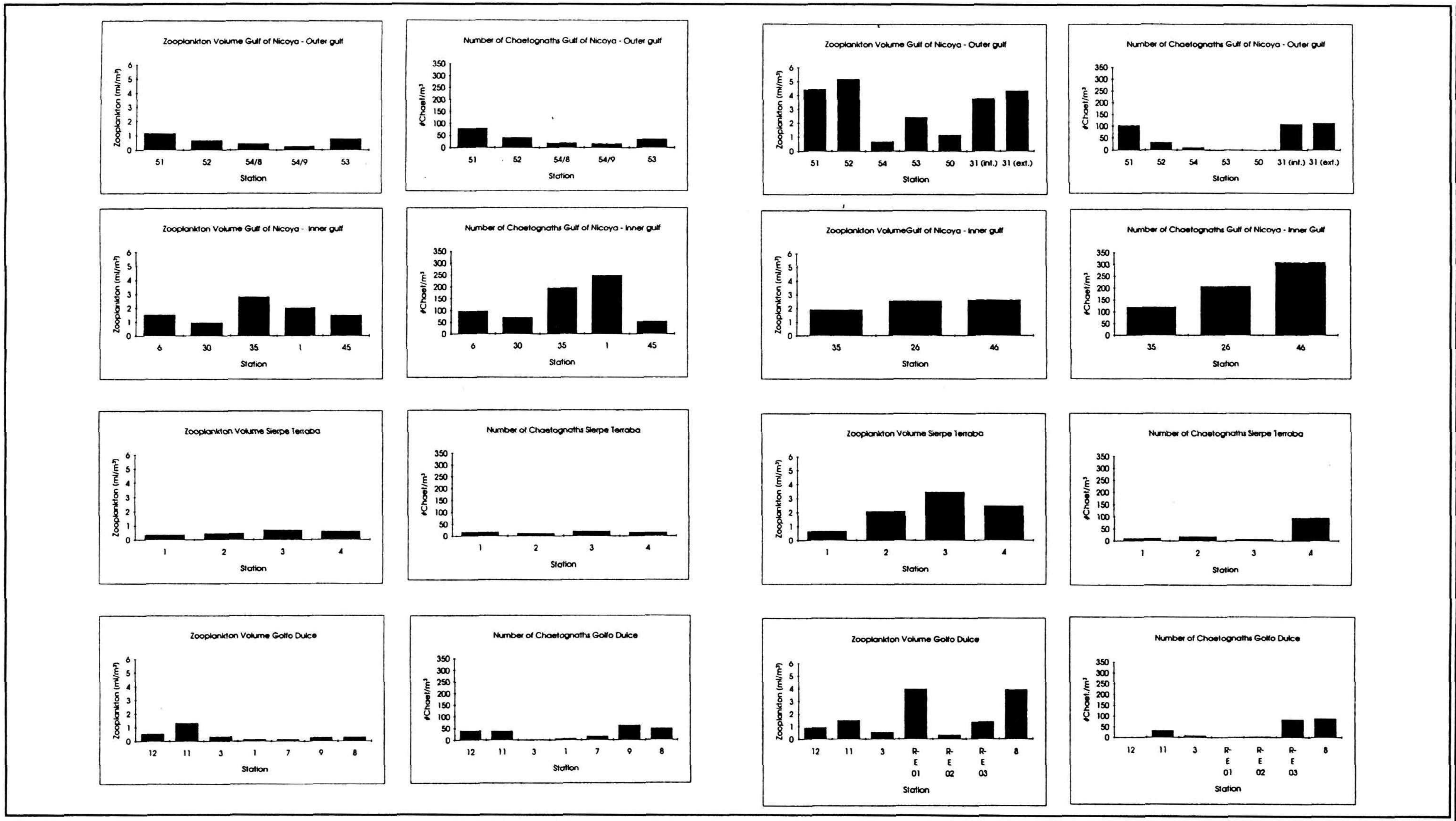


Fig. 4.1 Settling volume of zooplankton and number of chaetognaths in Golfo de Nicoya, Sierpe-Terraba and Golfo dulce (see station map) in December (left) and February (right)

Table 4.2. Zooplankton data from Gulf of Nicoya, Sierpe-Terraba and Golfo Dulce in December (above) and February (below). (The second column contains the number of revolutions read from the flow meter; values are expressed as (1) totals per sample (col. 4 and 6) and (2) per filtered m^3 of water (col. 5 and 7)

GULF OF NICOYA 2.12.93 - 5.12.93
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
31	2889	244,93	225	0,92		
51	616	52,22	60	1,15	129	79,04
52	702	59,52	40	0,67	148	39,79
54/8	1361	115,39	50	0,43	138	19,14
54/9	2568	217,72	56	0,26	222	16,31
53	931	78,93	60	0,76	165	33,45
6	735	62,31	95	1,52	378	97,06
30	743	62,99	60	0,95	277	70,36
35	526	44,59	125	2,80	272	195,18
1	591	50,10	100	2,00	388	247,8
45	241	20,43	30	1,47	552	54,03

SIERPE - TERRABA 6.12.93
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
1	1591	134,88	50	0,37	132	15,66
2	1782	151,08	70	0,46	99	10,48
3	854	72,40	50	0,69	87	19,23
4	402	34,08	20	0,59	31	14,55

GOLFO DULCE 7.12.93 - 8.12.93
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
12	2736	231,96	125	0,54	279	38,49
11	903	76,56	100	1,31	90	37,62
3	1451	123,02	42	0,34	53	0,86
1	3809	322,93	40	0,12	107	5,3
7	1425	120,81	15	0,12	112	14,83
9	645	54,68	15	0,27	214	62,62
8	801	67,91	20	0,29	212	49,95

GULF OF NICOYA 3.2.94 - 7.2.94
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
51	399	33,83	150	4,43	217	102,64
52	709	60,11	310	5,16	117	31,14
54	1835	155,57	105	0,67	190	9,77
53	1268	107,50	260	2,42	*	*
50	1030	87,32	100	1,15	*	*
31(int.)	206	17,46	66	3,78	118	108,1
31(ext.)	543	46,04	200	4,34	161	111,91
35	684	57,99	110	1,90	217	119,75
26	929	78,76	200	2,54	255	207,21
46	561	47,56	125	2,63	457	307,48

SIERPE TERRABA 7.2.94
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
1	1828	154,98	100	0,65	203	10,48
2	1983	168,12	350	2,08	193	18,37
3	547	46,37	160	3,45	48	8,28
4	600	50,87	125	2,46	302	94,99

GOLFO DULCE 8.2.94 - 9.2.94
Data from meshsize 300 µ

Station	# of rev.	Filtr. vol.(m³)	Zoopl. vol (ml)	Zoopl.(ml/m³)	#of Chaet.(subsample)	#of Chaet/m³
12	3834	325,05	300	0,92	*	*
11	803	68,08	100	1,47	268	31,49
3	1394	118,18	65	0,55	117	7,92
RE-001	623	52,82	210	3,98	*	*
RE-002	1928	163,46	50	0,31	64	1,57
RE-003	348	29,50	40	1,36	306	82,98
8	750	63,59	250	3,93	173	87,06

* not yet determined

zed showed similarities with the Sierpe -Terraba samples, particularily related to the abundance of anguilliform leptocephali and Trichuridae. Surprinsingly, Scorpaenid larvae were found at the inner station GD 007, although most species of this family are known from rocky coasts and coral reef areas, not given at this sampling site.

4.3. Copepods (size fraction 201μ)

Golfo de Nicoya

During December, a typical oceanic zooplankton was found in the outer part of the Gulf. At Stations 51,52 and 54, large copepods, mostly calanoids (e.g. Centropages furcatus, Eucalanus monachus and Labidocera lubbockii) were common. Other typical oceanic genera, such as the poecilomastoid Oncaea and the cyclopoid Oitona, were also present as were Cirripedian larvae and Pteropods, probably Clione sp.,

At the inner Gulf stations (6,30,35,01 and 45), a more estuarine zooplankton was found. Here, zoea-larvae, cladocera and peneid larvae, as well as copepods (e.g. calanoid Acartia lillinborgii and the cyclopoid Hemicyclops thalassius were found.

In February, the zooplankton of Ballena bay was dominated by species of the genera Oitona, Oncaea, Calocalanus and Corycaeus, all small, oceanic copepods. Centropages furcatus, Eucalanus monachus, Macrosetella graciles (usually found in both coastal and oceanic waters), as well as Temoras discaudata and Euterpina acutifrons (estuarine species) were common, as were decapod larvae (typically estuarine) and the pteropod Clione sp. (mostly oceanic). Less common were Clausocalanus sp. (a transitional genus) and Euchaetas sp.

The species composition of this plankton assemblage suggests a certain degree of mixture of oceanic with estuarine waters of the gulf. At the outer stations (e.g. 51 and 52) many salps (probably a single species), usually ocurring in oceanic waters, were present, as was a considerable amount of organic debris, which was absent in December. In February, specimens of the big Eucalanus elongatus and E. attenuatus (typical species of equatorial deep water) were collected for the first time. The genus Copilia (typically tropical oceanic) was found at St. 52. At St. 54, other oceanic genera such as Oithona (probably O. plumifera), Clausocalanus, Calocalanus and Corycaeus were found. A very interesting finding was on specimen of Plueromamma gracilis, which is a strong migrant of oceanic waters. At the inner stations (GN-046 and GN 026), the zooplankton was dominated by Hemycicplos thalassius and Acartia lillinborgi, both species characteristic for estuarine waters. Other species found were Paracalanus parvus and Pseudodiaptomus wrighthi.

Sierpe-Terraba

In December, the composition of the holoplankton species showed a strong gradient with the distance from the coast. The samples of the stations located furthest offshore (ST 001 and ST 002) showed a typical oceanic species composition. Some foraminifera were found, as well typical oceanic genera of copepods, such as Heterorhabdus and Lucicutia, strong migrants of the oceanic environment. Other groups like Ctenophores, appendicularians, pteropods and hydromedusae were observed too. St. ST

003 showed a transitional situation, since specimens of the genera Clausocalanus and Euchaeta were collected. At St. ST 004 (closest to the shore) a typical neritic plankton composition was found, with many small copepods, especially Paracalanus parvus.

The February samples showed the same pattern. However, many salps (other species than that found in Ballena Bay) were collected. The genus Haloptilus, a typicasl oceanic calanoid copedod was found only during this leg. Eucalanus elongatus was quite common, while the genus Saphirina, a typical tropical poecilostomatoid, was seldom found.

Golfo Dulce

During December an oceanic plankton composition was found at the outer stations of the gulf (GD 011 and GD 012) revealed by copepods like Oncaea and Corycaeus and by big copepods. Some of the inner stations (GD 003, GD 001 and GD 008) were dominated by ostracods of at least 3 different species. At St. GD 007 and GD 009 the plankton. was dominated by small calanoids.

During February a different situation was found: At St. GD 011 and GD 012, many organic aggregates were common in the samples, as well as many salps, pteropods and the copepods Eucalanus elongatus and Oithona (plumifera?). At Rincon Bay (St. GD 008), the same situation as in December was present: the zooplankton was dominated by ostracods and low amounts of a few species of copepods. Small ctenophores were very common, too.

A species list of the copepods found during the cruise is given in Appendix V. (p. 108)

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Leg.2:Microbiological investigations

Chief scientists: Dr. B. Thamdrup (MPI, Bremen)

1. Microbial ecology, water and sediment chemistry of Golfo Dulce (B. Thamdrup)

Introduction

The second leg of the Costa Rica expedition focused entirely on the bay Golfo Dulce. Golfo Dulce is an embayment on the Pacific coast of Costa Rica, approx. 20 wide and 50 km long. A sill at 60 m depth is present at the mouth, behind which depth increases steeply to about 200 m. The bay receives water from a number of smaller rivers some of which carry large amounts of particulate matter much of which probably originates from deforestation-related soil erosion. Mangroves along the coast are a major source of organic material in the sediments of the bay.

In the only report on the water chemistry of the bay (F.A. Richards, J.J. Anderson and J.D. Cline Limnol. Oceanogr. 16:43-50 (1971)), low oxygen levels (<10 µM) were reported at 100 m depth though oxygen did not disappear completely until 150 m depth. In the anoxic water column, hydrogen sulfide concentrations up to approx. 5 µM were found. Nitrate, which appeared to enter the bay with upwelling water spilling over the sill, was up to 25 µM about 50 m depth but did not penetrate deeper than did oxygen.

The studies undertaken during the second leg concerned the microbial ecology of the bay. Of particular interest was how the bacterial degradation of organic matter was regulated by the special geochemical environment and how, in turn, the microbially catalyzed processes affected the geochemistry of the system. Two main features were of interest for the research: i) The redox zonation in the water-column and ii) the sediments in the deep, expectedly anoxic part of the basin. A chemocline in the water column permits the study of the microbial ecology of an oxic-anoxic interface over a much larger - and therefore more easily resolved - depth interval than that found in sediments. The clastic fraction is smaller than in sediments and therefore obscures the bacteria less. The high temperature and organic loading expected in Golfo Dulce could stimulate microbial processes beyond those of temperate regions.

The investigation of the water-column put emphasis on the sulfur cycle. It included

- the depth distribution and speciation of sulfate-reducing bacteria studied with both molecular biological and microbiological techniques,
- the rate of bacterial sulfate reduction,
- the depth distribution and speciation of sulfide-oxidizing bacteria,
- the depth distribution of sulfur compounds of intermediate oxidation state,
- rates of oxygen consumption and denitrification,
- the depth distribution of inorganic nitrogen species, manganese and iron.

The sediment studies concerned the influence of bottom water oxygen concentrations on microbial processes in the sediment. Such effects may either be direct or act through the elimination of fauna (micro- to macro-) at low oxygen levels. The conditions in Golfo Dulce allow the comparison of sediments under different oxygen levels but with expectedly similar high inputs of organic matter.
The investigations encompassed

- the chemical zonation in the sediments including measurements with oxygen, sulfide and pH microelectrodes,
- the distribution of sulfur compounds of intermediate oxidation state,
- total rates of organic matter mineralization as measured by oxygen uptake and production of ΣCO_2 and NH_4^+,
- the relative importance of oxic respiration, denitrification, manganese reduction, iron reduction, and sulfate reduction in mineralization,
- the rate of burial of organic carbon,
- the microbiology of sulfate-reducing and sulfur-oxidizing bacteria.

At the moment an estimated 75% of the planned analyses have been performed, and work is continuing in the laboratory. The experiments are summarized below and the main results obtained so far are presented.

Material and methods

Scientific party

The following scientists contributed to the investigations summarized below:

Donald E. Canfield
Timothy G. Ferdelmann
Ronnie N. Glud
Jens K. Gundersen
Jan Kuever
Rolf Lillebæk
Bo Thamdrup
Cathrin Wawer

Stations and sampling

A total of 13 stations were visited (Fig. 1, Table 1). The investigations conducted at the stations may be divided into three parts:

- A general survey of the bay with CTD measurements and general water-column chemistry.
- Detailed biogeochemical studies of the water-column.
- Biogeochemical and microbiological sediment studies.

For the different parts a subgroup of stations was selected as listed below:

Table 1 Stations visited during leg 2

Station	Position	Depth (m)	CTD	Gen. water-column chem.	Detailed w.c. chem. & microbiol.	Sediment biogeochem. & microbiol.
GD1	8°41,7'N 83°23,7'E	205	+	+	+	+
GD1a	8°40,0'N 83°21,9'E	207	+			
GD2	8°36,6'N 83°18,0'E	208	+	+		
GD2a	8°36,6'N 83°18,0'E	200	+			
GD3	8°34,9'N 83°15,9'E	194	+	+		
GD3a	8°33,2'N 83°14,0'E	192	+			
GD9	8°39,0'N 83°25,5'E	53	+			+
GD11	8°27,2'N 83°13,0'E	75	+	+		
GD11a	8°23,8'N 83°13,3'E	75	+			
GD12	8°20,5'N 83°13,8'E	205	+	+		
GD30	8°38,9'N 83°25,6'E	42	+			+
GD89	8°31,5'N 83°13,0'E	101	+	+		
GD160	8°39,9'N 83°25,1'E	163	+			+

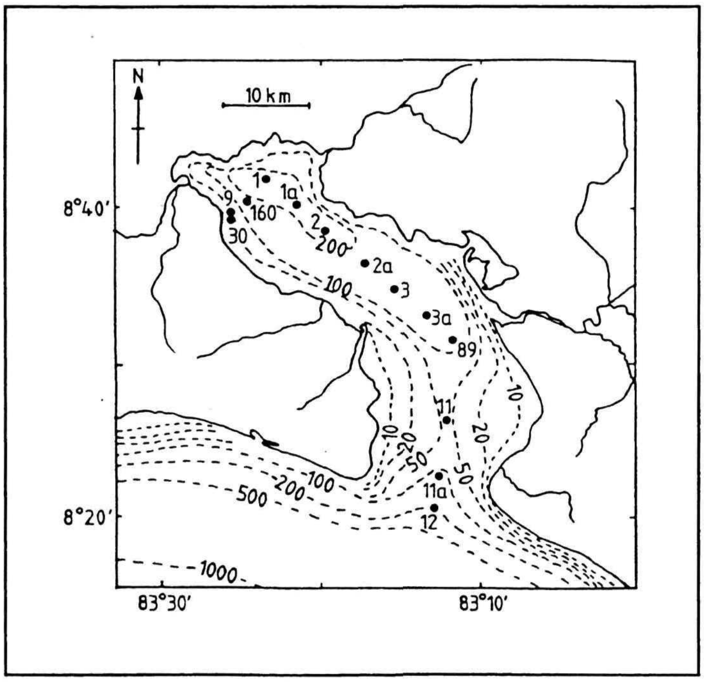

Fig. 1: Map of Golfo Dulce with sampling locations.

Stations 1,2,3,9,11,12 and 89 were identical to those visited during Leg 1. In addition to the listed stations, samples for microbiological studies were taken from the mangroves around rivers Rincón and Esquinas.

Water samples were obtained from 5 l Niskin and Go-Flo bottles. The latter was preferred for depths with low O_2 concentrations as it could be pressurized with N_2 during emptying to avoid contamination with atmospheric O_2. The bottles were held at the sampling depth for 3 min. before closing. Sediment was subsampled from 50x50 cm box cores that were only accepted when the sediment surface appeared undisturbed.

Experimental methods

Water-column chemistry:

Water temperature and salinity were measured by CTD. The water-column was analysed for O_2, NO_3^-, NH_4^+, and ΣCO_2. At stations 1-3 samples for Mn^{2+}, Fe^{2+}, particulate Mn and Fe, H_2S and pH were also taken, and at GD1 further samples were taken for S^0, $S_2O_3^{2-}$, SO_3^{2-}, and urea. The scalar irradiance was measured with a spherical quantum sensor.

Water-column microbiology:

At GD1, water samples were examined with phase contrast microscopy. Most-probable-number viable counts of sulfate-reducing and sulfide-oxidizing bacteria were performed, and cultures of the types of bacteria were established. For molecular ecological studies, bacteria were collected by filtering and frozen. These samples were used for analysis of DNA and RNA and for hybridization with fluorescent rRNA probes.

Processes in the water-column:

Rates of oxygen consumption were determined by dark incubation in Winkler-bottles at in situ temperature, denitrification rates were measured with the isotope-pairing technique, and sulfate reduction rates were quantified by addition of $^{35}SO_4^{2-}$.

Benthic fluxes:

Fluxes of O_2, ΣCO_2, NH_4^+, NO_3^-, urea, Mn^{2+}, and Fe^{2+} across the sediment-water interface were determined in sediment cores incubated in bottom water at in situ temperature and, initially, at in situ O_2 concentration.

Pore water chemistry:

Microdistributions of O_2 and pH in the surface sediment were measured with microelectrodes in the sediment cores used for flux measurements. Concentrations of ΣCO_2, NH_4^+, NO_3^-, Mn^{2+}, Fe^{2+}, SO_4^{2-}, H_2S, $S_2O_3^{2-}$, and SO_3^{2-} were determined after anoxic sectioning and centrifugation of the sediment, and filtering of the pore water. The distributions of ΣCO_2, NH_4^+, and NO_3^- near the sediment surface were further studied by whole-core-squeezing.

Solid phases:

Contents of C_{org}, total N and total S were determined on a CNS analyzer. FeS, FeS_2, and S^0 were determined by sulfide distillation with acid and Cr^{2+} and by sulfur extraction with methanol. Reactive iron and manganese were quantified with HCl, dithionite, oxalate, and Ferrozine extractions.

Processes in the sediment:

Rates of denitrification were determined with the isotope-pairing technique. Sulfate reduction rates were determined by whole-core injection with $^{35}SO_4^{2-}$. Rates of ΣCO_2, NH_4^+, Fe^{2+}, and Mn^{2+} liberation were determined by incubation of sediment at in situ temperature in gas-tight plastic bags.

Sediment microbiology:

Sulfate-reducing and sulfide-oxidizing bacteria were enumerated by the MPN technique, and anaerobic enrichment cultures of bacteria were established.

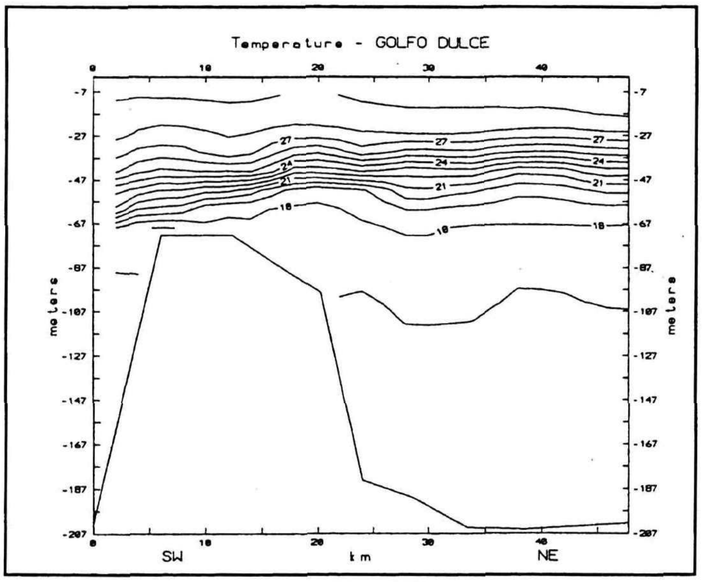

Fig. 2: Temperature measured by CTD on a transect along the middle of Golfo Dulce (stations 12, 11a, 11, 89, 3a, 3, 2a, 2,

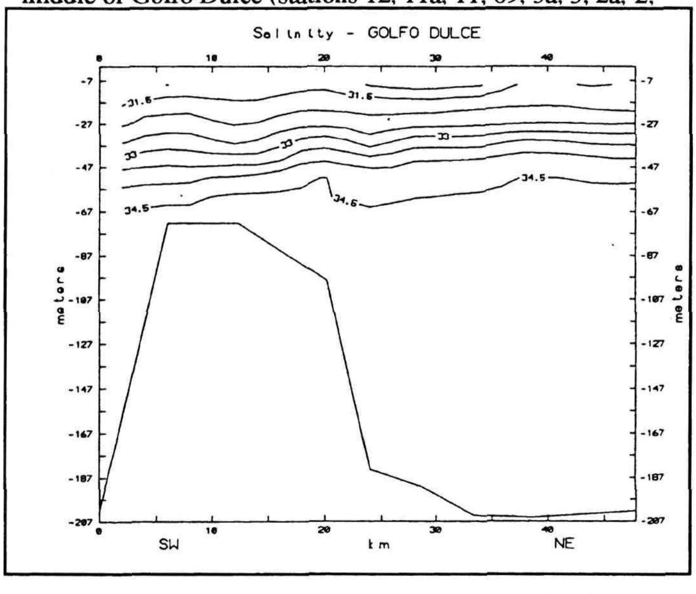

Fig. 3: Salinity measured on the same transect as Fig. 1.

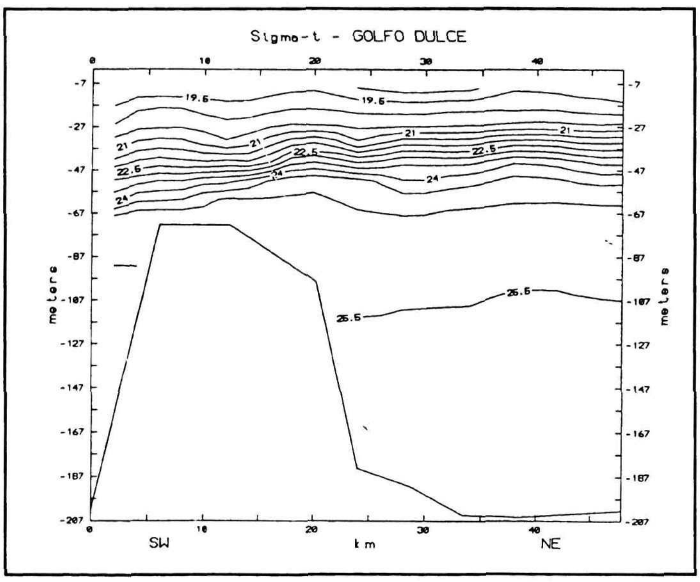

Figure 4: s_t calculated from the data in Fig. 1 and 2.

Results (state July 1994)

The water-column:

The CTD measurements (Fig. 2-4) showed a strong thermocline centered around 40 m depth at all stations as the major contributor to the pycnocline. The oxygen concentration decreased sharply through the pycnocline (Fig. 5). Inside the bay, oxygen disappeared at 80-100 m depth, the depth decreasing slightly towards the head, while concentrations outside were still >10% of air saturation at 200 m depth. Nitrate was not detected at the surface but reached maximum concentrations around 10µM just below the pycnocline (Fig. 6). The concentration decreased towards the bottom of the basin and NO_3^- was not detected at 200 m depth. Ammonia and dissolved Fe^{2+} were not detected in the water-column, but Mn^{2+} was present at appreciable concentrations near the bottom decreasing up through the anoxic zone and disappearing as oxygen appeared (Fig. 5 and 6). A small peak in particulate Mn was seen at the oxic-anoxic interface. Hydrogen sulfide was only barely detectable at 0.7 µM within 5 m of the bottom at GD1. A small maximum of 0.3 µM suspended S^0 was observed 7 m above the bottom, while SO_3^{2-} and $S_2O_3^{2-}$ were not detected.

High rates of oxic respiration were measured above the pycnocline (Fig. 7). Data on other processes in the water-column are not yet available. The scalar irradiance of light decreased below 1‰ of the surface value between 50 and 60 m depth. High numbers of both phytoplankton and bacteria were observed in the surface water. The numbers decreased with depth and dropped dramatically below 40 m. Near the bottom at

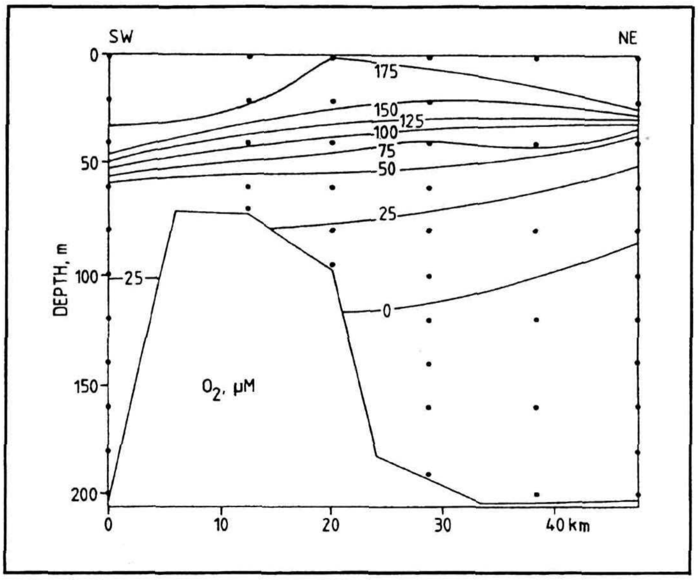

Fig. 5: Oxygen measured by Winkler titration along the same transect as in the preceding figures. Stations and depths of sampling are marked by dots.

200m depth the bacterial number increased again, approaching the density of the surface water. Sulfur granule-containing cells characterized the near-bottom population. Enumerations of sulfate-reducing bacteria showed their presence in the surface water and just above the sediment while none were found in the middle of the water column. GD160 was distinguished by large number of filamentous sulfur bacteria, expectedly *Beggiatoa,* that were observed at the sediment surface and suspended just above it in the retrieved box cores. The filaments were about 5 mm long.

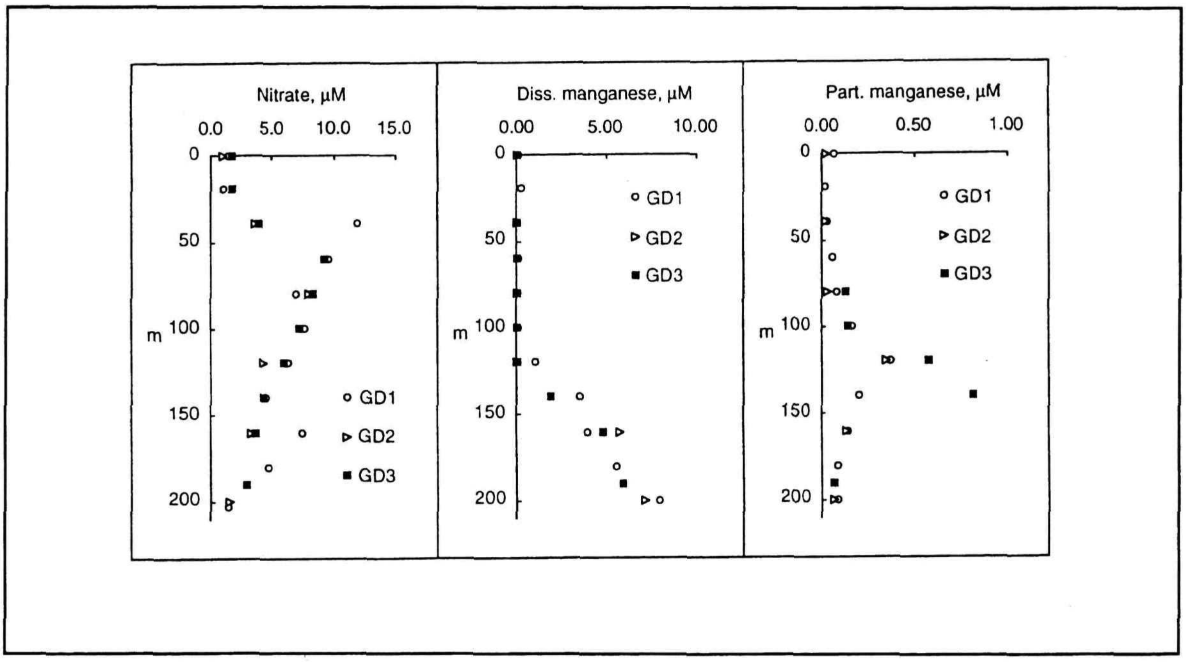

Fig. 6: Nitrate, dissolved manganese, and particulate manganese at three stations in the Golfo Dulce basin.

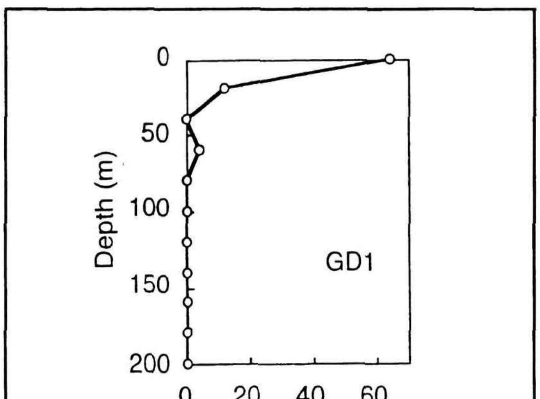

Fig. 7: Rates of oxic respiration at GD1.

Sediments:

The sediments at GD9 and GD30 were fine grained but contained much shell debris and some pebbles. The surface was light brown and there was some blackening with depth. At GD160 and GD1 well-sorted very fine-grained sediment was covered by a brown-black fluff-layer of up to 4 cm thickness. Just below this layer, a thin black horizon was seen. The sediment at GD160 was laminated below this with centimeter-thick layers in different shades of light and blackish brown and a particularly distinct pink layer at 17 cm

Table 2 Distributions in pore water.

	GD1				GD9				GD30			
Depth	Mn^{2+}	Fe^{2+}	NH_4^+	ΣCO_2	Mn^{2+}	Fe^{2+}	NH_4^+	ΣCO_2	Mn^{2+}	Fe^{2+}	NH_4^+	ΣCO_2
cm	μM	μM	μM	mM	μM	μM	μM	mM	μM	μM	μM	mM
0-0.5	26,2	6,2	118	4,64	31,6	9,3	20,4	2,7	28,8	7,5	31,4	2,49
0.5-1	28,9	5,3	145	5,28	15,1	14	27,1	2,84	14,1	12,4	36	2,71
1-1.5	26,7	6	196	6,27	9,6	22	35,9	2,89	12,3	30,2	40,9	2,8
1.5-2	35,1	12	234	7,06	5,7	8,4	28	2,93	9,1	24,9	47,6	2,9
2-3	35,5	16,9	268	7,91	4,2	9,3	33,6	3	5,6	20,4	34	2,9
3-4	35,7	18	313	8,75	3,6	2	38,6	2,98	3,6	10,2	38,5	2,92
4-6	28,8	16,7	378	9,59	3,2	8	41,4	3,02	4,2	18,4	28,5	3,03
8-10	28,7	8,7	529	10,73	3	4,9	54,7	3,04	4,1	10,7	93,5	3,83

depth. At GD1, a second black layer could be discerned about 15 cm depth in the otherwise light brown sediment. The input of terrestrial plant debris was evident at all stations as pieces of coco nuts, wood and large leaves were found both at the surface and deeper in the cores.

Table 3. Thiosulfate and hydrogen sulfide concentrations in pore water, μM.

Depth	GD9	GD160	Depth	GD1	
cm	$S_2O_3^{2-}$	$S_2O_3^{2-}$	cm	$S_2O_3^{2-}$	H_2S
0-1	25	2,6	0-0.5	23	2,1
1-2	8,2	2,9	0.5-1	7,4	2
2-3	3,9	10	1-1.5		2,1
3-4	8,1		1.5-2	2,5	0,5
4-5	9	19	2-3	6	1,4
5-6	14	35	3-4	6,1	0,7
6-7	7,4	17	4-5	3,8	1
7-8		46	5-6	5,7	0,9
8-9	11	53	6-7	9,3	1
9-10	8,6	60	7-8		1,2
11-12		60	10-12	13	3,1
10-12	11		12-14	10	1,2
			14-16	12	1,2

Table 4. Sulfate reduction rates determined in intact sediment cores.

Depth	Sulfate reduction rate nmol cm^{-3} d^{-1}		
cm	GD1	GD9	GD160
0-1	45	6,8	6,3
1-2	72	3,1	96
2-3	77	16	66
3-4	152	27	27
4-5	83	31	14
5-6	56	23	8
6-7	41	17	5,6
7-8	37	18	4,2
8-9	42	10	3,5
9-10	38	6,5	4,2
10-11	53	8,9	3,6
11-12	51		2,9
12-13	46		1,9
13-14	47		2,3
14-15	34		3,6
15-16	39		
16-17	74		
mmol m^{-2} d^{-1}	9,9	1,7	2,5

Table 5 ΣCO_2 production, NH_4^+ production, and SO_4^{2-} reduction rates in anaerobically incubated, homogenized sediment, nmol cm^{-3} d^{-1}.

Depth	GD1			GD9			GD30		
cm	ΣCO_2	NH_4^+	SRR	ΣCO_2	NH_4^+	SRR	ΣCO_2	NH_4^+	SRR
0-0.5	183	26	90	484	46	24	677	42	22
0.5-1	174	13	83	418	24	87	473	25	81
1-1.5	145	24	64	446	21	129	721	41	103
1.5-2	64	20	54	599	108	196	601	42	196
2-3	67	6	45	443	46	183	631	61	157
3-4	42	n.d.	48	444	41	157	398	39	95
4-6	31	n.d.	39	312	29	95	191	23	45
8-10	n.d.	n.d.	43	319	22	58	37	21	26
mmol m^{-2} d^{-1}	4,8	0,48	4,8	38	3,4	10	30	3,1	7

At GD9 and GD30 with oxic bottom water, oxygen penetrated only few mm into the sediment. Nitrate concentrations have not yet been calculated, but based on the low concentrations in the water-column, nitrate is expected to be of minor significance in the sediment. Below the oxic surface a broad suboxic zone was found with Mn^{2+} and Fe^{2+} but no H_2S in the pore water (Table 2). The distribution of Mn^{2+} and Fe^{2+} suggested that manganese reduction occurred in the upper 0.5 cm of the sediment and iron reduction immediately below this. Ammonia concentrations increased by 100 µM over the upper 10 cm and ΣCO_2 increases were similarly small.
Also the sediments at GD160 and GD1 had broad suboxic zones with high concentrations of Mn^{2+} and Fe^{2+} (Table 2). GD1 had very steep gradients of ΣCO_2 and NH_4^+ towards the surface. Hydrogen sulfide was only detected at GD1 where a maximum concentration of 2 µM was observed at the surface (Table 3). Thiosulfate was detectable at all depths in the sediments with concentration ranging from 2 to 60 µM. At GD9 and GD1 surface peaks of ca. 25 µM were observed, while at GD160 the concentration increased to 60 µM at 10 cm depth.
The oxygen uptake was 7.9 ± 2.4 mmol m^{-2} d^{-1} at GD9 and 13.8 ± 3.5 mmol m^{-2} d^{-1} at GD30. Other benthic fluxes have not been calculated yet. Sulfate reduction rates measured in intact cores are given in Table 4 and rates of sulfate reduction and of CO_2 and NH_4^+ production in the incubations in gas-tight plastic bags are in Table 5 . The contribution of carbonate dissolution to ΣCO_2 production has not yet been evaluated. Comparison of SRR to either oxygen uptake or to ΣCO_2 production shows that sulfate reduction was a dominating pathway of mineralization in the sediments.

Discussion

The general water-column chemistry observed during Leg 2 agrees largely with the findings of Richards and coworkers in 1967. They also found a sharp decrease but no disappearance of O_2 across the pycnocline. Based on - among other evidence - an increase in O_2 under the pycnocline towards the mouth of the bay over the week of the study, Richards et al. suggest that spills of oxygenated water over the sill occur at intervals and are related to rising of the pycnocline outside the bay. The introduced water is compensated by an outflow of surface water and by upwelling of bottom water at the head of the bay. The frequency of such introductions is not known but could be seasonal related to upwelling outside the bay during winter.

There is evidence that such a flushing of the basin preceded the 1994 cruise, as Dr. José A. Vargas (pers. comm.) found O_2 all the way to the bottom near GD1 during a visit in October 1993. It is therefore most likely that the chemical zonations found in the bay do not represent a situation at steady state but oscillate at an unknown frequency. In the previous study, the oxic-anoxic interface was situated around 140 m depth and roughly coincided with the deepest detectable NO_3^-. Below this depth, > 1µM H_2S was present. We found the anoxic, sulfide-free but NO_3^- containing zone near the bottom. This situation presumably represents an earlier stage in the succession after a major flushing of the basin than the observations from 1967.

In the absence of a marked O_2/H_2S transition in the water-column and assuming that anoxic conditions only developed recently, it is not surprising that numbers of sulfate reducing and sulfide oxidizing bacteria are low at most depths. The microbiological studies did, however, produce some interesting results. First, the occurrence of sulfate reducing bacteria in the surface waters raises the question whether these are active or just transported there from sediments or with suspended matter from the rivers. Sulfate reduction under aerobic conditions has only recently been described and organisms that perform this are not well known. The oxygen sensitivity of the enriched organisms has not yet been studied.

A second interesting phenomenon was the occurrence of sulfide-oxidizing bacteria at or near the bottom under anoxic conditions. Bacteria that oxidize H_2S with NO_3^- are known, but this metabolism has not been described for many of the morphotypes observed. Also the finding of large numbers of *Beggiatoa* at GD160 in the absence of both O_2 and H_2S indicates that bacteria with novel metabolic pathways may be found in the bay.

The sediments at GD9 and GD30 are quite similar to many temperate coastal sediments with respect to both pore water chemistry and flux and mineralization rates. The ratios of ΣCO_2 to NH_4^+ production were quite high at all stations, which could be related to the importance of terrestrial organic matter with high C/N ratios as a substrate. Comparison of ΣCO_2 production and sulfate reduction rates at these sites also indicates that dissimilatory Mn and Fe reduction may contribute to the mineralization of organic matter.

Given the observed rates of sulfate reduction it was surprising that H_2S was also largely absent in all the sediments within the depth intervals studied. The pore water data suggest that iron and manganese phases are important scavengers of the H_2S produced. Based on both direct observation and the pore water distributions of ΣCO_2 and NH_4^+, the sediments at GD9 and GD30 appeared heavily bioturbated. The flushing of pore spaces and downward transport of Mn and Fe oxides may explain the absence of H_2S here. The sediments at GD160 and GD1, on the other hand, were clearly free of zoobenthos and the best explanation for the low H_2S levels observed here seems to be a rapid sedimentation rate and a high content of Mn and Fe oxides in the settling matter. The sulfur chemistry at these sites is further distinguished by thiosulfate levels considerably above those usually found in sulfide-free sediments. This could be related to the efficient removal of H_2S. Data to explain these observations have yet to be thoroughly analysed.

The sediment surfaces at GD9 and GD30 were within the pycnocline and therefore experience large variations in O_2 concentration as the pycnocline moves up and down. As the oxygen uptake of sediments is dependent on the O_2 concentration in the over-lying water, the apparent seasonal oscillations in the water-column will directly affect this process and, thereby, the reoxidation of reduced metabolites produced in the sediment. Also the health of the infauna may be affected, and resulting changes in the bioturbation intensity will further influence the elemental cycles in the sediment. For a further prediction of how the processes studied here may vary seasonally, an understanding of the seasonal variations in the hydrography of Golfo Dulce would be valuable.

Golfo Dulce is quite different from the two other anoxic basins known from the tropics, Kau Bay in Indonesia, and The Cariaco Trench off Venezuela, as high concentrations of H_2S are found in the bottom water of both of these. Inflows of oxic water seem to maintain Golfo Dulce at a less reduced level and a high input of Mn and Fe oxides may further be important in the removal of H_2S. The bay, as we found it, is thus a unique environment for studying the biogeochemical cycles under suboxic (anoxic and non-sulfidic) conditions.

2. Temperature, salinity, oxygen, and nutrient profiles at a 200 m deep station in Golfo Dulce, Costa Rica - additional observations- (J. Vargas & R.Cordoba)

Introduction and objectives

The study by Richards et.al. (1971) provided a detailed description of physical and chemical parameters at five stations within the gulf. They found small concentrations of hydrogen sulphide in the bottom waters at the innermost station and proposed that the gulf receives boluses of offshore waters across the sill. This water can be identified by low silicate and phosphate concentrations, and relatively high concentrations of oxygen and nitrate. They also reported that the inner gulf was characterized by the rapid vertical decrease in dissolved oxygen, the disappearance of nitrate with increasing depth, and the appearance of a secondary nitrite maximum at 100m.
Thus it was considered appropriate to conduct a detailed sampling for nutrients, dissolved oxygen, salinity and temperature at the site, and to compare the results with those obtained 25 years ago.

Material and methods

The present study was conducted at a station located at 8°41.684 N -83°23.783 W, with a maximum depth of 200 m.
Samples for nutrients and dissolved oxygen were taken at 10 m depth intervals with a 5l Niskin bottle operated from the ship's oceanographic winch. Water temperature (mercury in glass thermometer) and salinity (optical refractometer) were recorded. Nutrient samples were stored frozen in 1 l plastic bottles. Samples for dissolved oxygen were taken using 350 ml BOD bottles, fixed, and analysed immediately on board, following the Winkler method (Strickland & Parsons, 1972). Nutrient analyses for dissolved $N0_3^-$ $N0_2^-$, SiO_4^{3-} and PO_4^{3-}. were conducted at the laboratories of the University of Costa Rica (CIMAR), and also following the methods outlined in Strickland and Parsons (1971).

Results

Temperature and salinity

Temperature ranged from 31.0°C at the surface to 17.1°C at 200 m. A thermocline was evident between 20 to 50 m. salinity ranged from 30 ppt at the surface to near 35 ppt at the bottom, being nearly homogeneous below 40 m (Fig. 1).

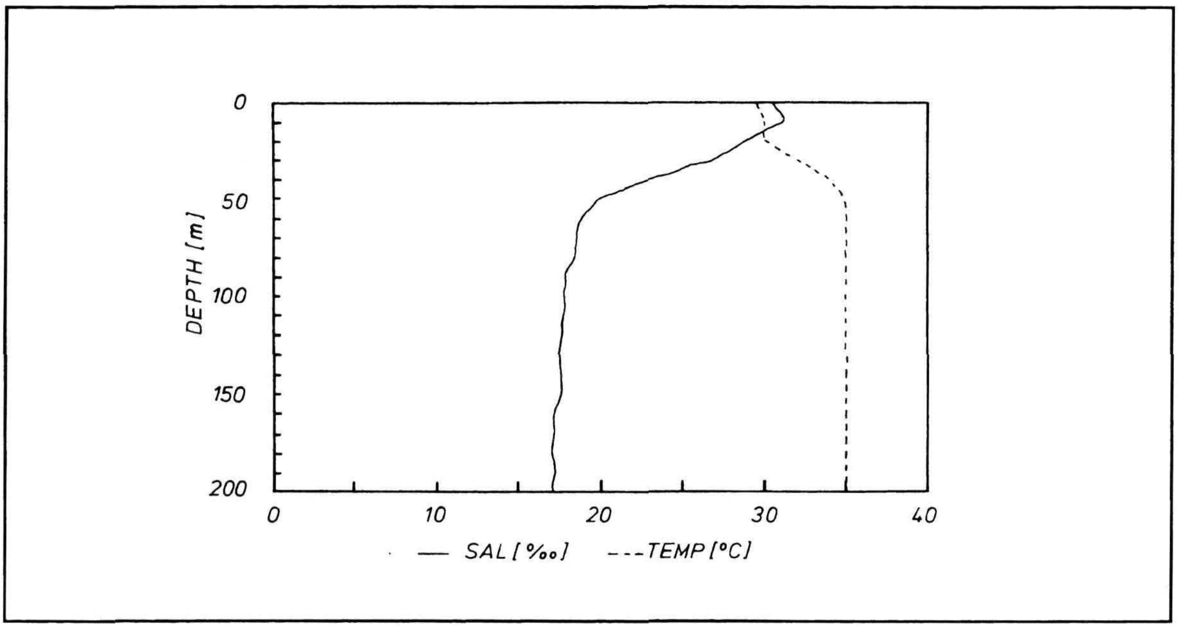

Fig. 1. Temeperature and salinity profiles at a 200m deep station in Bahia Rincón, Golfo Dulce. Costa Rica. 8°41.684 N-83°23.783W. January 12, 1994

Dissolved oxygen

Dissolved oxygen concentrations ranged from 6.76mg/l at 10 m to non detectable at 200 m. Values below 1.15 mg/l were typical of the waters deeper than 40 m. A sharp decrease was observed in the interval from 10 to 40 m when it dropped from 6.65 mg/l to 1.15 mg/l. The minimum value measured in the water column was 0.16 mg/l at 120 m, followed by a slight increase (0.33mg/l) in waters from 160 to 190 m (Fig.2)

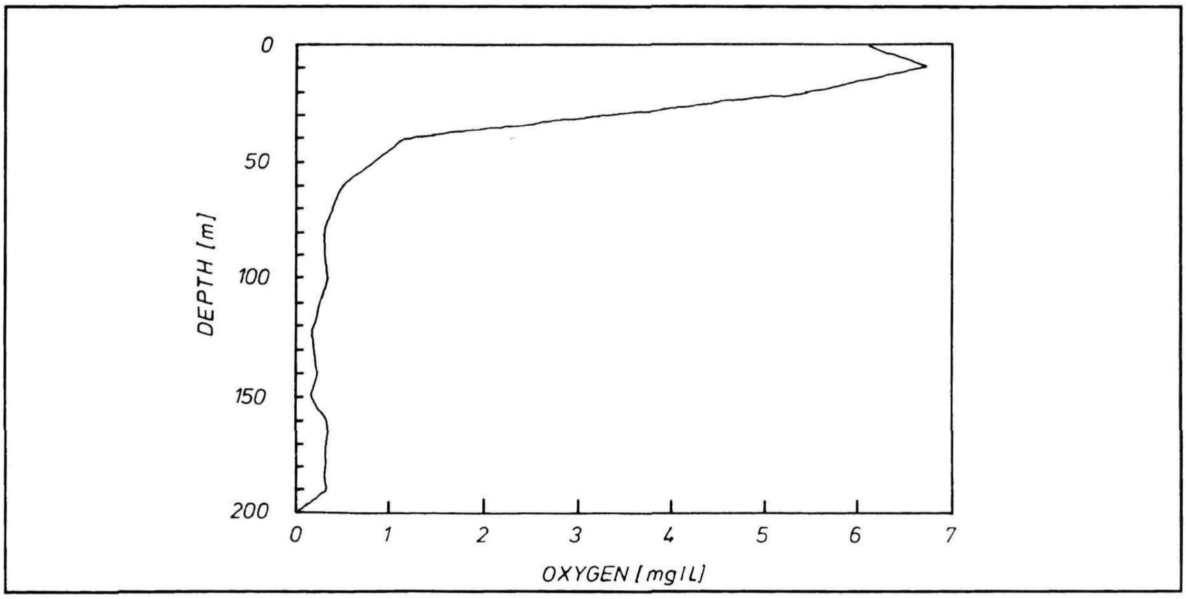

Fig.2. Dissolved oxygen profile at a 200 m deep station in Bahia Rincón, Golfo Dulce, Costa Rica (8°41.684 N - 83°23.783 W.)

Dissolved inorganic nutrients

Values for concentrations (µmol/l) of dissolved NO_3^- NO_2^-, SiO_4^{3-} and PO_4^{3-} are included in Table 1.

Table 1. Nutrient profiles in Bahia Rincon, Golfo Dulce, Costa Rica (8°41.684 N - 83°23.783 W.)

Depth (m)	NO_3^- (µmol/l)	NO_2^- (µmol/l)	$NO_3^- + NO_2^-$ (µmol/l)	SiO_4^{3-} (µmol/l)	PO_4^{3-} (µmol/l)
0	33,16	0,52	33,68	6,67	1,14
10	1,28	0,29	1,57	4,29	0,16
20	2,58	0,43	3,01	N.D.	1,27
30	2,61	0,48	3,09	0,64	0,34
40	23,47	1,34	24,81	6,52	0,15
50	16,95	0,22	17,17	14,58	3,09
60	31,5	0,56	32,06	19,36	2,32
70	23,34	N.D.	N.D.	23,39	2
80	20,82	0,01	20,83	24,56	2,14
90	19,55	0,43	19,98	24,97	2,11
100	15,18	0,49	15,67	36,53	2,61
120	14,08	0,66	14,74	25,29	2,1
150	15,39	1,24	16,63	22,65	2,68
160	4,45	0,72	5,17	30,36	2,19
170	6,36	0,63	6,99	34,3	2,09
180	3,64	0,57	4,21	35,76	2,2
190	2,93	0,38	3,31	33,8	7,91
200	N.D.	0,04	N.D	41,83	4,44

Dissolved inorganic nitrate

Dissolved inorganic nitrate concentrations ranged from non detectable at 200 m to a maximum of 33.16 µmol/l at the surface. A sharp increase was observed at 60 m.A slight increment up to 15.39µmol/l was observed at 150 m. In general it seems that the nitrate is being reduced below 150 m.

Dissolved inorganic nitrite

Dissolved inorganic nitrite concentrations varied from non detectable at 80 m to 1.34 µmol/l at 40 m. Two increments of 0.56 and 1-24µmol/l are observed at 60 and 150 m respectively. In general, dissolved inorganic nitrite presents a regular distribution in the sea water column without any trend. Below 150 m it shows a significant decrement similar to the nitrate pattern.

Dissolved inorganic silicate

Dissolved inorganic silicate concentrations ranged from non detectable at 20 m to 41.83 µmol/l at 200m. It showed a clear descending tendency from the 30 m to the deepest point sampled. A second high value of 36.53 µmol/l was found at 100 m.

Dissolved inorganic phosphate

Dissolved inorganic phosphate concentrations fluctuated from 0.15 µmol/l at 40 m to 7.91 µmol/l at 90 m. This latter value is very high if compared to the maximum concentrations (3.63 µmol/l PO_4^{3-} at 200m) reported by Richards et. al., (1971). A second maximum of 3.09 µmol/l was observed at 50 m. Two slight increments of 2.61 and 2.68 µmol/l were found at 100 and 150 m, respectively.

Comments

In general, the results obtained agree with those 25 years ago: a thermocline was present at a depth of about 40 m, and the salinity range from surface to bottom was also similar; oxygen decreased with depth to non detectable at the bottom; and dissolved inorganic silicate increased with depth. Dissolved inorganic NO_3^-, however, showed a layer, between 40 and 150 m where concentrations were generally higher than at shallower or deeper waters. It seems to be an organic material accumulation as depth increases.

References

Richards, F.A., J.J. Anderson and J.D. Cline. 1971. Chemical and physical observations in Golfo Dulce, an anoxic basin on the Pacific coast of Costa Rica. LIM. & OCEAN. 16 (1): 43 - 50.

Strickland, J.D.H. and T.R. Parsons. 1972. A practical handbook of seawater analysis. 2nd Ed. Fisheries research Board of Canada, Otawa. 310 p.

Leg.3: Geological investigations

Chief Scientists: Dr. D. Hebbeln (GeoB), Dr. J. Cortés (CIMAR)

1. Late quaternary paleoclimate of Costa Rica - Golfo Dulce and adjacent areas (D. Hebbeln)

Introduction

Golfo Dulce on the southern Pacific coast of Costa Rica (Fig. 1) is a fjord-like structure with a deep inner basin (>200 m) sheltered against the open Pacific by a shallow sill (60 m). Due to the morphology only a limited water exchange between Golfo Dulce and the ocean takes place, resulting in at least temporarily anoxic bottom waters in the inner basin. These conditions restrict the benthic community in Golfo Dulce leaving the sediments mostly in undisturbed layering. In combination with high sedimentation rates, which are to expect in Golfo Dulce, those sediments offer very good possibilities for high resolution paleoenvironmental reconstructions.
The aim of this expedition was the sampling of sediments and corals in order to reconstruct the paleoclimate and paleoenvironmental conditions of the region with the bestmost temporal resolution. In addition to sediment cores from Golfo Dulce, sediments were sampled from along the shelf and the continental slope off the Costa Rican west coast. Corals were collected at Punta Islotes (innermost Golfo Dulce) and on Isla del Caño.

Objectives

Recent studies have shown that climatic changes took place much faster than thought before. Thus, much higher temporal resolutions of paleoclimatic reconstructions are needed to improve the understanding of the dynamics of climate change. The focus of the planned paleoenvironmental reconstructions will be on one hand the 1,000 year time scale and on the other hand the 10,000 to 20,000 year time scale.
Informations about the climate history of the last 1,000 years can be obtained from sediments with very high sedimentation rates (ca. 10cm/100years) as they are most likely found in Golfo Dulce. Continuous paleoclimatic records will also be stored in coral skeletons. Of special interest within the last 1,000 years are climatic variations like the "Little Ice Age" and, if the temporal resolution is high enough, the ENSO circulation (ENSO = El Niño/Southern Oscillation). In a several years distance this El Niño phenomenon resulted in drastically changed environmental conditions in the entire East-Pacific, which today can also be traced to the Atlantic and Indian Oceans.
For a detailed reconstruction of the paleoclimate through the last 20,000 years still sediments with comparable high sedimentation rates (ca. 10cm/1000 years) are required. To obtain such cores small basins on the shelf and along the continental slope have been sampled. A tropical high resolution paleoclimatic record covering the whole

time span between the Last Glacial Maximum and the Holocene would provide detailed knowledge about the dynamic of this climatic turnover in the tropics.
In order to assess the present-day conditions and their imprint on the sediments, surface sediment samples as well as plankton tows and CTD-casts were taken on most of the stations. In addition, also a detailed morphologic mapping of Golfo Dulce has been carried out.

Material and methods

Itinerary

Leg 3 began on January 17, 1994, with a short trip from Caldera to Puntarenas for bunker and for embarking the last scientists. At 13:00 RV "Victor Hensen" left Puntarenas for a two week expedition with 2 german and 5 Costa Rican scientists heading for Golfo Dulce. The scientific program started at 6:00 on January 18 at the mouth of Golfo Dulce with echosounder profiling across the entire gulf. During the next days 12 stations inside Golfo Dulce have been sampled with CTD, plankton net, boxcorer and gravity corer. In addition one site in the very inner part of Golfo Dulce, Punta Islotes, has been sampled for corals. The work in the gulf was finished at the evening of January 21 in the port of Golfito. On January 22, after a little crew change - two Costa Rican scientists disembarked, one embarked - RV "Victor Hensen" left Golfo Dulce to work on the Costa Rican continental slope. That day was spend with coral observations near Punta Salsipuedes at the Osa peninsula. The following night was used for echosounder profiling along Cocos Ridge in order to find a suitable coring site. Unfortunately, also from the most promising site, according to the echosounder profiles, only some relict sediments could have been retrieved by the boxcorer the next morning, January 23. After dropping the coral group with the rubber boat close to the Osa peninsula, RV "Victor Hensen" started sampling on the continental slope until the coral group was taken onboard again in the afternoon. During the following days an extensive sampling program along the continental slope was carried out. There the most stations were sampled by CTD, plankton net and boxcorer. The gravity corer was only occasionally used. On January 26, after another Costa Rican scientist has disembarked in the port of Quepos, RV "Victor Hensen" made a transect across the continental shelf from Quepos to Isla del Caño. The last days of the expedition were spend with coral investigations and sampling by rubberboat and with echosounder profiling and boxcorer casts around Isla del Caño by RV "Victor Hensen". Isla del Caño was left in the evening of January 29 and Leg 3 ended on January 30 at 10:00 with the arrival in Caldera.

Sample collections onboard RV "Victor Hensen"

CTD-casts

The analyses of temperature and salinity in the water column has been carried out with a ME CTD. It was normally used for the uppermost 200 m of the water column. On the shallower sites it was only lowered to about 10 m above the sea floor. CTD-casts have been taken on stations 2401- to 2427 (Fig. 1).

Plankton samples

For the plankton tows a 20µm-handnet has been used. Samples have been taken from one or two casts, depending on the plankton concentration, from the uppermost 10 m of the water column. Afterwards the samples have been filtered and deep frozen. Plankton tows have been taken on stations 2401-2427 (Fig. 1).

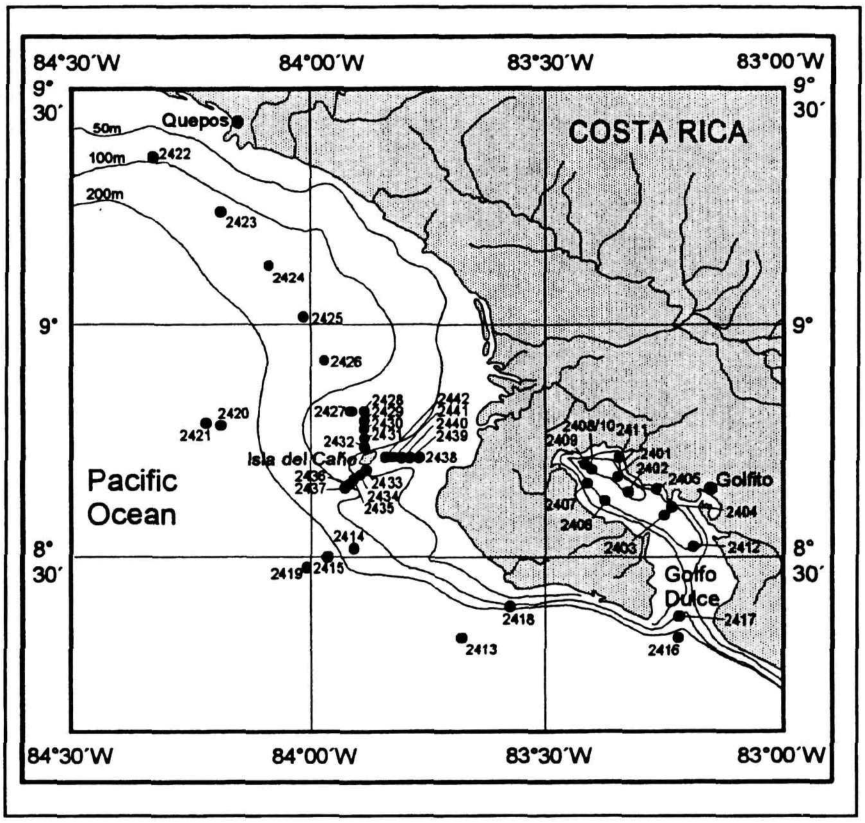

Fig. 1: Sample locations of Leg 3 of the RV "Victor Hensen" expedition to Costa Rica 1993/94.

Surface sediments

The boxcorer used during this expedition had a sampling area of 50 cm * 50 cm. Generally it was subsampled by taking one or two archive-cores (Ø 12 cm) over its whole length, one surface sample for planktonic and benthic organisms (0 cm to 1 cm), and one surface sample for organic material (0 cm to 1 cm). On some stations along the continental slope 3 boxcorers have been taken to investigate in detail the composition of the benthic community in the uppermost 15 cm of the sediment column. Along the profiles around Isla del Caño the boxcorers were sampled for large volume sediment samples. Due to the very soft bottom inside Golfo Dulce the boxcorer sank to deep into the sediments at some stations. Thus, at those stations several box corer have been taken to obtain a useful surface sample. The boxcorer was used on all stations 2401 to 2442 (Fig. 1).

Gravity corer

Long sediment cores with a length varying between 180 cm and 575 cm were taken using a 6 m gravity corer loaded with a 800 kg weight. In the very soft sediments inside Golfo Dulce the penetration of the gravity corer into the sediment has been controlled by the wire length, because otherwise penetration would have been much deeper than the core length. However, at some staions a second gravity corer had to be taken, due to too deep penetration. The gravity corer has been used on stations 2401 to 2412, 2414 to 2415, and 2419 to 2420 (Fig. 1)

Echosounder profiles

For the morphologic mapping of Golfo Dulce a shipmounted 18kHz ELAC sediment echosounder has been used. Data have been obtained from 14 profiles through Golfo Dulce. Control about the ships position (by GPS) and control about its velocity (on average 8 kn) made it possible to put the echosounder records in the geographic context.

Preliminary results and discussion

Surface sediment distribution

In Golfo Dulce the surface sediments are mostly extremely soft and of olive to black colours with sometimes leaves and small wooden sticks occurring. At some stations on the very top fluffy green to yellow patches reflect the last plankton bloom. Although the surface sediments were partly black, there was no strong H_2S-smell and, thus, no strong indications for actual anoxic bottom water conditions. One exception from this pattern was core 2405-3 from a small basin close to the coast, from where grey sediments with high amounts of gastropods and high amounts of mollusc fragments have been obtained.
The surface sediments along the continental slope consist mostly of olive-grey sandy-silty clay. Common features in some of the cores are burrows, black sand-sized grains, remains of planktonic foraminifera, and mollusc fragments.
Core 2413-3 from the Cocos Ridge contained coarse sand with several stones, thus, mostly fresh eroded material from the basement. On top of the sediment some otoliths, some ophiorides, and some planktonic foraminifera were observed.
On the shelf (stations 2425 to 2427) the sediments are coarser than along the continental slope. There the sediments consist of an olive-grey silty fine-sand with high amounts of mollusc and gastropod fragments.

Organic carbon content

After drying the sediment samples have been homogenized and carbon contents were determined using an elementary analyser (Hereaus CHN-O-Rapid). Organic carbon contents (TOC) were measured on HCl-treated samples.
Highest TOC contents (>2.3%) in Golfo Dulce are surprisingly not found in the deep basin but along its western side (Fig. 2). In the deep basin the TOC contents are slightly lower between 1.8% and 2.3% and they continue to decrease further to the east to values between 1.3% and 1.8%. Even lower contents (0.8% - 1.3%) have been observed in the outer part of Golfo Dulce and along the shelf off Osa peninsula. On the shelf north of Isla del Caño TOC contents are below 0.8%, but increase further to the northwest with a local maximum (>2.3%) at station 2424 and values between 1.8% and 2.3% off Quepos.
Along the 500 m isobath at the continental slope off Isla del Caño very high TOC contents (>2.3%) indicate a strong oxygen minimum zone in this waterdepth. Relatively high contents (1.8% - 2.3%) have also been found in 1000 m waterdepth.

Carbonate content

For the analysis of the carbonate content also the elementary analyser (Hereaus CHN-O-Rapid) has been used. In contrast to the TOC measurements, total carbon contents (TC) were measured on untreated samples. Carbonate contents were calculated as: $CaCO_3 = (TC - TOC) * 8.333$
Inside Golfo Dulce the carbonate contents are highest (4% - 7%) in the deepest parts and in the very northeast in front of the Rio Esquinas (Fig. 3). In the remaining part of Golfo Dulce the carbonate contents are less than 4%. Outside Golfo Dulce the highest carbonate contents (>17%) have been found on the shelf around Isla del Caño. To the northwest and downslope the carbonate contents decrease to values between 4% and 7%. At the shelf around Osa peninsula the carbonate contents vary between 7% and 17%. Very low contents (<4%) have been found at the Cocos Ridge and at the 200 m

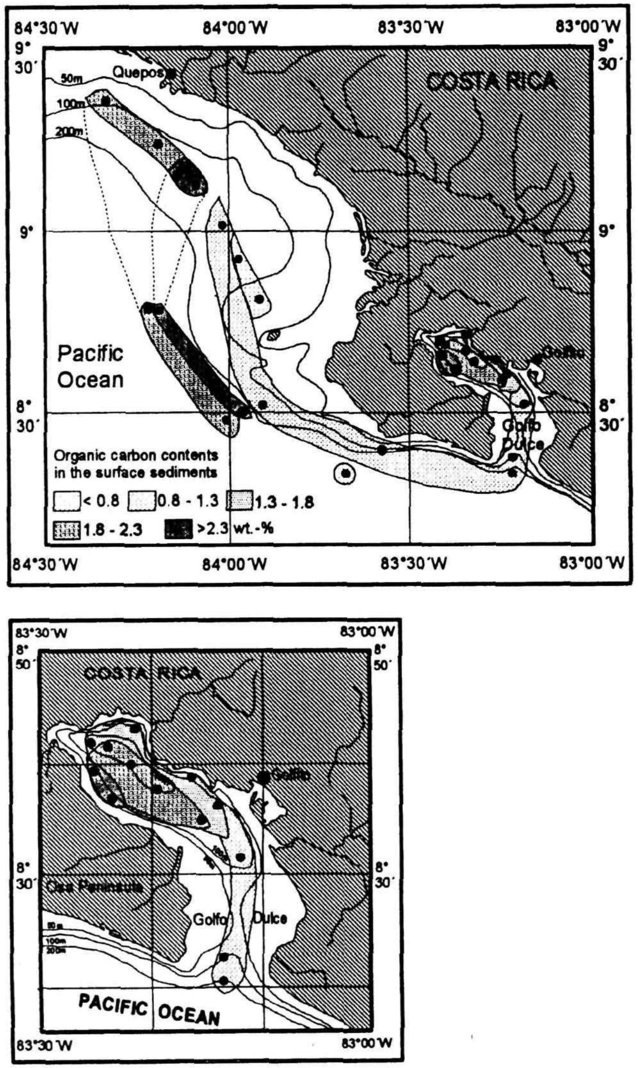

Fig. 2: Organic carbon contents in surface sediments off the Pacific coast of Costa Rica and inside Golfo Dulce.

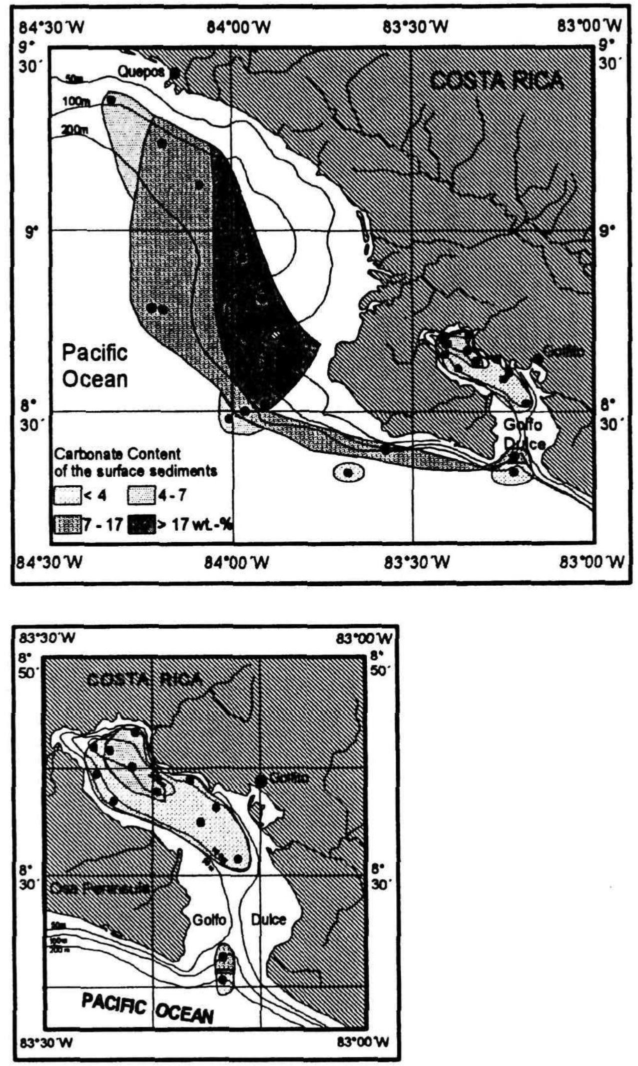

Fig. 3: Carbonate contents in surface sediments off the Pacific coast of Costa Rica and inside Golfo Dulce.

isobath directly off Golfo Dulce.

Long sediment cores

The long sediment cores from Golfo Dulce can be grouped in two different units: the basin cores and the slope cores. The basin cores consist mostly of turbidites, which have a typical sequence starting with a sand layer, followed by silty clay with high amounts of wood pieces (Fig. 4). The amount of wood decreases upward and the sequence ends with simple silty clay. Thus, the upper limit of the turbidites is hardly to detect. However, it is estimated that the turbidites account for 60% of the sediment column. Obviously for the non-turbiditic sediments is a high content of pteropods.

The sediments from the slope contain no turbidites and consist generally of silty clay, again with considerable amounts of pteropods. In these sediments differences in sediment composition are reflected rather in varying colours than in varying grain sizes. The most common colours are olive grey and black, but also light grey, dark grey, and brownish colours occur. Individual layers marked by a special colour vary in thickness between less than a mm to several cm. Wood pieces are far less important than in the basin and occur only scattered and not in special layers as in the basin.

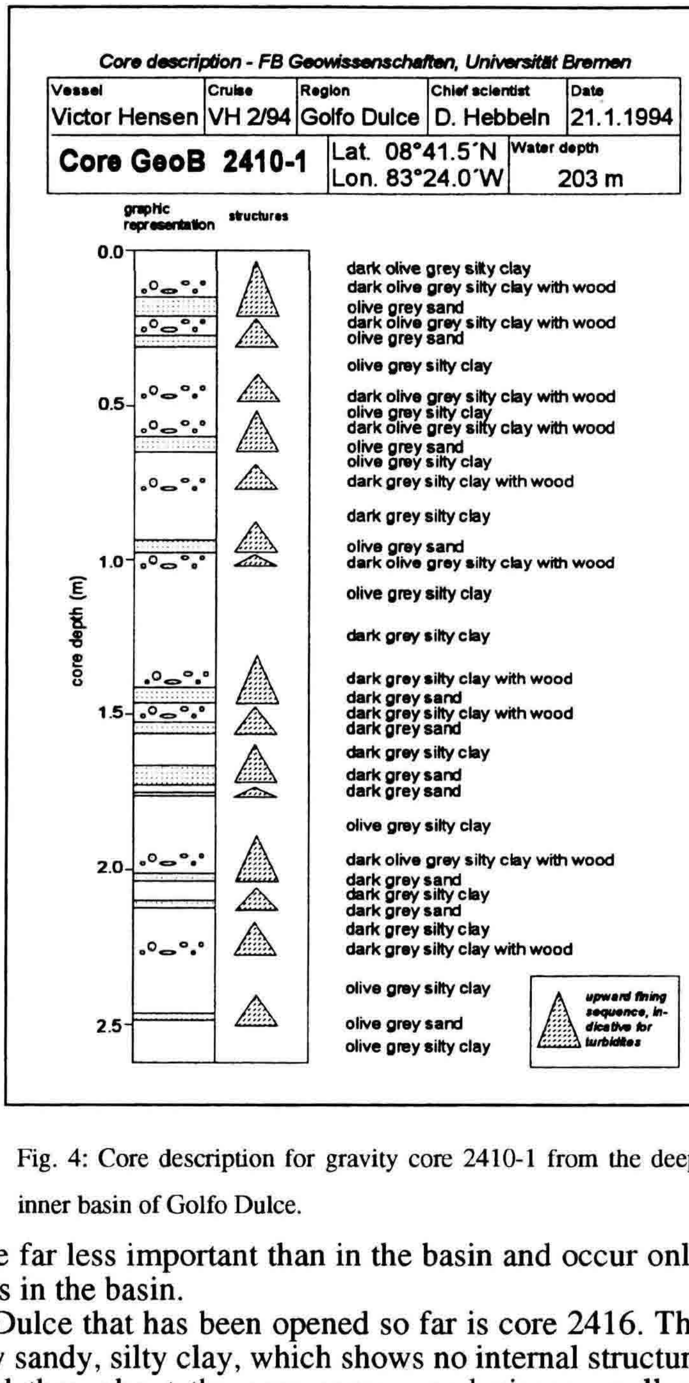

Fig. 4: Core description for gravity core 2410-1 from the deep inner basin of Golfo Dulce.

The only core from outside Golfo Dulce that has been opened so far is core 2416. The whole core consists of an olive grey sandy, silty clay, which shows no internal structure and no colour variations. Scattered throughout the core some wood pieces, mollusc shells and gastropod shells have been found.

Morphology and sediment structure in Golfo Dulce

The general morphology of Golfo Dulce as deduced from the 14 echosounder profiles is shown in Fig. 5. The echographs of the outer part of Golfo Dulce, the sill area, show only the sea floor as a single reflector, indicating a hard bottom with no young sediments. The inner basin of Golfo Dulce is characterised by a very flat sediment surface and has a steep wall to the northeast and a more gentle one to the west. Up to ten meters of sediments with some strong reflectors are resolved in the echographs from the inner basin. Close to the slopes some slump structures can be observed. In the very inner part of Golfo Dulce the depth of the deep basin is 205 m and it becomes slightly shallower to its outer part, where it is 185 m deep southwest of Golfito.

Along the slope the sediments resolved in the echographs are up to 15 m thick. The

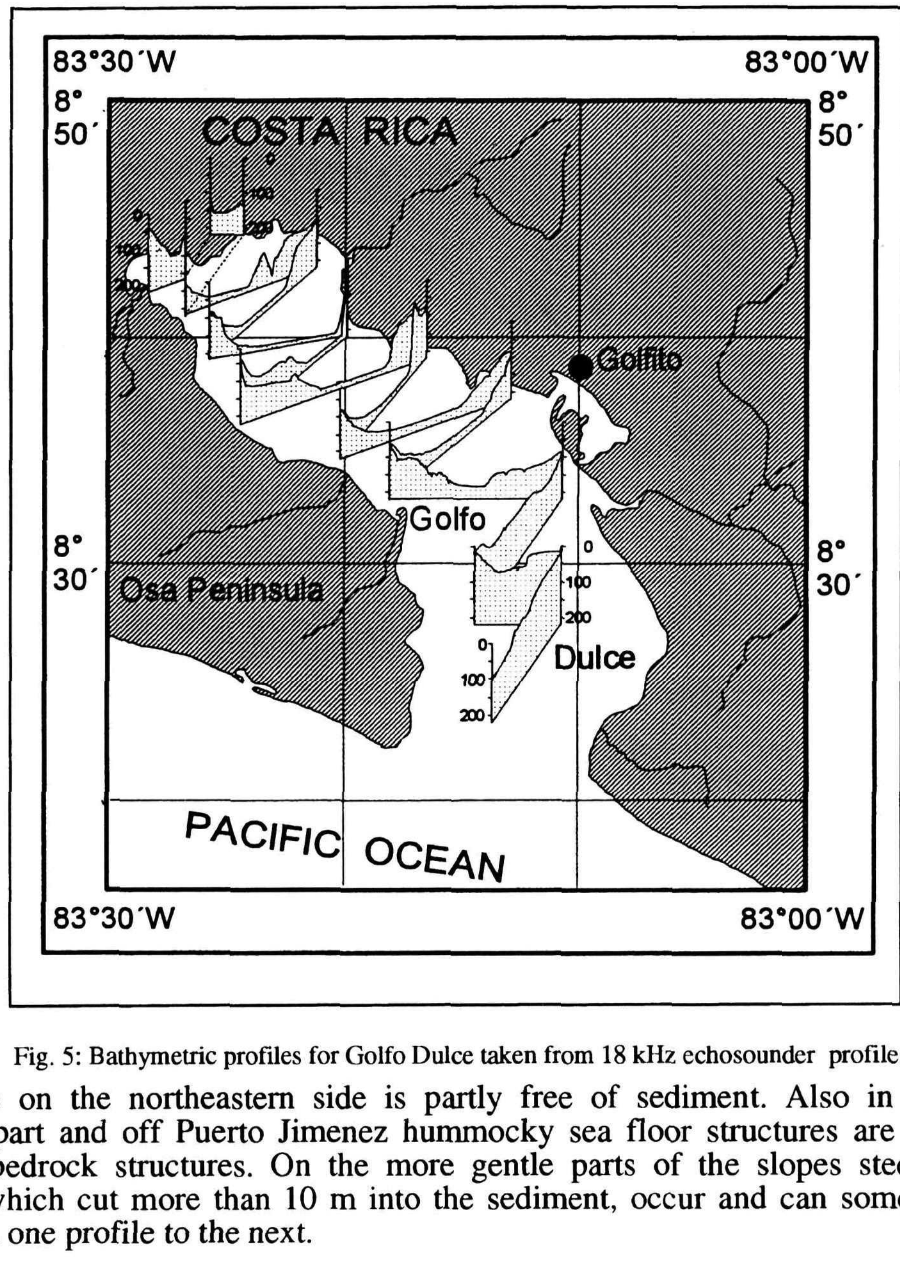

Fig. 5: Bathymetric profiles for Golfo Dulce taken from 18 kHz echosounder profiles.

steep slope on the northeastern side is partly free of sediment. Also in the very innermost part and off Puerto Jimenez hummocky sea floor structures are probably reflecting bedrock structures. On the more gentle parts of the slopes steep-walled channels, which cut more than 10 m into the sediment, occur and can sometimes be traced from one profile to the next.

2. Mapping of sediments around Isla del Caño (J. Cortés)

Introduction and objectives

While surveying the coral reefs around Isla del Caño the topography of the shallower areas (<30 m) as well as the bottom sediments have been studied before. In contrast, the deeper areas and zones further off the island have not been mapped or sampled before. With RV "Victor Hensen" it was possible to investigate and to map the bottom topography around the island (up to 6 miles off the coast). Sediment samples were taken to study the influence of the island on sediment composition in the adjacent areas.

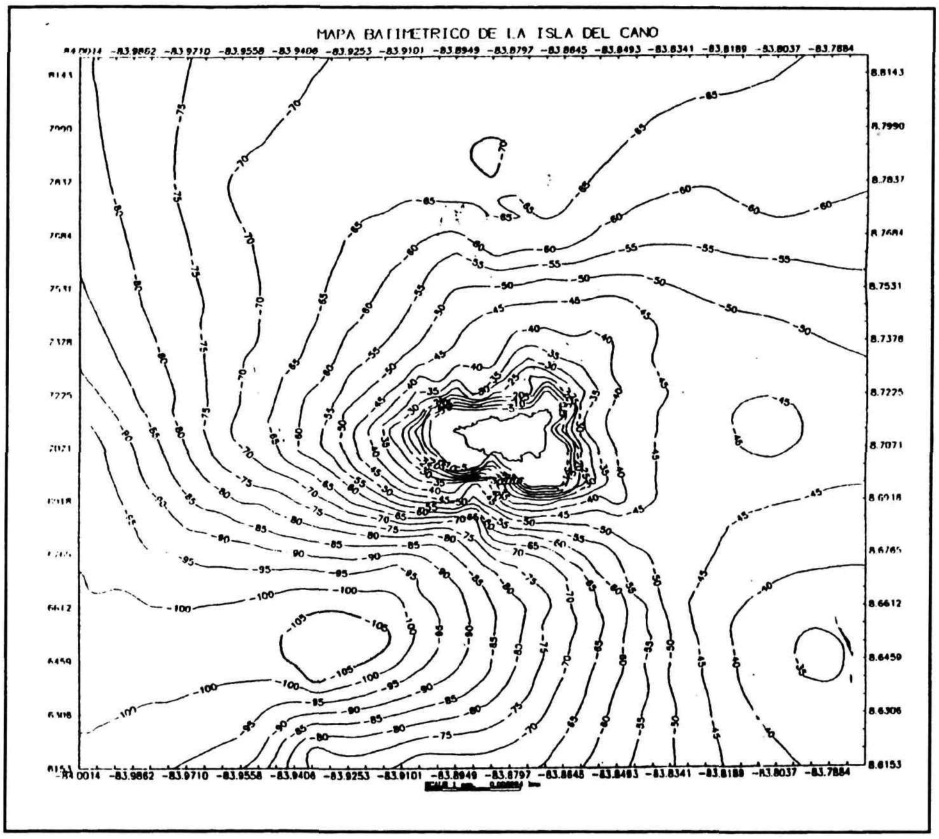

Fig.6: Bathymetric map the area around Isla del Caño

Mapping

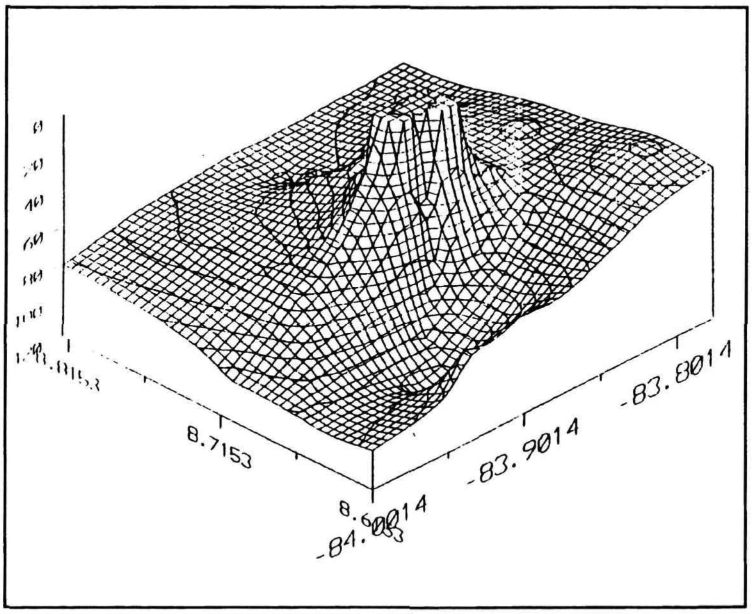

Fig. 7: Block diagram of Isla del Caño

A total of nine bottom profile transects (each 5 miles long) were done with the shipmounted echosounder around Isla del Caño (Fig. 1). The data were processed with the Surfer software to generate a map of the bottom topography (Fig. 6 and 7). The topographic map shows an elevated area to the southeast of the island, which was not known to exist, and a deep basin to the southwest. Putative shallow banks to the west and southwest were not seen in the depth soundings. Probably they are closer to the shore than indicated by local residents.

Bottom sediment samples

The north, east and southwest transects of the bottom profiling were also sampled for bottom sediments every mile by using the box corer. The $CaCO_3$ content was determined by the weight loss method. All samples were washed with destilled water to remove salts and then approx. 10 g dry sediment were digested in 25 ml of HCl. The residual was filtered (Watman paper filter #2), washed, dried, and re-weighted. Grain size distributions were accomplished by standard sieve technique with the following sieve sizes: 9500, 4000, 2000, 1000, 710, 500, 355, 250, 180, 125, and 75 µm. All analyses were done in duplicate or triplicate. The consistency limits of Atterberg limits were determined for the classification of fine-grained sediment samples. The first results of the grain size analysis show that on the profile north of Isla del Caño the coarsest sediments, mainly sand, are found on the most distant station 2428, approx. 6 nm off the coast. Along the profile towards the coast the sediments become finer and there is no strong difference between the four inner stations (Fig. 8a). The sediments from the profile to the southwest are the finest from all around the island. The outer stations (2435, 2426, and 2437) are located in a small basin (Fig. 6 and 7) consist mainly of clay and silt and contain less than 15% sand, while station 2434 has a slightly enriched fine sand content (Fig. 8b). Exceptional is the innermost station of this profile (2433), which is nearly a pure sand. East of the island the sediments are generally coarser (mainly sand) than on the other profiles and there is no obvious trend along the profile (Fig. 8c).

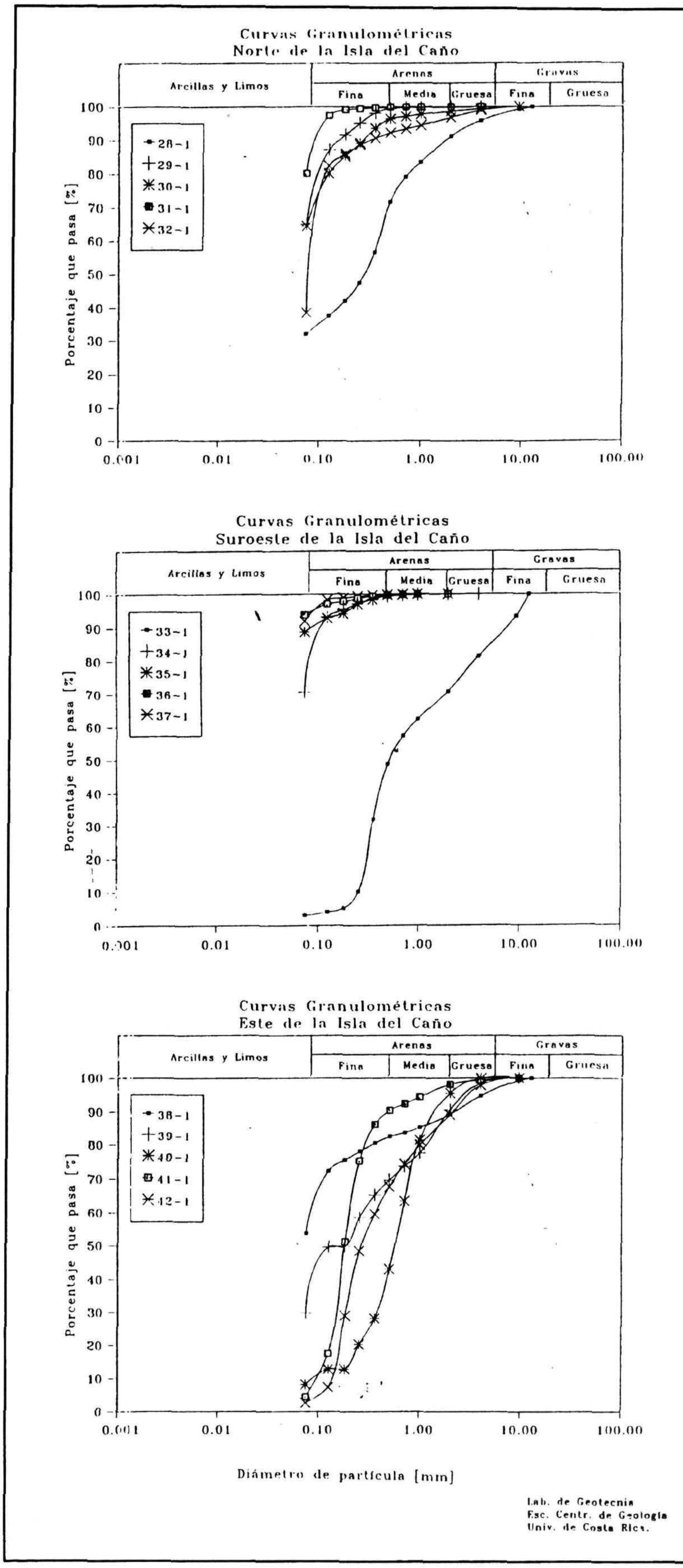

Fig. 8: Grain size analysis of surface sediments from three profiles off Isla del Caño. a) north, b) southwest, c) east

3. *Coral work (J. Cortés)*

Introduction and objectives

El Niño-Southern Oscillation (ENSO) results in warm waters in the eastern Pacific Ocean. The 1982-83 El Niño was specially strong causing the death of corals in the whole eastern Pacific region. Coral skeleton is an excellent recorder of past environmental conditions, as e.g. temperature variations are recorded in varying stable oxygen isotope compositions. Analyses done on corals from Isla del Caño show a warm temperature signature coincident with the 1983 warming event. But previous work with corals from Golfo Dulce has shown no El Niño signal, only what seems to be a freshwater isotopic deviation. The intention of this research project was to do a high resolution analysis of the corals from Golfo Dulce and Isla del Caño in search for El Niño and/or freshwater signals.

Table 1 - Localities and water depth of collected colonies of the massive coral *Porites lobata*.

Colony	Locality	Depth (m)
1	Punta Islotes, Golfo Dulce	8.5
2	Punta Islotes, Golfo Dulce	5.0
3	Punta Islotes, Golfo Dulce	3.0
4	Punta Islotes, Golfo Dulce	3.0
5	Isla del Caño	3.0
6	Isla del Caño	3.5
7	Isla del Caño	4.0

Table 2 - Coral species found on the outer part of Osa peninsula

Coral species	**Sites**	
	Punta Salsipuedes	Punta Llorona
Gardineroseris planulata		X
Oulangia bradleyi		X
Pavona clavus	X	X
Pavona gigantea	X	X
Pavona varians		X
Pocillopora damicornis		X
Pocillopora elegans	X	X
Pocillopora eydouxi		X
Porites lobata	X	X
Psammocora superficialis		X
Psammocora stellata	X	X
Total number of species	**5**	**11**

The outer coast of Osa peninsula is one of the most inaccessible of Costa Rica. For that reason the corals and coral reefs of that region, whose existence was known, were not studied previously. The presence of RV "Victor Hensen" on that coast was an excellent opportunity to visit and survey the area.

Field work

Coral work onboard RV "Victor Hensen" was carried out in three areas: Golfo Dulce, outer part of Osa peninsula (Corcovado National Park), and Isla del Caño (Fig.XX). Coral colonies of the massive species *Porites lobata* were collected for oxygen isotope analyses at Punta Islotes, Golfo Dulce, and at Isla del Caño (Table 1). These corals were cleaned with freshwater and sun dried.

The rocky points and islets on the ocean side of Osa peninsula were visited on two days. Transects were done along the coast to explore the presence of coral reefs. The coral species found at the sites are presented in Table 2. The number of coral species at Punta Llorona is relatively high and compares to other areas in Costa Rica. The types of reefs formed are extremely interesting, e.g. patch reefs formed by continuous growth of *Pocillopora* are rare in other parts of the coast. The low number of species at Punta Salsipuedes is probably due to the little time that was available for exploring that section of the coast. It is concluded after these short visits that more work is needed on the other sections of Osa peninsula.

Acknowledgements

We would like to thank Captain G. Sietas and the crew of RV Victor Hensen for their excellent work, which was the base for the success of the whole cruise.

Margarita Marchant (GeoB) and Ronald Kurmis (GeoB) helped to open and to describe the sediment cores. Javier Alvarado, Rolando Mora, Julio Hernádez and Luis Guillermo Salazar from The Geology School of the Universidad de Costa Rica helped with analyses of the sediment samples from around Isla del Caño and with the generation of the topographic map of the same area.

List of participants

1.) Dierk Hebbeln, GeoB (chief scientist)	(17.1.-30.1.94)
2.) Teresita Aguilar, UCR	(17.1.-22.1.94)
3.) Detlef Beese, GeoB	(17.1.-30.1.94)
4.) Beatriz Bofill, CIMAR	(17.1.-30.1.94)
5.) Jorge Cortés, CIMAR	(17.1.-30.1.94)
6.) Percy Denyer, UCR	(17.1.-22.1.94)
7.) Ana Fonseca, CIMAR	(17.1.-30.1.94)
8.) José Vargas, CIMAR	(22.1.-26.1.94)

GeoB:	Fachbereich Geowissenschaften, Universität Bremen, Germany
CIMAR:	Centro de Investigation en Ciencas del Mar y Limnologia, Universidad de Costa Rica
UCR:	Universidad de Costa Rica

Stationlist (Leg 3 - GeoB)

Station	Date	Time	Pos.Lat.	Pos.Lon.	depth	instruments
2401	19.1.94	06:54-11:04	08°40.0'N	83°22.0'W	204m	CTD, HN, BC III, GC II
2402	19.1.94	11:27-14:07	08°38.0'N	83°19.5'W	202m	CTD, HN, BC, GC II
2403	19.1.94	14:45-15:45	08°35.0'N	83°15.5'W	192m	CTD, HN, BC, GC
2404	20.1.94	06:45-07:45	08°36.5'N	83°14.0'W	160m	CTD, HN, BC, GC
2405	20.1.94	08:45-09:22	08°38.9'N	83°16.6'W	82m	CTD, HN, BC, GC
2406	20.1.94	10:39-11:27	08°37.1'N	83°23.6'W	129m	CTD, HN, BC, GC
2407	20.1.94	12:12-12:50	08°39.3'N	83°25.4'W	94m	CTD, HN, BC, GC
2408	20.1.94	13:12-14:20	08°41.5'N	83°24.0'W	202m	CTD, HN, BC, GC
2409	20.1.94	14:48-16:02	08°41.9'N	83°25.6'W	191m	CTD, HN, BC III, GC
2410	21.1.94	06:45-07:45	08°41.5'N	83°24.0'W	203m	GC II
2411	21.1.94	08:20-09:30	08°43.1'N	83°21.7'W	110m	CTD, HN, BC III, GC
2412	21.1.94	13:35-14:15	08°31.7'N	83°12.0'W	110m	CTD, HN, BC, GC
2413	23.1.94	06:00-07:38	08°20.2'N	83°41.7'W	820m	CTD, HN, BC II
2414	23.1.94	11:15-12:57	08°31.1'N	83°54.4'W	210m	CTD, HN, BC III
2415	23.1.94	13:20-15.22	08°30.1'N	83°56.9'W	490m	CTD, HN, BC III, GC
2416	24.1.94	11:35-13:18	08°20.3'N	83°13.5'W	210m	CTD, HN, BC III, GC
2417	24.1.94	13:38-14:34	08°22.7'N	83°13.5'W	102m	CTD, HN, BC III
2418	24.1.94	17:00-18:07	08°24.2'N	83°34.8'W	200m	CTD, HN, BC III
2419	25.1.94	06:00-11:28	08°28.7'N	84°00.7'W	1160m	CTD, HN, BC IIII, GC
2420	25.1.94	14:00-16:06	08°46.6'N	84°11.6'W	510m	CTD, HN, BC III, GC
2421	25.1.94	16:49-17:45	08°46.8'N	84°17.4'W	990m	CTD, HN, BC
2422	26.1.94	08:38-09:06	09°20.0'N	84°21.0'W	92m	CTD, HN, BC
2423	26.1.94	10:33-10:52	09°14.0'N	84°12.0'W	120m	CTD, HN, BC
2424	26.1.94	12:00-12:32	09°07.0'N	84°05.6'W	107m	CTD, HN, BC
2425	26.1.94	13:24-13:42	09°01.0'N	84°01.0'W	89m	CTD, HN, BC
2426	26.1.94	14:29-14:44	08°55.0'N	83°58'0'W	61m	CTD, HN, BC
2427	26.1.94	15:38-15:54	08°48.0'N	83°55.0'W	69m	CTD, HN, BC
2428	28.1.94	07:00-07:06	08°48.0'N	83°53.0'W	70m	BC
2429	28.1.94	07:19-07:25	08°47.0'N	83°53.0'W	73m	BC
2430	28.1.94	07:42-07:46	08°46.0'N	83°53.0'W	65m	BC
2431	28.1.94	08:00-08:30	08°45.0'N	83°53.0'W	57m	BC
2432	28.1.94	08:44-08:49	08°44.0'N	83°53.0'W	47m	BC
2433	28.1.94	12:00-12:11	08°41.2'N	83°52.9'W	40m	BC II
2434	28.1.94	12:20-12:28	08°40.5'N	83°53.6'W	82m	BC
2435	28.1.94	12:37-12:44	08°39.8'N	83°54.3'W	98m	BC
2436	28.1.94	12:52-13:02	08°39.1'N	83°55.0'W	108m	BC
2437	28.1.94	13:11-13:18	08°38.4'N	83°55.7'W	110m	BC
2438	28.1.94	15:28-15-40	08°42.5'N	83°46.5'W	47m	BC
2439	28.1.94	15:50-15:55	08°42.5'N	83°47.5'W	46m	BC
2440	28.1.94	16:05-16:11	08°42.5'N	83°48.5'W	43m	BC
2441	28.1.94	16:20-16:26	08°42.5'N	83°49.5'W	45m	BC
2442	28.1.94	16:36-16:43	08°42.5'N	83°50.5'W	42m	BC

CTD = CTD
HN = hand plankton net (20µm)
BC = box corer
GC = gravity corer

APPENDICES

Table 1.1.Victor Hensen cruise Leg 1 (December 2-8.1993). Nutrient data

STATION (code)	DATE (dd.mm.yy)	TIME (hh:mm)	GPS-POSITION (longitude/latitude)	BOTTOM (m)	SECCHII (m)	THERMOCLINE (m)	DEPTH OF HAUL (m)	NH4 (µmol/L)	NO3 (µmol/L)	NO2 (µmol/L)	PO4 (µmol/L)	SiO4 (µmol/L)
gn53		06:35	84°43,06/9°33,009	85	9,0	27	60	<1	22,53	0,04	1,75	15,08
gn53	3.12.93	06:35	84°43,06/9°33,009		9,0	27	27	<1	0,59	0,27	0,35	2,22
gn53	3.12.93	06:35	84°43,06/9°33,009	85	9,0	27	0	<1	0,23	0,08	0,09	12,98
bb31	3.12.93	15:50	84°59,24 / 9°43,46	28	9,0	15	28	<1	1,88	1,03	0,40	2,93
bb31	3.12.93	15:50	84°59,24 / 9°43,46	28	9,0	15	15	7	0,11	0,18	0,12	9,50
bb31	3.12.93	15:50	84°59,24 / 9°43,46	28	9,0	15	0	<1	0,63	0,02	0,09	10,21
gn51	3.12.93	11:25	85°00,087/9°38,089	60	11,0	28	55	<1	3,49	0,52	0,56	3,47
gn51	3.12.93	11:25	85°00,087/9°38,089		11,0	28	30	<1	0,11	0,02	0,16	0,40
gn51	3.12.93	11:25	85°00,087/9°38,089	60	11,0	28	0	<1	0,12	0,00	0,16	5,86
gn52	3.12.93	13:25	84°49,97/9°46,032	102	9,5	45	99	<1	8,52	0,03	0,72	15,02
gn52	3.12.93	13:25	84°49,97/9°46,032	102	9,5	45	44	<1	1,15	0,40	0,34	3,04
gn52	3.12.93	13:25	84°49,97/9°46,032	102	9,5	45	0	<1	0,18	0,02	0,07	8,62
gn54	3.12.93	18:15	84°49,97/9°43,46	240	8,0	50	200	6	27,18	0,02	2,24	22,90
gn54	3.12.93	18:15	84°49,97/9°43,46	240	8,0	50	50	<1	4,90	0,37	0,53	2,36
gn54	3.12.93	18:15	84°49,97/9°43,46	240	8,0	50	0	<1	0,38	0,02	0,07	0,54
gn06	3.12.93	17:30	84°46,55/9°45,09	50	4,0	-	45	-	8,83	0,11	0,74	6,32
gn06	3.12.93	17:30	84°46,55/9°45,09	50	4,0	-	25	<1	1,42	0,37	0,34	9,66
gn06	3.12.93	17:30	84°46,55/9°45,09	50	4,0	-	0	8	0,46	0,05	0,28	13,33
gn30	4.12.93	07:00	84°46,55/9°45,09	32	5,0	-	35	<1	10,32	0,52	1,29	12,33
gn30	4.12.93	07:00	84°46,55/9°45,09	32	5,0	-	21	<1	3,91	0,81	0,34	12,11
gn30	4.12.93	07:00	84°46,55/9°45,09	32	5,0	-	0	<1	0,71	0,37	0,32	15,29
gn35	4.12.93	09:30	84°47,64/9°55,67	18	6,0	-	16	<1	3,41	0,70	0,65	10,79
gn35	4.12.93	09:30	84°47,64/9°55,67	18	6,0	-	0	<1	0,58	0,03	0,16	12,87

STATION code	DATE dd.mm.yy	TIME hh:mm	POSITION longitude/latitude	BOTTOM in m	SECCHII in m	THERMOCLINE in m	DEPTH OF HAUL (m)	NH4 in µmol/L	NO3 in µmol/L	NO2 in µmol/L	PO4 in µmol/L	SiO4 in µmol/L
gn01	4.12.93	12:08	84°53,012/9°57,48	48	2,0	-	40	<1	4,51	0,77	0,51	15,15
gn01	4.12.93	12:08	84°53,012/9°57,48	48	2,0	-	0	<1	0,00	0,22	0,88	18,69
gn45 H2S!	4.12.93	14:20	85°00,75/10°03,06	7	1,0	-	7	<1	5,79	1,01	0,66	27,30
gn45 H2S!	4.12.93	14:20	85°00,75/10°03,06	7	1,0	-	0	<1	0,69	1,18	0,87	44,80
st01	6.12.93	08:00	84°03,45/8°47,079	178	20,0	?	150	<1	23,76	0,05	1,98	18,96
st01	6.12.93	08:00	84°03,45/8°47,079	178	20,0	?	40	<1	5,36	0,78	0,49	2,44
st01	6.12.93	08:00	84°03,45/8°47,079	178	20,0	?	0	<1	0,00	0,01	0,06	1,90
st02	6.12.93	09:50	84°00,82/8°47,01	102	17,0	?	90	<1	23,19	0,18	1,83	17,90
st02	6.12.93	09:50	84°00,82/8°47,01	102	17,0	?	40	<1	5,76	0,82	0,54	2,87
st02	6.12.93	09:50	84°00,82/8°47,01	102	17,0	?	0	<1	0,00	0,03	0,08	1,39
st03	6.12.93	13:00	83°44,79/8°46,92	50	9,0	35	45	<1	12,70	0,08	1,21	8,18
st03	6.12.93	13:00	83°44,79/8°46,92	50	9,0	35	35	<1	4,07	0,69	0,52	3,63
st03	6.12.93	13:00	83°44,79/8°46,92	50	9,0	35	0	<1	0,00	0,02	0,06	8,46
st04	6.12.93	14:50	83°41,51/8°46,93	27	5,0	-	25	2	0,86	0,27	0,27	1,32
st04	6.12.93	14:50	83°41,51/8°46,93	27	5,0	-	0	<1	0,55	0,01	0,15	12,50
gd01(12)	7.12.93	09:10	83°14,139/8°20,54	203	7,0	-	196	<1	2,47	0,04	2,21	20,70
gd01(12)	7.12.93	09:10	83°14,139/8°20,54	203	7,0	-	0	<1	0,62	0,05	0,06	5,94
gd02(11)	7.12.93	14:35	83°13,014/8°26,99	75	5,0	-	75	<1	23,71	0,09	1,80	15,16
gd02(11)	7.12.93	14:35	83°13,014/8°26,99	75	5,0	-	35	<1	5,67	0,15	0,48	16,10
gd02(11)	7.12.93	14:35	83°13,014/8°26,99	75	5,0	-	0	<1	0,42	0,07	0,07	21,90

STATION code	DATE dd.mm.yy	TIME hh:mm	POSITION longitude/latitude	BOTTOM in m	SECCHII in m	THERMOCLINE in m	DEPTH OF HAUL (m)	NH4 in µmol/L	NO3 in µmol/L	NO2 in µmol/L	PO4 in µmol/L	SiO4 in µmol/L
gd03	7.12.93	17:10	83°15,57/8°34,68	195	7,5	-	195	-	-	-	-	-
gd03	7.12.93	17:10	83°15,57/8°34,68	195	7,5	-	40	3	8,07	0,09	0,64	5,44
gd03	7.12.93	17:10	83°15,57/8°34,68	195	7,5	-	0	<1	0,03	0,02	0,18	13,30
gd05(1)	8.12.93	09:10	83°22,82/8°40,93	200	8,0	-	195	<1	0,90	0,06	2,23	31,39
gd05(1)	8.12.93	09:10	83°22,82/8°40,93	200	8,0	-	0	2	0,34	0,09	0,31	43,63
gd06(7)	8.12.93	12:15	83°24,14/8°39,08	100	4,5	-	95	4	9,86	0,08	2,36	31,41
gd06(7)	8.12.93	12:15	83°24,14/8°39,08	100	4,5	-	0	6	0,26	0,01	0,05	3,78
gd07(9)	8.12.93	13:00	83°25,68/8°38,33	41	-	-	35	2	-	-	-	-
gd07(9)	8.12.93	13:05	83°25,68/8°38,33	41	-	-	0	32	-	-	-	-
gd08	8.12.93	6:00	83°28,63/8°42,75	45	7,5	-	40	3	8,76	0,09	1,14	12,71
gd08	8.12.93	6:00	83°28,63/8°42,75	45	7,5	-	0	11	0,35	0,06	0,03	3,21

Table 1.2 Victor Hensen cruise leg 2 (February 2 - 8, 1994). Nutrient data

STATION (code)	DATE (dd.mm.yy)	TIME (hh:mm)	GPS-POSITION (longitude/latitude)	BOTTOM (m)	SECCHI (m)	THERMOCLINE (m)	DEPTH OF HAUL (m)	NH4 (µmol/L)	NO3 (µmol/L)	NO2 (µmol/L)	PO4 (µmol/L)	SiO4 (µmol/L)
gn26	3.2.94	14:20	84°53,33/9°52,07	13	2,5		10		0,71	0,16	0,32	5,10
gn26	3.2.94	14:20	84°53,33/9°52,07	13	2,5		5		0,34	0,03	0,10	4,19
gn26	3.2.94	14:20	84°53,33/9°52,07	13	2,5		0		0,32	0,06	0,26	2,16
bb1	4.2.94	07:13	84°53,33/9°52,07	12	8,0		20		0,28	0,13	0,28	1,02
bb1	4.2.94	07:13	84°53,33/9°52,07	12	8,0		10		0,16	0,05	0,15	0,07
bb1	4.2.94	07:13	84°53,33/9°52,07	12	8,0		5		0,02	0,09	0,11	0,91
bb1	4.2.94	07:13	84°53,33/9°52,07	12	8,0		0		2,32	0,00	0,15	31,91
bb2	4.2.94	08:27	84°53,33/9°52,07	20	9,0		10		0,10	0,03	0,09	3,02
bb2	4.2.94	08:27	84°53,33/9°52,07	20	9,0		0		0,00	0,00	0,10	2,31
bb3	4.2.94	09:15	84°53,33/9°52,07	30	11,0		30		18,67	0,40	1,60	9,68
bb3	4.2.94	09:15	84°53,33/9°52,07	30	11,0		20		1,32	0,10	0,16	2,23
bb3	4.2.94	09:15	84°53,33/9°52,07	30	11,0		10		0,00	0,13	0,26	1,39
bb3	4.2.94	09:15	84°53,33/9°52,07	30	11,0		0		0,09	0,00	0,14	1,98
bb4	4.2.94	09:58	84°53,33/9°52,07	40	8,0		38		19,21	0,24	1,64	11,53
bb4	4.2.94	09:58	84°53,33/9°52,07	40	8,0		30		6,99	0,55	0,60	3,45
bb4	4.2.94	09:58	84°53,33/9°52,07	40	8,0		20		2,93	0,34	0,43	-
bb4	4.2.94	09:58	84°53,33/9°52,07	40	8,0		10		0,63	0,04	0,11	3,58
bb4	4.2.94	09:58	84°53,33/9°52,07	40	8,0		0		0,17	0,00	0,00	4,09
bb5	4.2.94	11:05	84°53,33/9°52,07	50	9,0		45		18,18	0,31	1,43	12,84
bb5	4.2.94	11:05	84°53,33/9°52,07	50	9,0		40		18,02	0,20	1,53	11,40
bb5	4.2.94	11:05	84°53,33/9°52,07	50	9,0		30		14,60	0,52	1,34	10,55
bb5	4.2.94	11:05	84°53,33/9°52,07	50	9,0		20		8,75	0,67	1,07	2,74
bb5	4.2.94	11:05	84°53,33/9°52,07	50	9,0		0		0,11	0,00	0,15	3,05
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		55		21,37	0,16	1,93	18,77
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		45		16,36	0,21	1,67	14,14
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		35		7,93	0,08	0,28	6,24
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		25		7,21	0,33	0,58	6,89
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		15		2,35	0,45	0,40	1,81
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		5		0,00	0,03	0,18	1,41
ab	4.2.94	15:05	84°53,33/9°52,07	63	11,0		0		0,78	0,00	0,16	0,36
ab	4.2.94	18:25	84°53,33/9°52,07	60			60		18,35	0,10	1,65	15,59
ab	4.2.94	18:25	84°53,33/9°52,07	60			50		-	0,14	1,42	6,53
ab	4.2.94	18:25	84°53,33/9°52,07	60			40		8,81	0,09	0,44	2,82
ab	4.2.94	18:25	84°53,33/9°52,07	60			30		5,32	0,54	0,50	4,53
ab	4.2.94	18:25	84°53,33/9°52,07	60			20		1,90	0,29	0,48	1,35
ab	4.2.94	18:25	84°53,33/9°52,07	60			10		0,17	0,04	0,29	0,08
ab	4.2.94	18:25	84°53,33/9°52,07	60			0		0,07	0,05	0,19	0,93
ab	4.2.94	21:34	84°53,33/9°52,07	60			60		29,40	0,05	0,79	11,16
ab	4.2.94	21:34	84°53,33/9°52,07	60			50		9,53	0,02	-	7,64
ab	4.2.94	21:34	84°53,33/9°52,07	60			40		10,53	0,13	0,94	-
ab	4.2.94	21:34	84°53,33/9°52,07	60			30		-	0,34	1,04	0,45
ab	4.2.94	21:34	84°53,33/9°52,07	60			20		2,20	0,32	0,35	1,33
ab	4.2.94	21:34	84°53,33/9°52,07	60			10		0,33	0,03	0,18	0,78
ab	4.2.94	21:34	84°53,33/9°52,07	60			0		0,00	0,02	0,10	2,46
ab	5.2.94	00:34	84°53,33/9°52,07	60			60		21,52	0,11	1,76	17,41
ab	5.2.94	00:34	84°53,33/9°52,07	60			50		14,85	0,01	-	13,06
ab	5.2.94	00:34	84°53,33/9°52,07	60			40			0,26	1,25	11,49
ab	5.2.94	00:34	84°53,33/9°52,07	60			30		2,49	0,16	0,34	0,64
ab	5.2.94	00:34	84°53,33/9°52,07	60			20		1,62	0,18	0,22	2,47
ab	5.2.94	00:34	84°53,33/9°52,07	60			10		0,62	0,11	0,42	2,48
ab	5.2.94	00:34	84°53,33/9°52,07	60			0		0,17	0,09	0,04	0,32
ab	5.2.94	03:44	84°53,33/9°52,07	60			60		20,60	0,14	1,72	15,14
ab	5.2.94	03:44	84°53,33/9°52,07	60			50		19,07	0,04	1,45	15,91
ab	5.2.94	03:44	84°53,33/9°52,07	60			40		16,47	0,18	1,32	10,93
ab	5.2.94	03:44	84°53,33/9°52,07	60			30		4,63	0,37	0,48	2,34
ab	5.2.94	03:44	84°53,33/9°52,07	60			20		1,90	0,20	0,33	-
ab	5.2.94	03:44	84°53,33/9°52,07	60			10		0,01	0,00	0,09	1,21
ab	5.2.94	03:44	84°53,33/9°52,07	60			0		0,54	0,00	0,10	0,19

Table 1.2 continuation

STATION (code)	DATE (dd.mm.yy)	TIME (hh:mm)	GPS-POSITION (longitude/latitude)	BOTTOM (m)	SECCHII (m)	THERMOCLINE (m)	DEPTH OF HAUL (m)	NH4 (µmol/L)	NO3 (µmol/L)	NO2 (µmol/L)	PO4 (µmol/L)	SiO4 (µmol/L)
gn51	5.2.94	07:30	84°53,33/9°52,07	63	7,0		50		12,23	0,33	1,12	6,87
gn51	5.2.94	07:30	84°53,33/9°52,07	63	7,0		30		4,99	0,16	0,64	3,01
gn51	5.2.94	07:30	84°53,33/9°52,07	63	7,0		20		0,00	0,02	0,25	1,25
gn51	5.2.94	07:30	84°53,33/9°52,07	63	7,0		10		0,68	0,06	0,16	2,53
gn51	5.2.94	07:30	84°53,33/9°52,07	63	7,0		0		0,16	0,04	0,16	0,96
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		100		-	0,03	1,96	17,46
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		75		-	0,01	2,46	15,29
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		50		6,10	0,26	0,68	1,75
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		30		3,81	0,39	0,53	1,15
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		20		5,98	0,75	0,74	3,25
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		10		0,58	0,06	0,27	0,35
gn52	5.2.94	09:40	84°53,33/9°52,07	105	9,5		0		0,17	0,00	0,01	2,71
ah	5.2.94	19:50	84°53,33/9°52,07	42			38		17,33	0,44	1,35	11,34
ah	5.2.94	19:50	84°53,33/9°52,07	42			25		2,49	0,36	0,26	4,55
ah	5.2.94	19:50	84°53,33/9°52,07	42			15		2,46	0,11	0,40	2,68
ah	5.2.94	19:50	84°53,33/9°52,07	42			5		0,25	0,04	0,11	0,00
ah	5.2.94	19:50	84°53,33/9°52,07	42			0		0,64	0,05	0,16	1,75
ah	5.2.94	22:35	84°53,33/9°52,07				40		18,37	0,05	-	11,50
ah	5.2.94	22:35	84°53,33/9°52,07				30		6,64	0,14	0,38	2,35
ah	5.2.94	22:35	84°53,33/9°52,07				20		2,76	0,23	0,20	1,04
ah	5.2.94	22:35	84°53,33/9°52,07				10		-	-	-	-
ah	5.2.94	22:35	84°53,33/9°52,07				0		0,40	0,02	0,14	1,95
ah	6.2.94	01:40	84°53,33/9°52,07				40		23,30	0,22	2,28	12,1
ah	6.2.94	01:40	84°53,33/9°52,07				30		12,55	0,33	-	8,98
ah	6.2.94	01:40	84°53,33/9°52,07				20		-	0,66	1,17	6,60
ah	6.2.94	01:40	84°53,33/9°52,07				10		5,33	0,64	0,72	2,80
ah	6.2.94	01:40	84°53,33/9°52,07				0		0,25	0,03	0,17	2,03
ah	6.2.94	03:45	84°53,33/9°52,07				35		14,54	0,36	1,14	7,58
ah	6.2.94	03:45					25		13,04	0,67	-	6,82
ah	6.2.94	03:45	84°53,33/9°52,07				15		5,21	-	0,43	5,20
ah	6.2.94	03:45	84°53,33/9°52,07				2		3,63	0,50	0,36	3,81
ah	6.2.94	03:45	84°53,33/9°52,07				0		0,70	0,09	0,13	0,45
ah	6.2.94	06:05	84°53,33/9°52,07				35		14,23	0,76	1,08	5,00
ah	6.2.94	06:05	84°53,33/9°52,07				25		12,09	0,84	0,94	5,92
ah	6.2.94	06:05	84°53,33/9°52,07				15		5,65	0,83	0,61	5,85
ah	6.2.94	06:05					5		0,99	0,10	0,18	0,96
ah	6.2.94	06:05	84°53,33/9°52,07				0		1,05	0,07	0,18	1,27
gn53	6.2.94	08:00	84°53,33/9°52,07	90			70		11,36	0,01	0,81	9,51
gn53	6.2.94	08:00	84°53,33/9°52,07	90			45		2,24	0,20	0,42	1,01
gn53	6.2.94	08:00	84°53,33/9°52,07	90			20		1,83	0,22	0,42	0,08
gn53	6.2.94	08:00	84°53,33/9°52,07	90			10		0,45	0,00	0,15	1,78
gn53	6.2.94	08:00	84°53,33/9°52,07	90			0		0,04	0,01	0,03	0,64
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		200		28,90	0,04	2,13	17,20
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		150		28,30	0,02	2,07	-
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		100		19,60	0,00	1,40	17,56
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		75		-	0,04	-	15,53
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		50		17,31	0,14	1,24	12,87
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		30		4,34	0,24	0,52	2,04
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		20		1,86	0,08	0,37	1,75
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		10		0,02	0,00	0,00	1,01
st1	7.2.94	08:00	84°03,48/8°47,07	200	17,5		0		0,00	0,09	0,07	0,32
st2	7.2.94	09:35	84°01,07/8°47,01	100			90		19,60	0,00	1,53	-
st2	7.2.94	09:35	84°01,07/8°47,01	100			50		19,55	0,06	1,51	7,47
st2	7.2.94	09:35	84°01,07/8°47,01	100			30		2,49	0,17	0,37	0,99
st2	7.2.94	09:35	84°01,07/8°47,01	100			20		0,74	0,05	0,20	4,52
st2	7.2.94	09:35	84°01,07/8°47,01	100			10		1,18	0,00	0,22	0,70
st2	7.2.94	09:35	84°01,07/8°47,01	100			0		0,21	0,00	0,00	1,93

STATION (code)	DATE (dd.mm.yy)	TIME (hh:mm)	GPS-POSITION (longitude/latitude)	BOTTOM (m)	SECCHII (m)	THERMOCLINE (m)	DEPTH OF HAUL (m)	NH4 (µmol/L)	NO3 (µmol/L)	NO2 (µmol/L)	PO4 (µmol/L)	SiO4 (µmol/L)
st3	7.2.94	12:00	83°45,30/8°46,99	57	24,0		50		17,21	0,11	1,61	18,94
st3	7.2.94	12:00	83°45,30/8°46,99	57	24,0		30		13,31	-	1,24	6,60
st3	7.2.94	12:00	83°45,30/8°46,99	57	24,0		20		0,93	0,08	0,28	1,41
st3	7.2.94	12:00	83°45,30/8°46,99	57	24,0		10		0,20	0,00	0,08	0,02
st3	7.2.94	12:00	83°45,30/8°46,99	57	24,0		0		0,14	0,01	0,03	0,00
st4	7.2.94	13:10	83°45,30/8°46,99	25			20		0,15	0,02	0,16	0,77
st4	7.2.94	13:10	83°45,30/8°46,99	25			10		0,04	0,01	0,07	0,93
st4	7.2.94	13:10	83°45,30/8°46,99	25			0		0,44	0,00	0,00	0,00
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		200		21,26	0,01	1,46	11,95
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		175		26,40	0,02	2,18	16,37
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		150		21,88	0,00	1,94	18,95
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		125		13,01	0,01	1,07	6,71
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		100		9,01	0,02	0,63	6,31
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		75		22,25	0,03	1,48	7,99
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		50		22,60	0,03	2,25	15,50
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		25		7,18	0,54	0,76	5,59
gd12	8.2.94	06:55	83°45,30/8°46,99	206	10,5		0		0,33	0,02	0,14	0,06
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		65		16,83	0,03	0,74	11,59
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		55		29,24	0,15	2,18	13,71
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		45		17,83	0,18	1,36	7,53
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		35		21,87	0,33	2,25	12,42
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		15		0,20	0,12	0,16	1,44
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		5		0,13	0,05	0,13	0,00
gd11	8.2.94	09:10	83°45,30/8°46,99	73	5,5		0		0,34	0	0,00	1,06
gd3	8.2.94		83°45,30/8°46,99	190	10,0		175		17,95	0,05	2,22	25,18
gd3	8.2.94		83°45,30/8°46,99	190	10,0		150		15,95	0,03	1,97	22,62
gd3	8.2.94		83°45,30/8°46,99	190	10,0		125		6,82	0,01	0,58	10,69
gd3	8.2.94		83°45,30/8°46,99	190	10,0		100		13,17	0,01	1,81	19,63
gd3	8.2.94		83°45,30/8°46,99	190	10,0		75		8,43	0,00	1,52	2,02
gd3	8.2.94		83°45,30/8°46,99	190	10,0		50		16,95	0,00	2,02	14,27
gd3	8.2.94		83°45,30/8°46,99	190	10,0		25		21,23	0,05	1,82	13,66
gd3	8.2.94		83°45,30/8°46,99	190	10,0		10		0,67	0,13	0,25	0,21
gd3	8.2.94		83°45,30/8°46,99	190	10,0		0		0,00	0,09	0,02	0,60
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		45		11,38	0,03	2,36	19,66
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		35		12,48	0,06	2,36	27,67
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		25		9,81	0,08	1,03	11,43
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		15		0,70	0,92	0,52	3,41
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		2		0,56	0,02	0,20	1,37
re1	8.2.94	14:02	83°45,30/8°46,99	50	6,0		0		0,08	0,02	0,09	2,52
re2	8.2.94	15:00	83°45,30/8°46,99	100			100		3,55	0,06	2,32	22,86
re2	8.2.94	15:00	83°45,30/8°46,99	100			90		3,51	0,05	2,22	5,44
re2	8.2.94	15:00	83°45,30/8°46,99	100			80		6,77	0,01	2,60	26,38
re2	8.2.94	15:00	83°45,30/8°46,99	100			60		8,54	0,00	1,73	25,60
re2	8.2.94	15:00	83°45,30/8°46,99	100			50		16,54	0,00	0,78	17,51
re2	8.2.94	15:00	83°45,30/8°46,99	100			30		15,35	0,02	1,59	23,11
re2	8.2.94	15:00	83°45,30/8°46,99	100			20		6,55	0,10	0,53	8,25
re2	8.2.94	15:00	83°45,30/8°46,99	100			10		0,19	0,04	0,16	1,78
re2	8.2.94	15:00	83°45,30/8°46,99	100			0		0,44	0,03	0,07	2,53
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		140		1,00	0,06	0,48	11,02
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		120		1,22	0,49	1,10	43,10
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		100		3,78	0,45	2,35	28,03
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		80		5,52	0,25	2,09	33,50
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		60		7,24	0,02	1,78	24,98
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		40		10,18	0,00	1,70	-
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		20		4,85	0,00	0,55	32,40
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		10		0,03	0,01	0,05	3,40
re3	8.2.94	15:55	83°45,30/8°46,99	150	8,0		0		0,16	0,01	0,11	3,06

Table 1.2 continuation

STATION (code)	DATE (dd.mm.yy)	TIME (hh:mm)	GPS-POSITION (longitude/latitude)	BOTTOM (m)	SECCHII (m)	THERMOCLINE (m)	DEPTH OF HAUL (m)	NH4 (µmol/L)	NO3 (µmol/L)	NO2 (µmol/L)	PO4 (µmol/L)	SiO4 (µmol/L)
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		175		0,03	0,00	0,58	21,35
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		150		1,56	0,32	3,64	28,27
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		125		2,56	0,77	2,36	35,00
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		100		4,92	0,26	1,97	-
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		75		6,07	0,07	1,56	25,66
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		50		8,29	0,00	2,15	25,32
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		25		13,99	0,10	1,46	10,18
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		10		0,55	0,01	0,28	1,21
re4	8.2.94	17:25	83°45,30/8°46,99	200	6,5		0		0,10	0,01	0,05	4,95
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		140		6,19	0,54	1,43	22,00
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		120		5,10	0,01	1,47	12,55
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		100		2,88	0,17	0,70	15,91
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		80		6,29	0,03	2,06	24,15
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		60		18,82	0,00	1,54	-
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		40		11,47	0,04	1,74	17,24
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		20		3,06	0,24	0,52	6,13
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		10		0,61	0,00	0,26	0,95
re5	9.2.94	08:10	83°45,30/8°46,99	149	8,0		0		0,24	0,01	0,08	2,74
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		90		11,14	0,01	2,30	28,76
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		80		9,08	0,02	1,92	18,09
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		60		11,73	0,01	1,75	22,84
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		40		12,62	0,04	1,78	17,21
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		20		6,01	0,08	0,57	5,10
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		10		0,03	0,05	0,31	1,50
re6	9.2.94	09:15	83°45,30/8°46,99	98	1,0		0		0,00	0	0,10	0,09
re7	9.2.94		83°45,30/8°46,99	61	3,3		50		13,70	0,04	1,77	53,52
re7	9.2.94		83°45,30/8°46,99	61	3,3		40		11,80	0,04	1,45	42,01
re7	9.2.94		83°45,30/8°46,99	61	3,3		30		16,07	0,05	0,90	10,63
re7	9.2.94		83°45,30/8°46,99	61	3,3		10		0,09	0,01	0,15	0,80
re7	9.2.94		83°45,30/8°46,99	61	3,3		0		0,31	0,02	0,17	10,58

date	stat.	gear	species	B [g/ m2]	B(t) [g]	A [/ m2]	A (t)	P [g/m2]	size range [cm]	m.w. [g]
14.12.1993	31F	bk	Achirus kluzingeri	0,635949	1325	0,005760	12	0,178568	8...19	110,42
			Bollmannia sp.		...	0,001440	3	0,000000	...	
			Diplobatis ommata	0,131989	275	0,001440	3	0,038971	10,0;13,2;21,8	91,67
			Epinephelus niphobles	0,038858	81	0,000480	1	0,011864	5,00	
			Lutjanus guttatus		...	0,000000			<8	
			Microgobius erectus		...	0,000000			<8	
			Monolene sp.	0,082280	171	0,000480	1	0,020516	5,20	
			Paralichthys		...	0,000000			<8	
			Serranus psittacinus		...	0,000000			<8	
			Sphoeroides lobatus		...	0,000000			<8	
			Syacium latifrons	0,215983	450	0,030718	64	0,127562	3,5...14,8	7,03
			Symphurus leei	0,009599	20	0,005280	11	0,008168	4,3...9,5	1,82
15.12.1993	31F	gsn	Argentina aliceae	0,002468	200	0,000148	12	0,001155	12,7...14,7	16,67
			Arothron hispidus	0,030855	2500	0,000086	7	0,006310	22,0...24,9	357,14
			Bollmannia chlamydes	0,000926	75	0,000123	10	0,000537	8...11,3	7,50
			Bollmannia stigmatura	0,000457	37	0,000062	5	0,000266	2,7...12,9	7,40
			Calamus brachysomus	0,080222	6500	0,000111	9	0,013566	28,7...41,2	722,22
			Caranx speciosus	0,059241	4800	0,000025	2	0,007244	57,5 59,5	2400,00
			Cyclopsetta panamensis	0,003394	275	0,000012	1	0,000745	309,00	275,00
			Diplectrum macropoma	0,000259	21	0,000012	1	0,000114	63,20	21,00
			Diplectrum sp.	0,000012	1	0,000012	1	0,000012	6,00	1,00
			Diodon histrio	0,008331	675	0,000012	1	0,001435	22,00	675,00
			Engraulidae	0,000185	15	0,000012	1	0,000089	12,20	15,00
			Eucinostomus gracilis	0,029003	2350	0,002851	231	0,015504	6,0...14,9	10,17
			Gymnothorax aequatorialis	0,005307	430	0,000012	1	0,001032	63,20	430,00
			Hippoglossina tetrophthalmus	0,010491	850	0,000049	4	0,002468	21,6...29	212,50
			Kathetostoma averruncus	0,004011	325	0,000049	4	0,001224	4,2...18,3	81,25
			Lepophidium prorates	0,005554	450	0,000555	45	0,002983	7...15,7	10,00
			Lophiodes spilurus	0,000926	75	0,000037	3	0,000388	9,4 9,9 13,5	25,00
			Lutjanus guttatus	0,000148	12	0,000012	1	0,000076	9,20	12,00
			Ophichtus ramiger	0,005554	450	0,000025	2	0,001287	51,3 61,6	225,00
			Ophisoma prorigerum	0,006788	550	0,000148	12	0,002417	18,9...36,1	45,83
			Peristedion crustosum	0,000420	34	0,000049	4	0,000235	8,8...13,5	8,50
			Physiculus nematopus	0,023141	1875	0,001592	129	0,011234	4,8...18,4	14,53
			Physiculus rastrelliger	0,002468	200	0,000173	14	0,001204	8,1...17,1	14,29
			Pontinus sierra	0,029003	2350	0,000617	50	0,010256	4,7...28,9	47,00
			Porichthys margaritatus	0,001851	150	0,000148	12	0,000936	5,8...11,8	12,50
			Pronotogrammus eos	0,000278	23	0,000012	1	0,000120	8,20	
			Pseudupeneus vancolensis	0,000086	7	0,000025	2	0,000062	6,5 6,8	3,50
			Selar crumenophthalmus	0,000284	23	0,000025	2	0,000147	12,2 13,7	11,50
			Symphurus callopterus	0,000160	13	0,000012	1	0,000080	12,40	13,00
			Eucinostomus argenteus	0,001851	150	0,000025	2	0,000577	18,5 15,9	75,00
			Trachinotus paitensis	0,018513	1500	0,000012	1	0,002570	49,50	1500,00
			Urotrygon chilensis (?)	0,006171	500	0,000012	1	0,001152	39,50	500,00
			Cyclopsetta panamensis	0,003394	275	0,000012	1	0,000745	30,90	
			Zalieutes elater	0,000074	6	0,000012	1	0,000046	7,70	6,00
			sum	**1,456485**	**30019**	**0,052681**	**669**	**0,473864**		
14.12.1993	51F	bk	Achirus maximus	0,003360	7	0,000480	1	0,001987	7,90	7,00
			Bellator xenisma	0,000960	2	0,000960	2	0,000960	4,2 4,8	1,00
			Cynoscion latifrons		...	0,008639	18		8,6...17,9	
			Diplectrum sp.	0,002880	6	0,000960	2	0,002141	4,3 7,2	3,00
			Porichthys margaritatus	0,002400	5	0,000960	2	0,001874	7,5 6,8	2,50
			Scorpaena histrio	0,003360	7	0,000480	1	0,001987	9,10	7,00
			Scorpaena russula	0,002400	5	0,000480	1	0,001554	5,20	5,00
			Syacium latifrons	0,063365	132	0,003840	8	0,029724		
			Syacium ovale		...		...			
			Synchiropus attrilobata	0,002160	5	0,001920	4	0,002092	4,8 5,1 5,3 5,5	1,13
			Synodotus evermanni	0,005760	12	0,002400	5	0,004547	5,9...10,8	2,40
			sum	**0,086643**	**181**	**0,021118**	**44**	**0,046865**		
14.12.1993	52F	bk	Physiculus nematopus	0,001200	13	0,000480	1	0,000937	...	
			Rhynchoconger nitens	0,001025	11	0,000480	1	0,000835	...	
			Serranus psittacinus		...	0,000480	1		...	
15.12.1993	52F	gsn	Argentina alicea	0,001543	125	0,000148	12	0,000819	10...12	10,42
			Bollmannia chlamydes	0,004023	326	0,000518	42	0,002314	5,5...10,9	7,76
			Bollmannia stigmatura	0,000864	70	0,000160	13	0,000548	8,2...10,5	5,38
			Brotula clarkae	0,010799	875	0,000025	2	0,002091	39,2 39,7	437,50
			Caulolatilus affinis	0,043197	3500	0,000037	3	0,006418	40,7 40,8 45,5	1166,67
			Citharichthys platophrys	0,006788	550	0,001753	142	0,004709	6,0...12	3,87
			Diplectrum eumelum	0,053070	4300	0,000222	18	0,012099	18,5...30,5	238,89
			Engyophrys sanctilaurentii	0,000642	52	0,000074	6	0,000358	8,7...12,1	8,67
			Hemanthias peruanus	0,078371	6350	0,000889	72	0,023382	15...42,4	88,19
			Hemanthias signifer	0,053070	4300	0,000654	53	0,016194	9,3...36,5	81,13
			Hippoglossina tetraophthalmus	0,041962	3400	0,000185	15	0,009703	27...31,5	226,67
			Lepophidium negropinna	0,012959	1050	0,000099	8	0,003473	14,5...37	131,25
			Loligo sp.	0,088861	7200	0,010663	864	0,050129	2...7,5	8,33
			Mustelus lunulatus	0,018204	1475	0,000012	1	0,002539	37...49	
			Paralabrax loro	0,020981	1700	0,000025	2	0,003395	38,5 39,5	850,00
			Peprilus snyderi	0,095032	7700	0,001098	89	0,028501	14,3...31,1	86,52
			Peristedion barbiger	0,000112	9	0,000012	1	0,000062	8,30	
			Physiculus rastrelliger	0,004320	350	0,000173	14	0,001811	...	25,00

date	stat.	gear	species	B [g/ m2]	B(t) [g]	A [/ m2]	A (t)	P [g/m2]	size range [cm]	m.w. [g]
			Pomadasys branicki	0,045356	3675	0,000123	10	0,009205	25,7...32,5	367,50
			Porichthys margaritatus	0,001543	125	0,000518	42	0,001149	5,1...9,8	2,98
			Prionotus teaguei	0,000025	2	0,000012	1	0,000020	5,90	
			Raja velezi	0,000173	14	0,000025	2	0,000102	63 66	7,00
			Symphurus callopterus	0,000215	17	0,000025	2	0,000120	11 12,3	
			Synodus scituliceps	0,010491	850	0,000778	63	0,005196	8...16,5	13,49
			Trichiurus nitens	0,032089	2600	0,002209	179	0,015581	25...39,5	14,53
			Umbrina bussingii	0,032089	2600	0,000099	8	0,006732	36,8...31,8	325,00
			Zaliutes elater	0,000134	11	0,000025	2	0,000085	4 4,5	5,44
			sum	**0,659138**	**53250**	**0,022001**	**1669**	**0,208508**		
14.12.1993	53F	bk	Bellator xenisma	0,001920	4	0,000480	1	0,001320	4,80	4,00
			Bregmaceros bathymaster	0,000960	2	0,001920	4	0,001157	4,20	0,50
			Chiloconger labiatus		...	0,000960	2		17,4 22,6	
			Engyophrys sanctilaurentii	0,001920	4	0,000480	1	0,001320	6,40	4,00
			Porichthys margaritatus	0,003840	8	0,000480	1	0,002190	8,80	8,00
			Syascium latifons	0,004320	9	0,000480	1	0,002387	10,00	9,00
15.12.1993	53F	gsn	Antennarius aphalonis	0,001629	132	0,000025	2	0,000526	10,6 15,2	66,00
			Bellator xenisma	0,000099	8	0,000037	3	0,000076	6,3 7 7,6	2,67
			Bollmannia chlamydes	0,000025	2	0,000012	1	0,000020	6,20	2,00
			Caulolatilus affinis	0,005554	450	0,000012	1	0,001067	34,00	450,00
			Citharichthys platophrys	0,004011	325	0,000580	47	0,002380	5,6...11,7	6,91
			Diplectrum eumelum	0,014810	1200	0,000148	12	0,004271	7,8...30,4	100,00
			Diplectrum labarum	0,000703	57	0,000074	6	0,000383	8,3...12	9,50
			Diplectrum sp.	0,005554	450	0,000012	1	0,001067	33,50	450,00
			Engyophrys sanctilaurentii	0,000309	25	0,000049	4	0,000188	6,9...10,6	6,25
			Hemanthias peruanus	0,008022	650	0,000025	2	0,001683	28 40,3	325,00
			Hippoglossina tetrophthalmus	0,012342	1000	0,000049	4	0,002779	25,7...30,3	250,00
			Lophiodes caulinares	0,010799	875	0,000049	4	0,002521	14...24,7	218,75
			Morena sp.	0,014810	1200	0,000086	7	0,003693	38,5 47,5	171,43
			Mustelus lunulatus	0,038260	3100	0,000049	4	0,006348	53...64	775,00
			Pomadasys branickii	0,004320	350	0,000012	1	0,000888	27,50	350,00
			Pontinus fusarinus	0,001518	123	0,000012	1	0,000414	20,90	123,00
			Porichthys margaritatus	0,000062	5	0,000012	1	0,000040	8,30	5,00
			Prionotus albirostris	0,002777	225	0,000025	2	0,000776	16,5 21,9	112,50
			Pronotogrammus eos	0,000210	17	0,000012	1	0,000098	13,20	17,00
			Raja velezi	0,161678	13100	0,000173	14	0,025494	32...49,5	935,71
			Scorpaena russula	0,000494	40	0,000037	3	0,000245	8,9 9,1 10	13,33
			Symchirobus atrilabiatus	0,000037	3	0,000025	2	0,000033	5,4 5,9	1,50
			Synodus scituliceps	0,012342	1000	0,001506	122	0,006994	7,5...16,7	8,20
			Torpedo tremens	0,000021	2	0,000025	2	0,000022	13,5 31,5	0,85
			Trichiurus nitens	0,006171	500	0,000370	30	0,002887	...	16,67
			Zalieutes peruanus	0,002468	200	0,000222	18	0,001288	4,6...11,9	11,11
			Zapteryx exasperata	0,000052	4	0,000049	4	0,000051	19...29	1,05
			sum	**0,322035**	**25070**	**0,008490**	**309**	**0,074608**		
14.12.1993	54F	bk	Bollmannia chlamydes	0,009599	20	0,000960	2	0,005155	10,2 12,2	10,00
			Bregmaceros bathymaster	0,001200	3	0,000960	2	0,001130	4,7 5,4	1,25
			Rhynchoconger nitens	0,019198	40	0,001920	4	0,010310	14,6 18,2 18,5 18,6	10,00
			Physiculus rastrelliger	0,035997	75	0,001440	3	0,015095	14,7 17,2 18,6	25,00
			Scorpaena russula	0,000480	1	0,000480	1	0,000480	4,30	1,00
			Symphurus callopterus	0,024478	51	0,003840	8	0,014845	9,2...12,1	6,38
			Symphurus sp.		...	0,000960	2		10,1 10,4	
			new sp. of Congridae		...	0,000960	2		13,4 18,4	
			new sp. Congridae		...	0,000480	1		28,40	
15.12.1993	54F	gsn	Coelorhynchus scaphopsis		...	0,000012	1		12,60	
			Diplectrum euryplectrum	0,000457	37	0,000012	1	0,000172	14,20	37,00
			Gymnothorax aequatorialis	0,029003	2350	0,000210	17	0,007664	...	138,24
			Gymnothorax sp. (new?)	0,000015	1	0,000025	2	0,000018	...	0,63
			Lepophidiun negropinna	0,001049	85	0,000025	2	0,000381	18,7 25,3	42,50
			Peprilus snyderi	0,024067	1950	0,000432	35	0,008128	13,1...16,6	55,71
			Trichiurus nitens	0,090096	7300	0,008109	657	0,047027	22...44,5	11,11
			Urotrygon chilensis	0,005862	475	0,000012	1	0,001110	35,10	475,00
			sum	**0,241502**	**12388**	**0,020836**	**741**	**0,111515**		
14.12.1993	06F	bk	Ophichtiidae		...	0,000480	1		16,90	
			Porichthys greeni	0,001440	3	0,002400	5	0,001653	3,2 3,2 4,7 6,3	0,60
			Syascium ovale	0,003840	8	0,000480	1	0,002190	8,50	8,00
15.12.1993	06F	gsn	Anchoa nasus	0,000197	16	0,000049	4	0,000136	8,3 7 9 10	4,00
			Anchova sp.	0,022832	1850	0,004270	346	0,014520	5,2...8,4	5,35
			Bollmannia stigmatura	0,000136	11	0,000889	72	0,000225	4,5...11,7	0,15
			Caranx caninus	0,028386	2300	0,000012	1	0,003511	56,50	2300,00
			Cyclopsetta querna	0,101203	8200	0,000370	30	0,022248	18...43	273,33
			Diplectrum macropoma	0,011108	900	0,000296	24	0,004175	12,3...17,5	37,50
			Eucinostomus aureolus	0,014193	1150	0,000765	62	0,006451	9,9...12,4	18,55
			Isophistus altipinnis	0,007405	600	0,000272	22	0,003033	8,6...22,5	27,27
			Larimus pacificens	0,012342	1000	0,000185	15	0,003971	7,5...18,7	66,67
			Lepophidium prorates	0,001851	150	0,000062	5	0,000739	14,3...27	30,00
			Lutjanus guttatus	0,016353	1325	0,000012	1	0,002347	47,70	1325,00
			Microgobius erectus	0,000062	5	0,000074	6	0,000065	...	
			Neopistopterus tropicus	0,002160	175	0,001530	124	0,001968	6,6...10,6	1,41
			Ophictus sp.	0,009873	800	0,000062	5	0,002508	43...50	160,00

date	stat.	gear	species	B [g/ m2]	B(t) [g]	A [/ m2]	A (t)	P [g/m2]	size range [cm]	m.w. [g]
			Peprilus medius	0,178957	14500	0,000185	15	0,027972	16,8...24,6	966,67
			Peprilus snyderi	0,118482	9600	0,000592	48	0,028338	18...33,5	200,00
			Selene peruviana	2,295588	186000	0,002296	186	0,355544	18...22	1000,00
			Synodus scituliceps	0,053070	4300	0,001259	102	0,019326	9...29,9	42,16
			Trichurus nitens	0,004937	400	0,000383	31	0,002475	22...39,8	12,90
			Zalieutes elater	0,000123	10	0,000012	1	0,000066	6,00	10,00
			sum	**2,884539**	**233303**	**0,016936**	**1107**	**0,503463**		
16.12.1993	45F	bk	Menthicirrus nasus	0,003840	8	0,000480	1	0,002190	10,10	8,00
			Ophioscon typicus	0,041757	87	0,001440	3	0,016822	13,9 14,1 15,3	29,00
			Paralonchurus nathbani	0,002880	6	0,000960	2	0,002141	7,3 6,6	3,00
			Porichthys greeni	2,879770	6000	0,001440	3	0,369896	6,3 6,3 7,2	2000,00
			Pyopterus aureolus	0,004800	10	0,000480	1	0,002578	9,00	10,00
			Symphurus chabaunadi	0,010079	21	0,000960	2	0,005342	11,8 14,1	10,50
			Urotrygon mundus	0,095992	200	0,000480	1	0,022959	30,30	200,00
16.12.1993	45F	gsn	Achirus klunzingeri	0,000805	65	0,000115	9	0,000476	9,00	7,00
			Achirus scutum	0,092021	7456	0,002646	214	0,035295	7...9,5	34,78
			Anchoa lucida	0,412944	33459	0,000000	0		16,9...24,1	
			Anchoa lucida	0,025881	2097	0,000460	37	0,008719		56,25
			Anchoa sp.	0,161037	13048	0,019439	1575	0,090991	7,1...12,7	8,28
			Anisostremus pacifici	0,031632	2563	0,000115	9	0,006942	23,90	275,00
			Arius dasycephalus	0,517618	41940	0,013573	1100	0,193665	13...20,4	38,14
			Arius dowii	2,645603	214360	0,000920	75	0,308101	68,5...87	2875,00
			Arius dowii	0,051762	4194	0,000575	47	0,015359	21,9...23	90,00
			Arius troscheli	0,569380	46134	0,000460	37	0,083256	19...47	1237,50
			Cetengraulis mysticetus	0,069016	5592	0,001495	121	0,024525	16,2...18,6	46,15
			Cynoscion phoxocephalus	0,310571	25164	0,005406	438	0,104030	4,5...20,8	57,45
			Cynoscion albus	0,057513	4660	0,005406	438	0,030375		10,64
			Dasyatis longus	11,698167	947844	0,000920	75	0,911959	62...91	12712,50
			Diapterus peruvianus	0,037959	3076	0,001610	130	0,016172	20,7...32,5	23,57
			Diplectrum euplectrum	0,014378	1165	0,000115	9	0,003904	19,70	125,00
			Ilisha furthii	0,021855	1771	0,000345	28	0,007130	21 21,8 25,5	63,33
			Isophistus altipinnis	0,097772	7922	0,001265	103	0,030231	17,3...24,3	77,27
			Lutjanus guttatus	0,000805	65	0,000115	9	0,000476	9,20	7,00
			Menthicirrus nasus	0,051762	4194	0,000230	19	0,011993	26,2 26,7	225,00
			Neopistopherus tropicus	0,235919	19115	0,052797	4278	0,157478	7,6...10,8	4,47
			Ophistpterus dovii	0,002070	168	0,000115	9	0,000949	16,50	18,00
			Opistopherus aequatorialis	0,114221	9255	0,004256	345	0,046988	...	26,84
			Paralonchurus dumerilli	0,247306	20038	0,000690	56	0,050533	22,2...37,5	358,33
			Polydactylus aproximus	0,103524	8388	0,000230	19	0,019892	...	450,00
			Pomadasys leuciscus	0,138031	11184	0,001150	93	0,037897	16...28,7	120,00
			Prepillus snyderi	0,017254	1398	0,000115	9	0,004460	22,60	150,00
			Prionotus horrens	0,014953	1212	0,000805	65	0,006794	4,5 13,3	18,57
			Rhinobatus leucorhynchus	0,143783	11650	0,000115	9	0,020967	...	1250,00
			Selene peruviana	0,103524	8388	0,001955	158	0,035450	12...21	52,94
			Sphoeroides tricocephalus	0,003451	280	0,000230	19	0,001661	7; 8	15,00
			Symphurus chabaunari	0,008627	699	0,000575	47	0,004153	12,8...15	15,00
			Trinectes fonsecensis	0,069016	5592	0,000230	19	0,014795	23,8 26,6	300,00
			sum	**21,109277**	**1470467**	**0,124717**	**9613**	**2,707544**		
16.12.1993	01F	bk	Citharichthys gilberti	0,035997	75	0,001440	3	0,015095	12,2 7,2 16,7	25,00
			Menthicirrus nasus	0,049916	104	0,000960	2	0,017176	10,5 21,9	52,00
			Narcine brasiliensis	0,455964	950	0,000480	1	0,071605	49,80	950,00
			Ophiscion typicus	0,083033	173	0,002880	6	0,033503	13,8...15,3	28,83
			Paralonchurus dumerillit	0,215983	450	0,000480	1	0,041500	32,70	450,00
			Paralonchurus nathbani	0,013919	29	0,004320	9	0,010149	5,4...8	3,22
			pomadasys nitidus	0,003216	7	0,000480	1	0,001924	17,10	6,70
			Porichthys greeni	0,005280	11	0,002880	6	0,004483	4,1...6,8	1,83
			Sphoeroides trichocephalus	0,004320	9	0,000480	1	0,002387	7,2	9,00
			Symphurus chabaunadi	0,062395	130	0,003840	8	0,029391	8,1...17,6	16,25
			Symphurus elongatus	0,004166	9	0,000960	2	0,002803	...	
			Symphurus sp.		...	0,000960	2		...	
			Urotrygon chilensis	0,300456	626	0,000960	2	0,063677	15,8 45,5	313,00
16.12.1993	01F	gsn	Anchoa sp.	0,000583	47	0,000074	6	0,000334	6,7 7,2	7,88
			Arius dovii	0,010182	825	0,000037	3	0,002235	29,4	275,00
			Arius troscheli	0,012033	975	0,000259	21	0,004269	6,1...19,7	46,43
			Cynoscion albus	0,348041	28200	0,001481	120	0,079697	9,6...54	235,00
			Dasyatis longus	0,003703	300	0,000296	24	0,001872	67...106	12,50
			Isopistus altipinnis	0,027769	2250	0,000518	42	0,009479	11,2...19,9	53,57
			Leopisthopterus tropicus							
			Lepidochelis olivacea							
			Menthicirrus panamensis	0,129590	10500	0,000185	15	0,022100	14...39,7	700,00
			Nebris occidentalis	0,027769	2250	0,000111	9	0,006253	8,3 31,8 33,2	250,00
			Neopistoherus tropicus	0,000588	48	0,000185	15	0,000430	6,8 8	3,17
			Paralonchurus dumerilli	0,046282	3750	0,000111	9	0,009080	...	416,67
			Paralonchurus nathbuni	0,000346	28	0,000111	9	0,000254	7,4 8,1 10	3,11
			Polydactylus approximans	0,012959	1050	0,000037	3	0,002665	32,3	350,00
			Porichthys greeni	0,000037	3	0,000025	2	0,000033	5,8 6,3	1,50
			Prionotus horrens	0,016662	1350	0,000592	48	0,006768	4,9...17,7	28,13
			Rhinobates leucorhychus	0,048133	3900	0,000037	3	0,006945	70,1	1300,00
			Stellifer furthii	0,005554	450	0,000111	9	0,001931	16,2 17,7 5,6	50,00
			Stellifer illecebrosus	0,016662	1350	0,000074	6	0,003860	26,3 26,3	225,00

date	stat.	gear	species	B [g/ m2]	B(t) [g]	A [/ m2]	A (t)	P [g/m2]	size range [cm]	m.w. [g]
			Symphurus chabaunadi	0,000642	52	0,000037	3	0,000297	13,9	17,33
			Trachinotus sp. (poitensis?)	0,118482	9600	0,000074	6	0,016164	5,5 7,8	1600,00
			sum	**2,060658**	**69500**	**0,025475**	**397**	**0,468359**		175,06
16.12.1993	35F	bk	Achirus naxathlamus	0,004800	10	0,001920	4	0,003748	5,9 6,0 6,7 6,8	2,50
			Cyclopsetta querna	0,014399	30	0,000960	2	0,006931	10,7 12,4	15,00
			Cytorectus gilbertae	0,065275	136	0,012479	26	0,041757	6,5...8,9	5,23
			Diapterus aureolus	0,004800	10	0,000960	2	0,003108	8,3 8,7	5,00
			Diplectrum euriplectrum	0,103672	216	0,000960	2	0,029284	20 21,1	108,00
			Eucinostomus currani	0,008159	17	0,000480	1	0,003797	10,6	17,00
			Eutropus crossotus	0,078234	163	0,003840	8	0,034669	10,4...14,8	20,38
			Pomadasys nitidus	0,097432	203	0,002400	5	0,035843	8,6...17,1	40,60
			Porichthys greeni	0,000240	1	0,000480	1	0,000289	4,4	0,50
			Preonotus ruscarins	0,003360	7	0,001440	3	0,002673	3,3 5,6 5,9	2,33
			Pseudopeneus grandiquonos	0,027838	58	0,000480	1	0,009301	16,7	58,00
			Selar chrumenophtalmus	0,055196	115	0,000480	1	0,015329	21,7	115,00
			Sphoeroides trichomphalus	0,023998	50	0,003360	7	0,014113	4,8...7,1	7,14
			Syascium ovale	0,227982	475	0,011039	23	0,100661	7...15,7	20,65
			Symphurus chabaunadi	0,049436	103	0,003360	7	0,023920	4,3...17,5	14,71
			Symphurus elongatus	0,005760	12	0,001920	4	0,004281	8,1 8,2 9,1 9,8	3,00
			Symphurus melanudus	0,052316	109	0,009599	20	0,033098	8,5...10,8	5,45
			Synodus scituliceps	0,263979	550	0,010559	22	0,110694	7...15,9	25,00
16.121993	35F	gsn	Anchoa sp.	0,009454	766	0,000945	77	0,005077		10,00
			Arstrum hispidus	0,122900	9958	0,000189	15	0,021383	30 30,5 33,5 22,5	650,00
			Chaetorypterus sonatus	0,113446	9192	0,000425	34	0,025106	17...31	266,67
			Cyclopsetta panamensis	0,010636	862	0,000047	4	0,002464	15,5	225,00
			Cyclopsetta querna	0,001182	96	0,000047	4	0,000496	26,5	25,00
			Cynostium reticulatus	0,079176	6415	0,000284	23	0,017307	25...32	279,17
			Diapterus aureolus	0,066177	5362	0,003545	287	0,030028	8...13	18,67
			Diapterus peruvianus	0,590867	47875	0,002647	214	0,137194	8...13	223,21
			Eucinostomus argenteus	0,044906	3639	0,000851	69	0,015390	13...18	52,78
			Haemulopsis leuciscus	0,165443	13405	0,002033	165	0,050441	8...34	81,40
			Larimus aedivis	0,004727	383	0,000047	4	0,001363	20,5	100,00
			Mulloides dentatus	0,021271	1724	0,000378	31	0,007166	10...17,5	56,25
			Polydactylus approximans	0,075631	6128	0,000284	23	0,016737	37,5	266,67
			Pseudopeneus vanculensis	0,021271	1724	0,000378	31	0,007166		56,25
			Selene oerstrelli	0,033089	2681	0,000047	4	0,005643	37,0	700,00
			Selene peruviana	0,189077	15320	0,000095	8	0,024286	19,5 34,5	2000,00
			Synodus sciculuceps	0,023635	1915	0,000425	34	0,007989	9,5...35	55,56
			Trachiurus paitiensis	0,103993	8426	0,000047	4	0,013018	57,0	2200,00
			Umbrina xanti	0,009454	766	0,000047	4	0,002261	26,5	200,00
			sum	**2,773208**	**138900**	**0,079477**	**1173**	**0,864010**		118,40
16.12.1993	30F	bk	Cyclopsetta panamensis	0,001920	4	0,000480	1	0,001320	7,1	4,00
			Cyclopsetta querna	0,059995	125	0,000480	1	0,016291	25,5	125,00
			Isophistus altipinis	0,010559	22	0,004320	9	0,008295	5...8	2,44
			Lepophilium prorates	0,002880	6	0,000480	1	0,001775	11,6	6,00
			Microgobius erectus	0,000960	2	0,000960	2	0,000960	3,7 6,6	1,00
			Neophistopterus tropicus	0,001920	4	0,000480	1	0,001320	8,9	4,00
			Porichthys greeni	0,001440	3	0,000960	2	0,001291	6,2 6,7	1,50
			Selene peruvianus	0,000960	2	0,000480	1	0,000796	6,5	2,00
			Sphoeroides probatus	0,001920	4	0,000480	1	0,001320	5,7	4,00
			Symphurus chabaunadi	0,012959	27	0,000480	1	0,005322	16,7	27,00
			Symphurus elongatus	0,052796	110	0,008639	18	0,032385	9,1...13,6	6,11
16.12.1993	30F	gsn	Anchoa lucdia	0,027769	2250	0,000463	38	0,009193	11,5...21,5	60,00
			Botula clarkae	0,001111	90	0,000093	8	0,000568	11,00	12,00
			Cyclopsetta querna	0,043968	3563	0,000648	53	0,014080	8,6...23,9	67,86
			Cynoconticeps coniceps	0,647948	52500	0,000555	45	0,096264	72...91	1166,67
			Cynoscion reticulatus	0,055538	4500	0,000093	8	0,009874	38,5	600,00
			Cynoscion stolzmanni	0,055538	4500	0,000093	8	0,009874	38,0	600,00
			Diapterus peruvianus	0,037026	3000	0,000093	8	0,007344	30,50	400,00
			Isopistus altipinnis	0,023141	1875	0,000093	8	0,005211	28,5	250,00
			Lepophilus prorates	0,003240	263	0,000185	15	0,001496	14,9 18,2	17,50
			Lutjanus guttatus	0,074051	6000	0,000093	8	0,012181	43,0	800,00
			Neophistopterus tropicus	0,000000	0	0,001851	150	0,000000		0,00
			Opisthopterus dovii	0,018513	1500	0,000370	30	0,006438	16,8...21,8	50,00
			Polydactylus approximans	0,013885	1125	0,000093	8	0,003589	19,0	150,00
			Porichthys greeni	0,004351	353	0,002499	203	0,003746	4...6,8	1,74
			Prionotus horrens	0,000926	75	0,000185	15	0,000599	6,3 8,7	5,00
			Rhinoconger nitens	0,001296	105	0,000093	8	0,000636	21,20	14,00
			Scianidae	0,536871	43500		0			
			Selene peruviana	0,027769	2250	0,000555	45	0,009657	6,5...20,5	50,00
			Symphurus chabaunadi	0,002314	188	0,000093	8	0,000970	18,70	25,00
			Symphurus elongatus	0,002777	225	0,000648	53	0,001875	9,4...12,2	4,29
			Synodus scituliceps	0,023141	1875	0,000370	30	0,007577	17...25,7	62,50
			Trachinotus paitiensis	0,092564	7500	0,000093	8	0,014336	42,5	1000,00
			Trichiurus nitens	0,148102	12000	0,002407	195	0,048696	23,5...61	61,54
			sum	**1,990147**	**149544**	**0,029902**	**983**	**0,335282**		

date	stat	gear	species	B(t) [g]	B [g/ m2]	n (t)	n [/m2]	P [g/m2]	size range [cm]	m.w. [g]
14.02.1994	31	bk	Achirus lucinerae	135	0,064795	1	0,000480	0,017233	8,8	135,00
			Diplectrum eumelum	75	0,035997	1	0,000480	0,011220	...	
			Eucinosthomus gracilis	2	0,000960	1	0,000480	0,000796	6,3	2,00
			Hemanthias signifer	30	0,014399	1	0,000480	0,005748	15,7	30,00
			Lutjanus guttatus	12	0,005760	3	0,001440	0,003961	6,6...7,5	4,00
			Pontinus sierra	82	0,039357	1	0,000480	0,011975	19,4	82,00
			Syacium latifrons	500	0,239981	29	0,013919	0,111251	...	17,24
			Syacium sp.	10	0,004800	9	0,004320	0,004665	3,8...5,4	1,11
			Symphurus oligomerus	5	0,002400	1	0,000480	0,001554	9,3	5,00
			Synodus sechurae	50	0,023998	2	0,000960	0,010063	13...18,6	25,00
			Zalieutes elater	5	0,002400	1	0,000480	0,001554	7,3	5,00
14.02.1994	31	gsn	Achirus mazatlatus	190	0,002345	3	0,000037	0,000765	11,8...17,7	63,33
			Albula nemoptera	269	0,003320	553	0,006825	0,004033	...	0,49
			Ancylopsetta dendritica	2050	0,025301	4	0,000049	0,004694	27,5...35,3	512,50
			Anisostremus dovii	16000	0,197470	51	0,000629	0,041825	...	313,73
			Arius platypogon	11000	0,135761	25	0,000309	0,026245	...	440,00
			Bellator xenisma	3,95	0,000049	1	0,000012	0,000034	3,4	
			Calamus brachisomis	26200	0,323357	30	0,000370	0,051947	...	873,33
			Caranx caballus	300	0,003703	...			51,3...75	
			Caranx otrynter	2800	0,034557	10	0,000123	0,007548	26...32	280,00
			Caranx speciosus	5500	0,067880	2	0,000025	0,008001	60...61	2750,00
			Caranx vinctus	3650	0,045048	8	0,000099	0,008624	30,9...38	456,25
			Cyclopsetta panamensis	4200	0,051836	14	0,000173	0,011112	19,4...37	300,00
			Cynoscion albus	3400	0,041962	1	0,000012	0,004670	75,0	3400,00
			Dasyatis longus	27464,53	0,338964	4	0,000049	0,031206	76...117	
			Diplectrum eumelum	147	0,001814	25	0,000309	0,001125	...	5,88
			Diplobatis ommata	300	0,003703	2	0,000025	0,000957	19,8...21,4	150,00
			Eucinosthomus argenteus	500	0,006171	6	0,000074	0,001870	16,7...20,8	83,33
			Eucinostomus gracilis	1400	0,017279	131	0,001617	0,009114	...	10,69
			Gerres cinereus	4250	0,052453	8	0,000099	0,009637	34...39	531,25
			Hoplopagrus guntheri	2600	0,032089	1	0,000012	0,003840	51,0	2600,00
			Lutjanus argentriventis	2100	0,025918	1	0,000012	0,003285	50,5	2100,00
			Lutjanus guttatus	2283	0,028176	19	0,000234	0,007733	6,6...53	120,16
			Lutjanus peru	1800	0,022215	5	0,000062	0,004534	25...34,4	360,00
			Mulloides dentatus	28	0,000346	2	0,000025	0,000169	10,6...11,2	14,00
			Narcine brasiliensis	9250	0,114162	8	0,000099	0,017002	...	1156,25
			Paralichthys wodmani	160	0,001975	1	0,000012	0,000502	25,5	160,00
			Prionotus horrens	3300	0,040728	11	0,000136	0,008731	24...37	300,00
			Rhinobatus leucorhynchus	12425	0,153348	7	0,000086	0,020342	...	1775,00
			Selene brevortii	2600	0,032089	5	0,000062	0,005930	29...39	520,00
			Selene oerstedii	14100	0,174020	24	0,000296	0,031115	...	587,50
			Sphaeroides annulatus	6275	0,077445	6	0,000074	0,011851	24,7...42,2	1045,83
			Sphaeroides lobatus	5900	0,072817	11	0,000136	0,013344	19,4...29,4	536,36
			Syacium latifrons	400	0,004937	8	0,000099	0,001717	6,4...18,6	50,00
			Syacium ovale	300	0,003703	6	0,000074	0,001288	15,6...19,7	50,00
			Synodus evermanni	21	0,000259	16	0,000197	0,000241	5,6...6,6	1,31
			Synodus scituliceps	22	0,000272	3	0,000037	0,000159	9,6...14,2	7,33
			Synodus sechurae	125	0,001543	4	0,000049	0,000609	12,4...25,5	31,25
			Urotrygon chilensis	150	0,001851	1	0,000012	0,000479	28,5	150,00
			Zapteryx exasperata	4100	0,050602	3	0,000037	0,007203	56...61	1366,67
			sum	**178469**	**2,626311**	**1070**	**0,036587**	**0,543497**		
13.02.1994	51	bk	Bellator gymnostethus	34	0,016319	6	0,002880	0,010216	6,0	5,67
			Bellator loxias	2	0,000960	1	0,000480	0,000796	6,3	2,00
			Bellator xenisma	11	0,005280	3	0,001440	0,003717	5,1...7,2	3,67
			Decodon melasma	10	0,004800	2	0,000960	0,003108	7,2...6,6	5,00
			Diplectrum rostrum	29	0,013919	1	0,000480	0,005607	14,5	29,00
			Engyophris sanctilaurentii	65	0,031198	7	0,003360	0,017093	7,0	9,29
			Gymnothorax sp.	125	0,059995	2	0,000960	0,019644	30...43,5	62,50
			Hippoglossina tetraophthalmus	175	0,083993	1	0,000480	0,020827	1,0	175,00
			Perissias taeniopterus	82	0,039357	17	0,008159	0,025734	...	4,82
			Pontinus sierra	67	0,032157	18	0,008639	0,022551	...	3,72
			Prionotus albirostris	3	0,001440	1	0,000480	0,001070	7,2	3,00
			Raja velezi	19	0,009119	1	0,000480	0,004118	15,3	19,00
			Scorpaena histrio	17	0,008159	1	0,000480	0,003797	1,0	17,00
			Scorpaena russula	7	0,003360	1	0,000480	0,001987	7,7	7,00
			Syacium latifrons	300	0,143988	16	0,007679	0,065256	16,0	18,75
			Syacium sp.	14	0,006719	6	0,002880	0,005345	3,4...9,5	2,33
			Symphurus atramentatus	5	0,002400	1	0,000480	0,001554	9,0	5,00
			Synchiropus atrilobiatus	250	0,119990	210	0,100792	0,114473	210,0	1,19
			Synodus evermanni	62	0,029758	11	0,005280	0,018656	7...12,3	5,64
			Zalieutes elater	45	0,021598	6	0,002880	0,012536	4,3...8,6	7,50
			sum	**1322**	**0,634509**	**312**	**0,149748**	**0,358086**		
13.02.1994	52	bk	Antennarius avalones	54	0,025918	1	0,000480	0,008828	12,9	54,00
			Bellator gymnostethus	11	0,005280	1	0,000480	0,002763	10,2	11,00
			Bollmannia chlamydes	225	0,107991	49	0,023518	0,071557	...	
			Citharichthys platophrys	365	0,175186	30	0,014399	0,089228	...	12,17
			Kathetostoma averruncus	76	0,036477	1	0,000480	0,011329	15,6	76,00
			Monolene maculipinna	7	0,003360	1	0,000480	0,001987	11,1	7,00
			Physiculus nematopus	11	0,005280	1	0,000480	0,002763	11,7	11,00
			Pontinus sierra	...		...		...		

date	stat	gear	species	B(t) [g]	B [g/ m2]	n (t)	n [/m2]	P [g/m2]	size range [cm]	m.w. [g]
			Porichthys margaritatus	5	0,002400	2	0,000960	0,001874	6,7...7	2,50
			Pronotogrammus eos	22	0,010559	3	0,001440	0,006166	6,9...13	7,33
			Serranus aequidanus	3	0,001440	1	0,000480	0,001070	6,6	3,00
			Symphurus callopterus	465	0,223182	53	0,025438	0,124166	...	
			Symphurus oligomerus	19	0,009119	3	0,001440	0,005540	8,8...10,4	6,33
			Synchiropus atrilabiatus	...		...			...	
			Zalieutes elater	8	0,003840	3	0,001440	0,002946	3,5...7,8	2,67
14.02.1994	52	gsn	Bollmannia stigmatura	275	0,003394	81	0,001000	0,002440	...	3,40
			Citharichthys platophrys	450	0,005554	51	0,000629	0,003085	...	8,82
			Diplectrum eumelum	300	0,003703	2	0,000025	0,000957	22,1...22,8	150,00
			Engyophris sanctilaurentii	8	0,000099	1	0,000012	0,000056	10,1	8,00
			Hemanthias peruanus	650	0,008022	5	0,000062	0,002155	27,5...38	130,00
			Hemanthias signifer	200	0,002468	11	0,000136	0,001128	7,5...17,7	18,18
			Lophiodes caulinaris	54	0,000666	2	0,000025	0,000274	10,7...11	27,00
			Peprilus snyderi	7000	0,086393	135	0,001666	0,029750	...	51,85
			Peristedion barbiger	30	0,000370	2	0,000025	0,000178	10,3...15,7	15,00
			Peristedion crustosum	6	0,000074	1	0,000012	0,000046	11,2	6,00
			Physiculus nematopus	146	0,001802	6	0,000074	0,000761	11,6...16,8	24,33
			Pontinus sierra (amarillo)	30	0,000370	8	0,000099	0,000259	4,3...10,8	3,75
			Pontinus sierra (rojo)	1	0,000012	1	0,000012	0,000012	4,6	1,00
			Porichthys margaritatus	80	0,000987	22	0,000272	0,000697	5,9...11,7	3,64
			Symphurus callopterus	43	0,000531	5	0,000062	0,000297	9,9...12,7	8,60
			Symphurus sp.	2	0,000025	1	0,000012	0,000020	6,2	2,00
			Synchiropusatrilabiatus	7	0,000086	9	0,000111	0,000092	4,1...15,8	0,78
			Synodus evermanni	250	0,003085	16	0,000197	0,001469	11,6...14	15,63
			Zalieutes elater	10	0,000123	5	0,000062	0,000102	3,8...7,8	2,00
			sum	**10813**	**0,727797**	**513**	**0,076007**	**0,373998**		
13.02.1994	53	bk	Antennarius avalones	19	0,009119	1	0,000480	0,004118	9,4	19,00
			Bollmannia chlamydes	15	0,007199	...			6...9,5	
			Physiculus nematopus	15	0,007199	1	0,000480	0,003465	14,4	15,00
			Pontinus sierra (amarilla)	13	0,006240	7	0,003360	0,005279	4,4...6,9	1,86
			Pontinus sierra (rojo)	42	0,020158	3	0,001440	0,009886	45...13,5	14,00
			Symphurus callopterus	21	0,010079	3	0,001440	0,005960	10,4...13	7,00
			Symphurus oligomerus	13	0,006240	4	0,001920	0,004539	7,1...9,4	3,25
			Synchiropus atrilabiatus	46	0,022078	18	0,008639	0,017137	...	2,56
			Zalieutes elater	2	0,000960	2	0,000960	0,000960	4,3	1,00
14.02.1994	53	gsn	Antennarius sp.	23	0,000284	1	0,000012	0,000122	9,6	23,00
			Auxis sp.	350	0,004320	2	0,000025	0,001071	224,9...26	175,00
			Bellator gymnostethus	115	0,001419	4	0,000049	0,000573	6,2...8,8	28,75
			Bellator loxias	14	0,000173	2	0,000025	0,000102	7,8...9,2	7,00
			Bellator xenisma	8	0,000099	1	0,000012	0,000056	7,9	8,00
			Bellator xenisma	180	0,002222	44	0,000543	0,001519	...	4,09
			Bollmannia stigmatura	20	0,000247	6	0,000074	0,000178	5,7...10,5	3,33
			Citharichthys platophrys	1550	0,019130	186	0,002296	0,010792	...	8,33
			Diplectrum eumelum	2,73	0,000034	11	0,000136	0,000049	...	0,25
			Diplectrum euryplectrum	475	0,005862	22	0,000272	0,002558	10,2...13,1	21,59
			Diplectrum labarum	400	0,004937	7	0,000086	0,001656	13,1...19,1	57,14
			Diplectrum maximum	...		1	0,000012		33,6	
			Gymnothorax equatorialis	950	0,011725	5	0,000062	0,002843	41...58	190,00
			Hemanthias peruanus	325	0,004011	2	0,000025	0,001015	24,3...29,5	162,50
			Hippoglossina tetraophthalmus	250	0,003085	1	0,000012	0,000695	28,1	250,00
			Lophiodes caulinaris	500	0,006171	7	0,000086	0,001949	7,8...19,7	
			Mustelus lunulatus	400	0,004937	1	0,000012	0,000979	48	400,00
			Paralabrax loro	525	0,006479	1	0,000012	0,001194	35	525,00
			Paralichthys wodmani	350	0,004320	20	0,000247	0,001994	12,3...19,5	17,50
			Peristedion barbiger	15	0,000185	2	0,000025	0,000107	10,9...11,5	7,50
			Pontinus sierra (rojo)	7	0,000086	1	0,000012	0,000051	8,2	7,00
			Prionotus albirostris	900	0,011108	14	0,000173	0,003609	...	64,29
			Raja velezi	11900	0,146868	11	0,000136	0,022269	50...64	1081,82
			Symphurus callopterus	13	0,000160	2	0,000025	0,000097	10,3...11,6	6,50
			Symphurus elongatus	2	0,000025	1	0,000012	0,000020	6,5	2,00
			Synodus evermanni	950	0,011725	10	0,000123	0,003429	...	95,00
			Torpedo clemens	325	0,004011	2	0,000025	0,001015	18,9...20,3	162,50
			Umbrina bussingii	300	0,003703	1	0,000012	0,000794	27	300,00
			Zalieutes elater	160	0,001975	29	0,000358	0,001245	4,5...12	
			Zapteryx exasperata	850	0,010491	1	0,000012	0,001698	54	850,00
			sum	**22046**	**0,359063**	**437**	**0,023631**	**0,115024**		
13.02.1994	54	bk	Bollmannia chlamydes	19	0,009119	4	0,001920	0,005988	8,7...12,2	4,75
			Lophiodes spirulus	175	0,083993	9	0,004320	0,037694	8,5...11,4	19,44
			Neobithes stelliferoides	6	0,002880	1	0,000480	0,001775	10,5	6,00
			Ophichthys sp.	275	0,131989	1	0,000480	0,028968	59,0	275,00
			Ophistoma prorigerum	175	0,083993	8	0,003840	0,036514	18,7...24,3	21,88
			Peristedion barbiger	11	0,005280	1	0,000480	0,002763	12,4	11,00
			Physiculus rastrelliger	125	0,059995	35	0,016799	0,042545	...	3,57
			Pontinus sierra	50	0,023998	11	0,005280	0,015945	7,1...10,9	4,55
			Rhynchoconger nitens	65	0,031198	5	0,002400	0,015608	18...21,3	13,00
			Symphurus atramentatus	5	0,002616	1	0,000480	0,001655	...	
			Symphurus callopterus	900	0,431965	103	0,049436	0,240586	...	
			Symphurus gorgonae	2	0,000960	1	0,000480	0,000796	8,3	2,00
			Symphurus leei	150	0,071994	20	0,009599	0,041786	...	7,50

date	stat	gear	species	B(t) [g]	B [g/ m2]	n (t)	n [/m2]	P [g/m2]	size range [cm]	m.w. [g]
			Synchiropus atrilabiatus	6	0,002880	2	0,000960	0,002141	7...7,4	3,00
			Trichiurus nitens	61	0,029278	5	0,002400	0,014901	25,9...33	12,20
14.02.1994	54	gsn	Argentina alicea	112	0,001382	6	0,000074	0,000627	13,2...14,5	18,67
			Arius platypogon	11700	0,144400	27	0,000333	0,028030	...	433,33
			Bellator gymnostethus	48	0,000592	4	0,000049	0,000303	10,2...11,2	12,00
			Bollmannia chlamydes	89	0,001098	14	0,000173	0,000667	7,7...13	6,36
			Caulolatius affinis	300	0,003703	1	0,000012	0,000794	30,8	300,00
			Chrophthalmus mento	40	0,000494	3	0,000037	0,000245	11,5...13	13,33
			Citharichthys platophrys	7	0,000086	1	0,000012	0,000051	9,8	7,00
			Coryphaenoides leucophaeus	11	0,000136	10	0,000123	0,000132	5,5...10,7	1,10
			Diplectrum euryplectrum	194	0,002394	5	0,000062	0,000892	12,4...17,4	38,80
			Hemanthias signifer	700	0,008639	2	0,000025	0,001777	15,7...39	350,00
			Kathetostoma averruncus	100	0,001234	2	0,000025	0,000429	13,5...14,3	
			Lophiodes caulinaris	125	0,001543	3	0,000037	0,000564	9,2...17,4	41,67
			Neobithes stelliferoides	325	0,004011	40	0,000494	0,002278	...	8,13
			Peprilus snyderi	45	0,000555	1	0,000012	0,000199	15,2	45,00
			Peristedion barbiger	45	0,000555	7	0,000086	0,000336	10,2...10,5	6,43
			Physiculus nematopus	52	0,000642	11	0,000136	0,000422	6,4...12,3	4,73
			Pontinus sierra	525	0,006479	60	0,000741	0,003607	...	8,75
			Porichthys margaritatus	2	0,000025	1	0,000012	0,000020	7,5	2,00
			Rhynchoconger nitens	4	0,000049	1	0,000012	0,000034	15,0	4,00
			Rya equatorialis	300	0,003703	1	0,000012	0,000794	39,8	300,00
			Serranus aequidanus	25	0,000309	2	0,000025	0,000156	7,4...12,7	12,50
			Symphurus callopterus	7	0,000086	1	0,000012	0,000051	12,3	7,00
			Synchiropus atrilabiatus	3	0,000037	1	0,000012	0,000028	7,2	3,00
			Trichiurus nitens	25300	0,312249	119	0,001469	0,073461	...	212,61
			Umbrina bussingii	1150	0,014193	3	0,000037	0,002848	30,7...33	383,33
			sum	**43234**	**1,480734**	**533**	**0,103376**	**0,608409**		
13.02.1994	6	bk	Bollmannia chlamydes	75	0,035997	32	0,015359	0,028602	...	2,34
			Citharichthys platophrys	4	0,001920	1	0,000480	0,001320	8	4,00
			Cyclopsetta sp.	9	0,004320	5	0,002400	0,003686	3,1...7,5	1,80
			Gymnothorax equatorialis	29	0,013919	1	0,000480	0,005607	32,5	29,00
			Microgobius erectus	0,5	0,000240	1	0,000480	0,000289	6	0,50
			Porichthys greeni	39	0,018719	29	0,013919	0,017279	...	1,34
			Porichthys margaritatus	425	0,203984	124	0,059515	0,146270	...	3,43
			Prionotus horrens	325	0,155988	6	0,002880	0,053086	7,1...23,7	54,17
			Raja equatorialis	225	0,107991	1	0,000480	0,025021	36,7	225,00
			Scorpaena russula	8	0,003840	4	0,001920	0,003184	4,3...6,1	2,00
			Sphaeroides lobatus	3	0,001440	1	0,000480	0,001070	4,7	3,00
			Syacium ovale	225	0,107991	21	0,010079	0,056924	...	10,71
			Symphurus elongatus	53	0,025438	11	0,005280	0,016638	8,7...12,5	4,82
			Symphurus oligomerus	1	0,000480	1	0,000480	0,000480	6,8	1,00
			Synodus evermanni	10	0,004800	4	0,001920	0,003748	5,9...8,3	2,50
			Synodus scituliceps	375	0,179986	8	0,003840	0,063692	9,7...25,6	46,88
14.02.1994	6	gsn	Bollmannia chlamydes	8	0,000099	4	0,000049	0,000082	9...10,8	2,00
			Bollmannia stygmatura	20	0,000247	8	0,000099	0,000193	5,4...9,1	2,50
			Caranx caninus	1337,5	0,016507	1	0,000012	0,002364	13,2	
			Citharichthys platophrys	75	0,000926	29	0,000358	0,000716		2,59
			Cyclopsetta querna	5200	0,064178	14	0,000173	0,012987		371,43
			Diplectrum macropoma	850	0,010491	24	0,000296	0,004004		35,42
			Gymnothorax equatorialis	1350	0,016662	14	0,000173	0,004853	34,5...57	96,43
			Lophiodes caulinaris	150	0,001851	1	0,000012	0,000479	19	150,00
			Peprilus snyderi	8900	0,109843	53	0,000654	0,027542	7	167,92
			Peristedion barbiger	8	0,000099	1	0,000012	0,000056	10,6	8,00
			Porichthys margaritatus	700	0,008639	139	0,001716	0,005584		5,04
			Prionotus sp.	3600	0,044431	23	0,000284	0,011354		156,52
			Raja velezi	1317,79	0,016264	2	0,000025	0,002819	54	
			Selene peruviana	25600	0,315952	28	0,000346	0,050134		914,29
			Syacium latifrons	850	0,010491	24	0,000296	0,004004	6,2...24,4	35,42
			Syacium ovale	2000	0,024684	26	0,000321	0,007641		76,92
			Symphurus callopterus	5	0,000062	1	0,000012	0,000040	9,4	5,00
			Symphurus elongatus	2	0,000025	1	0,000012	0,000020	8,6	2,00
			Symphurus sp.	4	0,000049	1	0,000012	0,000034	9,9	4,00
			Synchiropus atrilabiatus	17	0,000210	8	0,000099	0,000171	5,9...7,7	2,13
			Synodus evermanni	14,81	0,000183	1	0,000012	0,000088	59	
			Synodus scituliceps	1800	0,022215	30	0,000370	0,007354		60,00
			sum	**55616**	**1,531156**	**683**	**0,125334**	**0,569417**		
15.02.1994	45	bk	Achirus scutum	75	0,035997	5	0,002400	0,017327	5...11,1	15,00
			Arius kessleri	45	0,021598	1	0,000480	0,007728	17,5	45,00
			Cynoscion phoxocephalus	7	0,003360	2	0,000960	0,002396	6,5...7,5	3,50
			Menthicirrus nasus	3	0,001440	1	0,000480	0,001070	7,2	3,00
			Porichthys greeni	2	0,000960	2	0,000960	0,000960	2,1...5,9	1,00
			Stellifer sp.	0,8	0,000384	1	0,000480	0,000408	5,1	0,80
			Symphurus chabaunadi	150	0,071994	11	0,005280	0,035557	9,2...13	13,64
			Symphurus melanurus	35	0,016799	1	0,000480	0,006432	18,1	35,00
			Symphurus sp.	3,9	0,001872	1	0,000480	0,001296	8,1	3,90
16.02.1994	45	gsn	Achirus mazaflatus	2000	0,024684	5	0,000062	0,004896	24,9...29	400,00
			Achirus scutum	1050	0,012959	75	0,000926	0,006355	...	14,00
			Anchoa nasus	220	0,002715	99	0,001222	0,002189	6,3...7,9	2,22
			Anchoa walkeri	255,75	0,003156	58	0,000716	0,002115	7,3...11,3	4,41

date	stat	gear	species	B(t) [g]	B [g/ m2]	n (t)	n [/m2]	P [g/m2]	size range [cm]	m.w. [g]
			Anisostremus dovii	500	0,006171	3	0,000037	0,001550	24,1...24,7	166,67
			Arius dovii	5050	0,062326	1	0,000012	0,006234	82,2	5050,00
			Arius troschelli	1225	0,015119	12	0,000148	0,004336	16,6...21,5	102,08
			Cetengraulis mysticetus	130	0,001604	3	0,000037	0,000580	16,2...17,7	43,33
			Cyclopsetta querna	451	0,005566	6	0,000074	0,001734	21,6...31,7	75,17
			Cynoscion phoxocephalus (?)	400	0,004937	67	0,000827	0,003047	...	5,97
			Cynoscion sp.	57	0,000703	4	0,000049	0,000343	9,8...10,5	14,25
			Dasyatis longus	13732	0,169482	2	0,000025	0,015603	47...89	6866,14
			Diapterus peruvianus	1800	0,022215	7	0,000086	0,004965	24...26,5	257,14
			Etropus sp.	5	0,000062	1	0,000012	0,000040	8,0	5,00
			Haemulopsis elongatus	650	0,008022	4	0,000049	0,002029	17,5...27	162,50
			Isopisthus altipinnis	375	0,004628	6	0,000074	0,001515	17,8...19	62,50
			Neopisthopterus tropicus	5051,2	0,062341	1793	0,022129	0,047133	...	2,82
			Opisthopterus dovii	101	0,001247	2	0,000025	0,000432	20,2...20,8	50,50
			Paralonchurus dumerilli	9900	0,122185	20	0,000247	0,022881	29,3...39,2	495,00
			Polydactylus approximans	*1100*	*0,013576*	*5*	*0,000062*	*0,003165*	*24,2...31,1*	*220,00*
			Prionotus horrens	750	0,009256	22	0,000272	0,003570	...	34,09
			Selene peruviana	125	0,001543	1	0,000012	0,000419	23,5	125,00
			Stellifer cestocarus	20	0,000247	1	0,000012	0,000110	12,1	20,00
			Stellifer chrysoleuca	350	0,004320	1	0,000012	0,000888	29,4	350,00
			Stellifer illecebrosus	113	0,001395	3	0,000037	0,000524	10,6...18,2	37,67
			Symphurus chabaunadi	200	0,002468	12	0,000148	0,001155	8,1...19,1	16,67
			Trinectes fonsecensis	800	0,009873	6	0,000074	0,002635	15,7...20,4	133,33
			Trinectes sp.	76	0,000938	12	0,000148	0,000570	5,9...7,8	6,33
			Urotrygon nana	2175	0,026844	15	0,000185	0,007003	...	145,00
			sum	**48984**	**0,754986**	**2271**	**0,039719**	**0,221190**		
16.12.1993	01F	bk	Citharichthys platophrys	1,6	0,000768	1	0,000480	0,000676	5,2	1,60
			Cyclopsetta sp. (juv.)	2,3	0,001104	1	0,000480	0,000882	7,1	2,30
			Cynoscion phoxocephalus	49	0,023518	6	0,002880	0,013340	7,7...10,6	8,17
			Cynoscion phoxocephalus (juv. ?)	17	0,008159	19	0,009119	0,008408	3,0...5,9	0,89
			Diaperus aureolus	1,9	0,000912	1	0,000480	0,000767	5,2	1,90
			Diplectrum macropoma	7	0,003360	1	0,000480	0,001987	8,6	7,00
			Menthicirrus nasus	25	0,011999	8	0,003840	0,008821	3,8...8,8	3,13
			Myrichthys sp.	175	0,083993	1	0,000480	0,020827	65,5	175,00
			Ophioscon sp.	45	0,021598	1	0,000480	0,007728	16	45,00
			Polydactylus approximans	250	0,119990	1	0,000480	0,027021	28,1	250,00
			Pomadasys sp.	0,9	0,000432	1	0,000480	0,000444	4	0,90
			Porichthys greeni	7	0,003360	5	0,002400	0,003068	2,2...7,1	1,40
			Prionotus horrens	42	0,020158	1	0,000480	0,007348	14,1	42,00
			Sphaeroides lobatus	50	0,023998	2	0,000960	0,010063	5,1...10,5	25,00
			Stellifer illecebrosus	24	0,011519	4	0,001920	0,007101	7,7...8,9	6,00
			Stellifer mancorensis	31	0,014879	3	0,001440	0,007920	8,6...9,6	10,33
			Symphurus chabaunadi	59	0,028318	2	0,000960	0,011356	15,7...18,6	29,50
			Symphurus gorgonae	8	0,003840	2	0,000960	0,002641	8,4	4,00
			Synodus scituliceps	19	0,009119	1	0,000480	0,004118	12,2...12,3	19,00
			sum	**815**	**0,391025**	**61**	**0,029278**	**0,144516**		
15.02.1994	35	bk	Cyclopsetta querna	75	0,035997	11	0,005280	0,000957	6,2...16,3	6,82
			Diplectrum pacificum	45	0,021598	4	0,001920	0,011236	9...11,8	11,25
			Epinephelus nigritus	28	0,013439	1	0,000480	0,005466	12,5	28,00
			Epinephelus niphobles	1,2	0,000576	1	0,000480	0,000548	4,1	1,20
			Etropus crossotus	125	0,059995	9	0,004320	0,029485	6,4...14,6	13,89
			Etropus sp.	72	0,034557	15	0,007199	0,022626	5,5...13,7	4,80
			Microgobius erectus	2	0,000960	2	0,000960	0,000960	5,2...6,6	1,00
			Porichthys margaritatus	25	0,011999	1	0,000480	0,005032	5,1...11,8	25,00
			Sciaenidae	14	0,006719	8	0,003840	0,005777	4,3...6	1,75
			Scorpaena russula	0,5	0,000240	1	0,000480	0,000289	3,4	0,50
			Sphaeroides annulatus	425	0,203984	6	0,002880	0,064570	8,3...25	70,83
			Syacium ovale	700	0,335973	51	0,024478	0,165643	...	13,73
			Symphurus gorgonae	53	0,025438	6	0,002880	0,014126	7,7...10,1	8,83
			Synodus scituliceps	700	0,335973	20	0,009599	0,128649	5,2...38,8	35,00
			sum	**2266**	**1,087449**	**136**	**0,065275**	**0,455363**		
15.02.1994	30	bk	Synodus evermanni	50	0,023998	2	0,000960	0,010063	9,2...22,7	25,00
			Porichthys margaritatus	150	0,071994	27	0,012959	0,045313	...	
			Porichthys greeni	*5*	*0,002400*	*3*	*0,001440*	*0,002091*	*6,0...6,7*	*1,67*
			Bollmannia chlamydes	6	0,002880	6	0,002880	0,002880	6,0...7,5	1,00
			sum	**211**	**0,101272**	**38**	**0,018239**	**0,060346**		
15.02.1994	43	bk	Anchoa lucida	55	0,026398	5	0,002400	0,013816	11,2...13,6	
			Anisostremus dovii	2313	1,109911	25	0,011999	0,326911	46...26,4	
			Arius kessleri	55	0,026398	3	0,001200	0,011458	13,7	
			Arius osculus	3250	1,559875	43	0,020398	0,483667	15,4...34,3	
			Arius sp. a	2500	1,199904	8	0,003600	0,250017	18,8...43,5	
			Arius sp. b	188	0,089993	3	0,001200	0,028051	22,5	
			Batrachoides sp.	38	0,017999	3	0,001200	0,008663	10,7	
			Catherops tuyra	1438	0,689945	38	0,017999	0,257780	13,1...20,2	
			Cynoscion phoxocephalus	95	0,045596	5	0,002400	0,020590	10,4...14,3	
			Haemulon scuderi	625	0,299976	3	0,001200	0,067553	26,2	
			Haemulopsis leuciscus	305	0,146388	3	0,001200	0,040012	16,6	
			Himantura pacifica	11700	5,615551	3	0,001200	0,573358	67 (width)	

date	stat	gear	species	B(t) [g]	B [g/ m2]	n (t)	n [/m2]	P [g/m2]	size range [cm]	m.w. [g]
			Ophioscon sciera	340	0,163187	3	0,001200	0,043314	22	
			Prionotus horrens	5	0,002400	3	0,001200	0,001990	5,4	
			Seiadeaps troschelli	313	0,149988	5	0,002400	0,049110	16...20,9	
			Stellifer illecebrosus	185	0,088793	5	0,002400	0,033494	14,3...14,8	
			Stellifer oscitans	78	0,037197	3	0,001200	0,014718	14,1	
			Stellifer sp.	288	0,137989	3	0,001200	0,038323	5,3	
			Stellifer sp.	18	0,008399	20	0,009599	0,008708	3,3...5	
			Symphurus chabaunadi	83	0,039597	18	0,008399	0,026052	7,1...11,2	
			Symphurus elongatus	20	0,009599	3	0,001200	0,005475	11,9	
			Urotrygon chilensis		0,000000	3	0,001200	0,000000	41,2	
			Urotrygon nana		0,000000	8	0,003600	0,000000	25,4...27,7	
			Urotrygon sp. ?		0,000000	8	0,003600	0,000000	10...11	
			Urotrygon sp. b		0,000000	3	0,001200	0,000000	28	
			sum	**23888**	**11,465083**	**218**	**0,104392**	**2,303060**		
13.02.1994	50	bk	Bellator loxias	3	0,001440	3	0,001440	0,001440	3,8...4,9	
			Bellator xenisma	13	0,006240	15	0,007199	0,006485	2,4...4,3	
			Bollmannia (new species)	1	0,000480	1	0,000480	0,000480	4,5	
			Bollmannia chlamydes	4	0,001920	1	0,000480	0,001320	9,3	
			Diplobates ommata	49	0,023518	1	0,000480	0,008223	14,9	
			Hemanthias signifer	52	0,024958	2	0,000960	0,010355	14,2...15,2	
			Lophiodes caulinaris	11	0,005280	3	0,001440	0,003717	5...5,7	
			Ophictus (new species)	17	0,008159	1	0,000480	0,003797	27,8	
			Porichthys margaritatus	104	0,049916	97	0,046556	0,048986	...	
			Prionotus teaguei	2	0,000960	1	0,000480	0,000796	5,6	
			Scorpaena russula	71	0,034077	41	0,019678	0,029382	...	
			Sphaeroides lobatus	13	0,006240	3	0,001440	0,004200	4,8...5,2	
			Syacium ovale	325	0,155988	61	0,029278	0,099293	...	
			Symphurus callopterus	23	0,011039	3	0,001440	0,006369	9,8...13	
			Symphurus oligomerus	10	0,004800	1	0,000480	0,002578	12,8	
			Synchyropus atrilabiatus	3	0,001440	2	0,000960	0,001291	5,5...6	
			Synodus evermanni	105	0,050396	43	0,020638	0,039601	...	
			Synodus scituliceps	250	0,119990	36	0,017279	0,071106	...	
			sum	**1056**	**0,506839**	**315**	**0,151188**	**0,339420**		

date	stat.	gear	species	B(t) [g]	B [g/m2]	A(t)	A [/m2]	P [g/m2]	size range [cm]	m.w. [g]
13.12.1993	N	bk	Ballmania chlamydes	25	0,011999	6	0,002880	0,008162	4,2...10,4	4,17
			Bregmaceros bathymaster	1,08	0,000518	1	0,000480	0,000508	5	
			Chiloconger labiatus	100	0,047996	2	0,000960	0,016691	23,5 24,2	50,00
			Decodon melasma	325	0,155988	13	0,006240	0,065410	7,1...18,1	25,00
			Diplectrum euryplectrum	...		...			...	
			Hemanthias signifer	75,7	0,036333	1	0,000480	0,011297	13,6	
			Hippoglossina ballmanni	...		...			...	
			Longimanus fasciatus	117	0,056156	2	0,000960	0,018718	13,8 24	58,50
			Lophiodes caulinaris	550	0,263979	3	0,001440	0,064639	16,7 20,9 22,4	183,33
			Merluccius angustimanus	150	0,071994	2	0,000960	0,022440	19,6 22	75,00
			Monalena macalipinna	100	0,047996	7	0,003360	0,023409	9,8...15,5	14,29
			Nerbithytes stelliferoides	50	0,023998	1	0,000480	0,008346	15	50,00
			Physiculus nematopus	250	0,119990	21	0,010079	0,061475	9...16	11,90
			Pontinus fusarinus	48	0,023038	43	0,020638	0,022364	10...22,5	1,12
			Pontinus sierra	57,32	0,027511	4	0,001920	0,013407	...	
			Pronotogrammus eos	480	0,230382	17	0,008159	0,093483	7,2...16,8	28,24
			Pronotogrammus multifasciates	125	0,059995	5	0,002400	0,025158	11,4...16,1	25,00
			Serranus aequicleus	...		...			...	
			Symphurus alligomerus	150	0,071994	14	0,006719	0,037950	8,5...12,9	10,71
			Symphurus gorgonae	13,89	0,006667	4	0,001920	0,004764	6,5 6,5 7,2 7,7	
			Syneliropus attrilobata	9	0,004320	9	0,004320	0,004320	4,8...6,1	1,00
			Synodus evermanni	25	0,011999	1	0,000480	0,005032	15,7	25,00
			Zalieutes elater	40	0,019198	11	0,005280	0,013548	7,8...12,4	3,64
			sum	**2691,99**	**1,292052**	**167**	**0,080154**	**0,521120**		**16,12**
13.12.1993	O	bk	Ballmania chalmydes	10	0,004800	7	0,003360	0,004359	4,3...8,1	1,43
			Citharichthys platophrys	10	0,004800	10	0,004800	0,004800	6...11,5	1,00
			Lophiodes caulinares	400	0,191985	2	0,000960	0,045919	19,4 22,4	200,00
			Monolene maculipinna	29,09	0,013962	2	0,000960	0,006777	10,2 10,2	
			Prionotus gymnosthetus	5	0,002400	3	0,001440	0,002091	11,4 12,1 13	1,67
			Symphurus gorgonae	8	0,003840	4	0,001920	0,003184	6,5 6,5 7,2 7,7	2,00
			Synchiropus attrilobata	9	0,004320	9	0,004320	0,004320	4,8...6	1,00
			Synodus evermanni	25	0,011999	1	0,000480	0,005032	15,7	25,00
			sum	**496,09**	**0,238104**	**38**	**0,018239**	**0,076480**		**13,06**
13.12.1993	P2	bk	Bollmania stigmatura	11	0,005280	5	0,002400	0,004267	4,7...8,1	2,20
			Citarichthys platophrys	325	0,155988	68	0,032637	0,102249	2,8...14,4	4,78
			Cyclopsetta querna	275	0,131989	6	0,002880	0,046992	9,2...25,1	45,83
			Diplectrum macopoma	4	0,001920	1	0,000480	0,001320	7,8	4,00
			Lophiodes caulinaris	200	0,095992	3	0,001440	0,030887	19,9	66,67
			Porichthys margaritatus	225	0,107991	41	0,019678	0,068195	10,1	5,49
			Prionotus albirostris	500	0,239981	1	0,000480	0,044818	15,6	500,00
			Rhynchoconger nitens	2	0,000960	1	0,000480	0,000796	14,8	2,00
			Scorpaena russula	11,07	0,005313	1	0,000480	0,002776	5,9	
			Syascium ?	4	0,001920	1	0,000480	0,001320	14,8	4,00
			Symphurus elongatus	8,68	0,004166	2	0,000960	0,002803	6,1	
			Symphurus leei	52,76	0,025323	7	0,003360	0,014678	7,9...11,2	
			Synchirpous attrilobata	10	0,004800	9	0,004320	0,004665	4,8...6	1,11
			Synodus evermanni	5	0,002400	34	0,016319	0,004027	5,1...6,5	0,15
			Synodus scituliceps	425	0,203984	14	0,006719	0,081168	9,2...17,1	30,36
			sum	**2058,51**	**0,988006**	**194**	**0,093113**	**0,410962**		**10,61**
13.12.1993	Q	bk	Achirus maxalanus	53	0,025438	1	0,000480	0,008708	14,9	53,00
			Citharichthys gilberti	75	0,035997	37	0,017759	0,029745	2,5...12,6	2,03
			Diplectrum macropoma	150,54	0,072253	6	0,002880	0,030269	4,1...4,8	
			Porichthys margaritatus	25	0,011999	11	0,005280	0,009613	3,3...9,9	2,27
			Scorpaena russula	5,09	0,002443	2	0,000960	0,001898	2,8 3,5	
			Sphaeroides annulatus	264,33	0,126868	1	0,000480	0,028143	3,4	
			Sphaeroides lobatus	183,71	0,088174	1	0,000480	0,021579	3,8	
			Symphurus elongatus	18	0,008639	4	0,001920	0,005756	7,8 9,1 10 10,1	4,50
			Synodus evermanni	4	0,001920	6	0,002880	0,002142	3,3...6,0	0,67
			Synodus sechurae (?)	25	0,011999	2	0,000960	0,006067	12 8,4	12,50
			sum	**803,67**	**0,385731**	**71**	**0,034077**	**0,143921**		**11,32**
13.12.1993	R	gsn	Achirus maxalanus	75	0,000926	1	0,000012	0,000289	15,9	75,00
			Alutera monocerus	1150	0,014193	2	0,000025	0,002553	35,3 43	575,00
			Amylopsetta dendritica	300	0,003703	1	0,000012	0,000794	27,8	300,00
			Arothron hispicluus	750	0,009256	1	0,000012	0,001549	24,7	750,00
			Arothron hispiculus	75	0,000926	1	0,000012	0,000289	24,7	75,00
			Ballister polylepis	275	0,003394	1	0,000012	0,000745	24,6	275,00
			Citharichthys gilberti	12	0,000148	1	0,000012	0,000076	10,7	12,00
			Cyclopsetta panamensis	125	0,001543	1	0,000012	0,000419	24,4	125,00
			Dasyatis longus	17	0,000210	3	0,000037	0,000131	6,6 7,8 8,7	5,67
			Diplectrum macropoma	1	0,000012	1	0,000012	0,000012	4,3	1,00
			Eicinostomus gracilis	17	0,000210	3	0,000037	0,000131	6,6 7,8 8,7	5,67
			Lutjanus guttatus	9	0,000111	1	0,000012	0,000061	8,7	9,00
			Myrichthys gracilis	75	0,000926	1	0,000012	0,000289	50,1	75,00
			PSeudopeneus grandiquamis	6	0,000074	1	0,000012	0,000046	8,5	6,00
			Synodus sechurae	60	0,000741	3	0,000037	0,000330	11,6 18,5 8,3	20,00
			sum	**2947**	**0,036371**	**22**	**0,000272**	**0,007713**		**133,95**

date	stat.	gear	species	B(t) [g]	B [g/m2]	A(t)	A [/m2]	P [g/m2]	size range [cm]	m.w. [g]
13.12.1993	S	gsn	Bollmania stigmatura	4	0,000049	1	0,000012	0,000034	9	4,00
			Carangoides otrynter	3300	0,040728	3	0,000037	0,006148	46 46 46	1100,00
			Citharichthys platophrys	3	0,000037	1	0,000012	0,000028	7,8	3,00
			Cyclopsetta panamensis	125	0,001543	4	0,000049	0,000609	12,2...18,7	31,25
			Cyclopsetta querna	3100	0,038260	10	0,000123	0,008130	21,9...36,5	310,00
			Engyophrys sanctilaurentii	3	0,000037	1	0,000012	0,000028	7,3	3,00
			Gymnothorax	950	0,011725	7	0,000086	0,003114	38...52	135,71
			Jara aequatorialis	275	0,003394	1	0,000012	0,000745	37,5	275,00
			Lophiodes caulinaris	9	0,000111	2	0,000025	0,000074	5,3 7	4,50
			Lutjanus guttatus	1449,91	0,017895	5	0,000062	0,003872	46...59,5	
			Porichthys margaritetes	85	0,001049	10	0,000123	0,000589	8...13,5	8,50
			Prionotus stephanophrys	1425	0,017587	6	0,000074	0,004016	25,5...39	237,50
			Raja velezi	1275	0,015736	1	0,000012	0,002282	46	1275,00
			Selene oerteri	5700	0,070349	9	0,000111	0,012326	28...38,5	633,33
			Synodus scituliceps	500	0,006171	6	0,000074	0,001870	11,3...31,3	83,33
			Synodus secgurae	11	0,000136	5	0,000062	0,000110	5,4...10	2,20
			Zalieutes elater	12	0,000148	2	0,000025	0,000091	7,1 8,9	6,00
			Zapteryx exasperata	500	0,006171	1	0,000012	0,001152	45,5	500,00
			Zapteryx exasperata	500	0,006171	1	0,000012	0,001152	45,5	500,00
			sum	**19226,91**	**0,237296**	**76**	**0,000938**	**0,046368**		**252,99**
13.12.1993	T	kinderwagen	Bothidae	...		1	0,000480	...		
			Porichthys	...		3	0,001440	...		
			sum			**4**	0,001920			**0,00**
13.12.1993	U	kinderwagen	Bollmannia chlamydes	2	0,000960	1	0,000480	0,000796	5,7	2,00
			Lepophilium prorates (?)	7	0,003360	1	0,000480	0,001987	**12,4**	**7,00**
			Ophichthidae sp.II	5	0,002400	2	0,000960	0,001874	23,3 0,8	2,50
			Ophichtidae sp.I	7	0,003360	1	0,000480	0,001987	17,8	7,00
			Porichthys margaritatus	8	0,003840	2	0,000960	0,002641	9,6 3,5	4,00
			Synodus evermanni	5	0,002400	1	0,000480	0,001554	3,4	5,00
			sum	**34**	**0,016319**	**8**	**0,003840**	**0,010838**		**4,25**

date	stat.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P [g/m2]	size range [cm]	mm.w. [g]
12.02.1994	N	bk	Antennarius avalones	500	0,239981	1	0,000480	0,044818	26	500,00
			Bollmannia stigmatura	19	0,009119	3	0,001440	0,005540	9,7...12,1	6,33
			Chlorophthalmus mento	95	0,045596	3	0,001440	0,017938	13,8...17,3	31,67
			Gymnothorax sp.	325	0,155988	1	0,000480	0,032725	62	325,00
			Hemanthias signifer	1850	0,887929	49	0,023518	0,333115	...	37,76
			Lophiodes caulinaris	19	0,009119	1	0,000480	0,004118	10,1	19,00
			Monolene asaedai	27	0,012959	3	0,001440	0,007160	11...11,3	9,00
			Monolene maculipinna	350	0,167987	24	0,011519	0,081477	...	14,58
			Physiculus nematopus	275	0,131989	19	0,009119	0,064148	...	14,47
			Physiculus rastrelliger	67	0,032157	7	0,003360	0,017475	7,5...13,2	9,57
			Pikae longilepis	111	0,053276	2	0,000960	0,018012	12,7...25,2	55,50
			Polylepion cruentum	38	0,018239	3	0,001440	0,009189	5,5...13,7	12,67
			Pontinus furcirhinus	400	0,191985	5	0,002400	0,058807	9...23	80,00
			Pontinus sierra	500	0,239981	24	0,011519	0,105709	...	20,83
			Pronotogrammus eos	100	0,047996	4	0,001920	0,020126	8,7...15,7	25,00
			Syacium latifrons	11	0,005280	1	0,000480	0,002763	9,9	11,00
			Symphurus callopterus	5	0,002400	2	0,000960	0,001874	7,9...9	2,50
			Symphurus gorgonae	1	0,000480	1	0,000480	0,000480	7,4	1,00
			Symphurus oligomerus	325	0,155988	38	0,018239	0,087382	...	8,55
			Zalieutes elater	50	0,023998	6	0,002880	0,013538	5...10,3	8,33
			sum	**5068**	**2,432445404**	**197**	**0,09455244**	**0,926395881**		
12.02.1994	O	bk	Bellator gymnostethus	67	0,032157	3	0,001440	0,013902	11,2...12,5	22,33
			Bollmannia stigmatura	250	0,119990	58	0,027838	0,080878	...	
			Cyclopsetta sp.	1,5	0,000720	1	0,000480	0,000645	5,6	1,50
			Decodon melasma	7	0,003360	1	0,000480	0,001987	9	7,00
			Diplectrum euryplectrum	125	0,059995	1	0,000480	0,016291	19,6	125,00
			Engyophrys sanctilaurentii	38	0,018239	5	0,002400	0,010548	7,7...10,7	7,60
			Gymnothorax sp. (new species)	87	0,041757	1	0,000480	0,012504	47	87,00
			Hemanthias signifer	4	0,001920	1	0,000480	0,001320	7,1	4,00
			Lophiodes caulinaris	7	0,003360	1	0,000480	0,001987	6,7	7,00
			Monolene maculipinna	90	0,043197	11	0,005280	0,024489	10...15,5	8,18
			Physiculus nematopus	57	0,027358	7	0,003360	0,015530	5,6...12,5	8,14
			Pontinus sierra	9	0,004320	6	0,002880	0,003872	2,3...5,6	1,50
			Porichthys margaritatus	129	0,061915	...			...	
			Pronotogrammus eos	29	0,013919	6	0,002880	0,009096	5,2...11	4,83
			Rhynchoconger nitens	74	0,035517	3	0,001440	0,014947	26,3...29,7	24,67
			Symphurus callopterus	300	0,143988	19	0,009119	0,068355	...	15,79
			Symphurus gorgonae	6	0,002880	2	0,000960	0,002141	5,8...6,3	3,00
			Synchiropus atrilabiatus	38	0,018239	22	0,010559	0,015736	...	1,73
			Synodus evermanni	350	0,167987	20	0,009599	0,077563	...	17,50
			Zalieutes elater	9	0,004320	1	0,000480	0,002387	8,1	9,00
			sum	**1677,5**	**0,805135589**	**169**	**0,08111351**	**0,37417769**		
12.02.1994	P	bk	Bollmannia chlamydes	225	0,107991	41	0,019678	0,068195	...	5,49
			Cycloopsetta sp.	17	0,008159	7	0,003360	0,006421	6,4...8,2	2,43
			Cyclopsetta querna	125	0,059995	1	0,000480	0,016291	24,5	125,00
			Diplectrum macropoma	33	0,015839	2	0,000960	0,007430	9,9...13,1	16,50
			Gymnothorax equatorialis	70	0,033597	1	0,000480	0,010669	45,7	70,00
			Porichthys margaritatus	600	0,287977	86	0,041277	0,170440	...	6,98
			Prionotus teaguei (juv.)	8	0,003840	4	0,001920	0,003184	1...1,5	
			Rhynchoconger nitens	17	0,008159	1	0,000480	0,003797	25,2	17,00
			Syacium ovale	350	0,167987	92	0,044156	0,117111	...	3,80
			Symphurus leei	31	0,014879	5	0,002400	0,009091	7,6...11,8	6,20
			Synodus evermanni	19	0,009119	6	0,002880	0,006680	6,8...8,8	3,17
			Synodus scituliceps	825	0,395968	16	0,007679	0,136562	...	51,56
			sum	**2320**	**1,113510919**	**262**	**0,12574994**	**0,555872605**		
12.02.1994	Q	bk	Bollmannia sp. (new species)	...		14	0,006719	0,000000	...	
			Cyclopsetta sp.	3,3		2	0,000960	0,000000	6,3...8,1	
			Diplectrum sp.	70	0,033597	28	0,013439	0,026234	...	2,50
			Engraulidae	30		2	0,000960	0,000000	larvae	
			Lophiodes sp.	...		2	0,000960	0,000000	<2	
			Paralichthyidae	...		2	0,000960	0,000000	postlarvae < 2	
			Porichthys margaritatus	33,66		6	0,002880	0,000000	<3	
			Scorpaena russula	5,09		2	0,000960	0,000000	< 2	
			Sphaeroides annulatus	350	0,167987	1	0,000480	0,034544	24,3	350,00
			Sphaeroides lobatus	450	0,215983	2	0,000960	0,050041	4,8...25,3	225,00
			Syacium sp.	174	0,083513	74	0,035517	0,066298	...	2,35
			Synodus sechurae	125	0,059995	16	0,007679	0,034440	...	7,81
			sum	**1241,05**	**0,561075114**	**151**	**0,0724742**	**0,211557426**		

date	stat.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P.[g/m2]	size range [cm]	m. w. [g]
10.12.1993	A	bk	Bollmania chlamydes	125	0,059995	27	0,012959	0,039666		4,63
			Porichthys margaritatus	125	0,059995	19	0,009119	0,036076	6,5...12,5	6,58
			Symphurus attramentatus	35	0,016799	51	0,024478	0,018596	6...12,5	0,69
			sum	285	0,136789057	97	0,046556275	0,09433774		2,94
10.12.1993	B	bk	Bellator sp.			1	0,000480	0,000000	5	
			Bregmaceros bathymaster	1,08	0,000518	1	0,000480	0,000508	4	
			Camarones	575	0,275978	1000	0,479962	0,320453	30...65	0,58
			Cynoscion phococephalus	32,19	0,015450	2	0,000960	0,007297	6,2 6,4	
			Porichthys margaritauts	16,83	0,008078	3	0,001440	0,005071	8,9 10,1 6,7	
			Symphurus altramentatus	10,9	0,005232	2	0,000960	0,003310	9,3 10,9	
			sum	636	0,30525558	1009	0,484281257	0,336637632		0,63
10.12.1993	C	bk	Camarones sp. I	3	0,001440	3	0,001440	0,001440		
			Camarones sp.II	146	0,070074	146	0,070074	0,070074	...	1,00
			Cynoscion phoxocephalus	17,7	0,008495	1	0,000480	0,003910	12,5	17,70
			Diplectrum labarum	500	0,239981	4	0,001920	0,065164	7,7...14,8	125,00
			Porichthys margaritatus	32,6	0,015647	9	0,004320	0,011054	3,7...9	3,62
			Prionotus stephanophus	475	0,227982	2	0,000960	0,052056	6,5 10,3	
			Syascium latifrons	19,7	0,009455	5	0,002400	0,006530	6,2...7,9	3,94
			Symphurus attramentatus	225	0,107991	31	0,014879	0,063236	9,2...11,3	7,26
			sum	1419	0,681065515	201	0,096472282	0,273464801		7,06
10.12.1993	D	bk	Achirus mazaflanus	33	0,016031	1	0,000480	0,006216	12	33,40
			Ballmania chlamydes	19,9	0,009551	26	0,012479	0,010266	3,6...5,6	0,77
			Cithrichthys gilberti	35,5	0,017039	3	0,001440	0,008744	11,0 11,5 11,7 35,5	11,83
			Cyclopsetta panamensis	90,1	0,043245	1	0,000480	0,012828	21,7	90,10
			Diplectrum pacificum	63,27	0,030367	1	0,000480	0,009910	5,2	
			Lutjanus guttatus	26,6	0,012767	1	0,000480	0,005265	13,5	26,60
			Scorpaena russula	38,7	0,018575	5	0,002400	0,010690	7,1...9,4	7,74
			Sphaeroides annulatus	13,7	0,006575	1	0,000480	0,003243	9,1	13,70
			Synodus scituliceps	475	0,227982	11	0,005280	0,082484	7,2...32	43,18
			Synodus sechurae	169	0,081114	2	0,000960	0,024482	17,5 24,2	84,50
			sum	965,17	0,46324454	52	0,024958003	0,174127672		18,56
10.12.1993	E	bk	Achirus mazaflanus	72	0,034317	2	0,000960	0,013066	12,9 16,6	35,75
			Ballmania chlamydes	12,2	0,005856	12	0,005760	0,005829	2,5...8,4	1,02
			Citharichthys gilberti	8,2	0,003936	1	0,000480	0,002230	10,2	8,20
			Citharichthys sp.	3,4	0,001632	2	0,000960	0,001414	6,8 6,9	1,70
			Cyclopsetta panamensis	25,2	0,012095	1	0,000480	0,005061	14,5 25,2	25,20
			Diplectrum pacificens	12,1	0,005808	1	0,000480	0,002962	11,2 12,1	12,10
			Prionatus ruscarius	105,1	0,050444	1	0,000480	0,014354	21,6	105,10
			Sphaeroides annulatus	24,9	0,011951	1	0,000480	0,005017	11,7	24,90
			Sphaeroides labatus	6,2	0,002976	3	0,001440	0,002446	4,2 4,7 5,2	2,07
			Symphurus sp.	8,7	0,004176	5	0,002400	0,003596	4,5...9,4	1,74
			Synodus scituliceps	112	0,053756	4	0,001920	0,021862	12,6...22,8	28,00
			sum	389,5	0,186945044	33	0,015838733	0,07783711		11,80
10.12.1993	F	bk	Bellator xenisma	41	0,019678	6	0,002880	0,011712		6,83
			Cephalopoda			1	0,000480			
			Citharichthys platophrys	475	0,227982	30	0,014399	0,108147		15,83
			Diplectrum labarum	90	0,043197	3	0,001440	0,017244		30,00
			Engyophris sanctilaurentii	7,61	0,003653	1	0,000480	0,002112		
			Gastropoda	1200	0,575954					
			Gymnothorax	275	0,131989	1	0,000480	0,028968		275,00
			Morena			1	0,000480			
			Prionotus albirostris	21	0,010079	1	0,000480	0,004430		21,00
			Scorpaena russula	15	0,007199	2	0,000960	0,004179		7,50
			Syacium ovale	23,64	0,011346	1	0,000480	0,004830		
			Symphurus attramentates	38,14	0,018306	7	0,003360	0,011582		
			Synodus scituliceps	170	0,081593	5	0,002400	0,031489		34,00
			Trichurus nitens	0,5	0,000240	1	0,000480	0,000289		0,50
			Zalieutes elater	2	0,000960	1	0,000480	0,000796		2,00
			sum	2358,89	1,132176626	61	0,029277658	0,225778249		38,67
10.12.1993	G	bk	Camarones rojos	160	0,076794	61	0,029278	0,059191	4,2...11,0	2,62
			Camaron tigre	75	0,035997	35	0,016799	0,029302	5,5...7,6	2,14
			Chiloconger labiatus	28	0,013439	1	0,000480	0,005466	23	28,00
			Galatheidae	1700	0,815935	421	0,202064	0,559745	17...29	4,04
			Hildebrandia nitens	27	0,012959	3	0,001440	0,007160	14,5 19,5 20,7	9,00
			Kathestostoma averruncus	31	0,014879	2	0,000960	0,007099	8,2 9,2	15,50
			Lophiodes caulinares	75	0,035997	1	0,000480	0,011220	15,4	75,00
			Lophiodes prorates	33	0,015839	1	0,000480	0,006162	20,3	33,00
			Lophiodes spirulus	78	0,037437	2	0,000960	0,013922	11,5 14	39,00
			Monolene maculipinna	87	0,041757	9	0,004320	0,022631	11...12,8	9,67
			Neobythites stelliferides	198	0,095032	3	0,001440	0,030662	9,8 10,1 10,6	66,00
			Ophisoma parigena	108	0,051836	3	0,001440	0,019698	248 250 25,3	36,00
			Peristedion barbiger	9,06	0,004348	1	0,000480	0,002398	11,5	
			Peristedion crustosum	16	0,007679	2	0,000960	0,004380	8,9 9,2	8,00
			Physiculus nematopus	53	0,025438	4	0,001920	0,012661	9,7...14,4	13,25
			Pontinus sierra	1025	0,491961	169	0,081114	0,302388	4,6...15,7	6,07
			Porichthys greeni	2500	1,199904	1	0,000480	0,145112	8	2500,00

date	stat.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P.[g/m2]	size range [cm]	m. w. [g]
			Porichthys margaritatus	28	0,013439	10	0,004800	0,010177	5,8...8,4	2,80
			Pronotogrammus eos	41	0,019678	1	0,000480	0,007220	17,8	41,00
			Symphurus alligomeras	74	0,035517	9	0,004320	0,020109	11,2...13,7	8,22
			Symphurus callopterus	295	0,141589	24	0,011519	0,071917	8,9...12,7	12,29
			Symphurus sp.	2	0,000960	1	0,000480	0,000796	8	2,00
			Synchiropus sp.	12	0,005760	8	0,003840	0,005162	4,8...6,2	1,50
			Zalieutes elater	10	0,004800	2	0,000960	0,003108	5,5 8,4	5,00
			sum	**6665,06**	**3,198972882**	**774**	**0,371490281**	**1,357687477**		8,61
11.12.1993	H	gsn	Achirus scutum	7	0,000086	1	0,000012	0,000051	8	7,00
			Anchoa ischiana	168	0,002073	13	0,000160	0,001039	10,7...12,6	12,92
			Carangoides otrynter	1300	0,016044	5	0,000062	0,003575	24,3...34,4	260,00
			Caranx caninus	375	0,004628	1	0,000012	0,000934	30,7	375,00
			Caranx vinctus	5500	0,067880	28	0,000346	0,016315	...	196,43
			Diplectrum pacificum	150	0,001851	1	0,000012	0,000479	21,3	150,00
			Eucinostomus argenteus	959,2	0,011838	17	0,000210	0,003985	12,3...16	
			Himantura pacifica	7800	0,096267	2	0,000025	0,010325	53 120	3900,00
			Narcine brasiliensis	2700	0,033323	4	0,000049	0,005739	27,1...36	675,00
			Pomadasys panamensis	425	0,005245	3	0,000037	0,001377	...	141,67
			Pseudopeneus vancolensis	200	0,002468	4	0,000049	0,000858	10,5...17,6	50,00
			Selene oerstedii	750	0,009256	2	0,000025	0,001868	32,3 32,3	375,00
			Selene peruviana	200	0,002468	1	0,000012	0,000590	14,2	200,00
			Sphaeroides annulatus	27	0,000333	1	0,000012	0,000137	11,2	27,00
			Synodus sechurae	95	0,001172	4	0,000049	0,000499	5,7...19,5	23,75
			Urotrygon aspirura	150	0,001851	2	0,000025	0,000577	9 11	75,00
			Urotrygon chilensis	15	0,000185	2	0,000025	0,000107	11,1 14	7,50
			sum	**20821,2**	**0,256972539**	**91**	**0,00112311**	**0,048455096**		228,80
11.12.1993	I	gsn	Anisostremus dovii	350	0,004320	2	0,000025	0,001071	23,1 20,3	175,00
			Argentina alicea	325	0,004011	14	0,000173	0,001716	14,5...16,7	23,21
			Bollmania stygmatura	8,58	0,000106	2	0,000025	0,000071	5,9 6,3	
			Carangoides otrynter	150	0,001851	1	0,000012	0,000479	25,2	150,00
			Caranx vinctus	4000	0,049367	17	0,000210	0,011301	22...30,2	235,29
			Chlorophtalmus mentis	30,32	0,000374	1	0,000012	0,000149	9,1	
			Cynoscion nannus	150	0,001851	2	0,000025	0,000577	21,1 26,4	75,00
			Diplectrum pacificum	43	0,000531	1	0,000012	0,000192	15,5	43,00
			Eucinostomus argenteus	225	0,002777	4	0,000049	0,000935	12,8...16,2	56,25
			Monolene maculipinna	45	0,000555	25	0,000309	0,000474	10,8...16,2	1,80
			Peristedion barbiger	47	0,000580	10	0,000123	0,000382	8,3...13,4	4,70
			Physiculus nematopus	225	0,002777	27	0,000333	0,001567	7,5...12,7	8,33
			Pontinus sierra	150	0,001851	13	0,000160	0,000957	5...17,5	11,54
			Pronotogrammus eos	250	0,003085	7	0,000086	0,001175	11,3...17,8	35,71
			Trichiurus nitens	400	0,004937	18	0,000222	0,002137	32...47	22,22
			Zalieutes elater	8	0,000099	1	0,000012	0,000056	8,9	8,00
			sum	**6406,9**	**0,079073126**	**145**	**0,001789571**	**0,023238765**		44,19
11.12.1993	I(2)	gsn	Argentina alicea	4382,82	0,081138	2	0,000037	0,010168	14,8...17,4	2191,41
			Bollmania chlamydes	43,29	0,000801	3	0,000056	0,000390	5,2...11,1	14,43
			Bollmania synatura	8,19	0,000152	1	0,000019	0,000086		8,19
			Caranx vinctus	263,25	0,004873	1	0,000019	0,001082	27	263,25
			Chlorophtalmus mentus	3100,5	0,057399	107	0,001981	0,023129	8,5...18	28,98
			Diplectrum euryplectrum	702	0,012996	11	0,000204	0,004231	12,5...17,6	63,82
			Engyophrys sanctilaurentii	14,04	0,000260	1	0,000019	0,000127	11,2	14,04
			Hemanthias signifer	117	0,002166	2	0,000037	0,000722	15,2 16,9	58,50
			Kathestoma averuncus	63,18	0,001170	2	0,000037	0,000460	7,4...12,4	31,59
			Lophiodes spilurus	234	0,004332	4	0,000074	0,001444	8,4...16,3	58,50
			Monolene maculipinna	1023,75	0,018952	71	0,001314	0,009220	10,2...16,7	14,42
			Mustelus lunulatus	2223	0,041154	1	0,000019	0,005137	83	2223,00
			Neobithytes stegiferoides	4299,75	0,079600	188	0,003480	0,034191	8,8...17	22,87
			Ophisoma prorigen	555,75	0,010288	11	0,000204	0,003568	17,5...31	50,52
			Peristedon barbiger	476,19	0,008816	83	0,001537	0,005501	5,6...14,6	5,74
			Physiculus nematopus	5206,5	0,096387	219	0,004054	0,040970	8,7...17,5	23,77
			Pontinus sierra	8570,25	0,158659	598	0,011071	0,077315	4,1...16,6	
			Pronotogrammus eos	2398,5	0,044403	70	0,001296	0,017100	9,2...19,5	34,26
			Symphurus allpoterus	146,25	0,002707	8	0,000148	0,001235	10,8...12,3	18,28
			Symphurus sp.	14,04	0,000260	3	0,000056	0,000171	11,7...13,5	4,68
			Synoscium nannus	12168	0,225264	135	0,002499	0,066815	10,5...25,5	90,13
			sum	**46010**	**0,851778**	**1521**	**0,024363**	**0,303064**		30,25
11.12.1993	J	gsn	Dasyatis longus	18000	0,222154	1	0,000012	0,015766	1800	18000,00
			Diodon hystrio	3225	0,039803	6	0,000074	0,007290	15,2...31	537,50
			Diplobates ommata	350	0,004320	3	0,000037	0,001195	17,5...21,5	116,67
			Lutjanus peru	775	0,009565	30	0,000370	0,003976	19,2...36	25,83
			Mustrellus danulatus	33984	0,419426	32	0,000395	0,063915	6,2...22	
			Octopus sp.	...		1	0,000012		...	
			Peristedion crustosum	130	0,001604	20	0,000247	0,000968	7,1...13,5	6,50
			Pharantias colonus	425	0,005245	10	0,000123	0,001906		42,50
			Phistularia sp.	650	0,008022	1	0,000012	0,001396	100,9	650,00
			Rypticus bicolor	225	0,002777	1	0,000012	0,000643	23,7	225,00
			Sphaeroides annulatus	2600	0,032089	30	0,000370	0,009619	37 39,5	86,67
			Sphaeroides lobates	12,1	0,000149	26	0,000321	0,000184	19...32	0,47
			sum	**60376,1**	**0,745153965**	**161**	**0,001987041**	**0,106857044**		375,01

date	stat.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P.[g/m2]	size range [cm]	m. w. [g]
12.12.1993	K	gsn	Antennarius avalensis	525	0,006479	1	0,000012	0,001194	18,8	525,00
			Bellator xenisma	3	0,000037	1	0,000012	0,000028	6,5	3,00
			Diplectrum labarum	1350	0,016662	114	0,001407	0,008548	8,4...17,3	11,84
			Eucinostomus gracilis	14250	0,175872	696	0,008590	0,077834	10,8...17,4	20,47
			Eugerres aurelus	...		2	0,000025		...	
			Prionotus sp.	42	0,000518	1	0,000012	0,000189	15,7	42,00
			Sphaeroides annulatus	10	0,000123	1	0,000012	0,000066	8,2	10,00
			Synodus scituliceps	275	0,003394	3	0,000037	0,001002	25,325,3 25,7	91,67
			sum	**16455**	**0,203085467**	**819**	**0,010107991**	**0,088861774**		20,09
12.12.199	L	gsn	Calamares			1	0,000012		...	
			Camarones rojos	650	0,008022	248	0,003061	0,006185	...	
			Cynoscium nannus	1000	0,012342	112	0,001382	0,006834	5,7...18,8	8,93
			Engraulidae	15	0,000185	1	0,000012	0,000089	4,2	
			Eucinostomus gracilis	1300	0,016044	56	0,000691	0,006864	8...15,7	23,21
			Myctophidae	195	0,002407	168	0,002073	0,002312	3,4...6,5	1,16
			Ophichthidae	1500	0,018513	1	0,000012	0,002570	...	1500,00
			Porichthys sp.			1	0,000012		6,5	
			sum	**4660**	**0,057513**	**587**	**0,007245**	**0,024853**		7,94
12.12.1993	M	gsn	Ballmania chlamydes	89	0,001098	42	0,000518	0,000897	4,2...12	2,12
			Bregmaceros sp.	1500	0,018513	1	0,000012	0,002570	6,2	1500,00
			Cithorichthys platophrys	12	0,000148	4	0,000049	0,000110	8,9 9,2 9,6 9,7	3,00
			Cynoscium nannus	15000	0,185128	509	0,006282	0,074258	6,6...18,3	29,47
			Diplectrum lavarum	6200	0,076520	290	0,003579	0,033471	8...15,4	21,38
			Pontinus sierra	575	0,007097	63	0,000778	0,003906	4,9...13,0	9,13
			Porichthys margaritatus	275	0,003394	70	0,000864	0,002346	4,5...9,8	3,93
			Prionotus albirostris	150	0,001851	39	0,000481	0,001287	4,8...8,5	3,85
			Pronotogrammus eos	29	0,000358	3	0,000037	0,000194	10,5 11,4 11,5	9,67
			Symphurus callopterus	8,73	0,000108	1	0,000012	0,000060	9,7	
			Synodus sechurae	23	0,000284	1	0,000012	0,000122	15,7	23,00
			Trichiurus nitens	7	0,000086	1	0,000012	0,000051	26,5	7,00
			Umbrina bussingii	125	0,001543	5	0,000062	0,000647	11,7...13,6	25,00
			sum	**23993,73**	**0,296127**	**1029**	**0,012700**	**0,119919**		

date	sta.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P [g/m2]	size range [cm]	m. w. [g]
10.02.1994	B	bk	Cynoscion nannus	179	0,085913	1	0,000480	0,021173	13	179,0
			Porichthys greeni	2,7	0,001296	1	0,000480	0,000991	6,7	2,7
			sum	181,7	0,087209023	2	0,00095992	0,022164397		
10.02.1994	C	bk	Cynoscion nannus	28,7	0,013775	2	0,000960	0,006710	12...12,3	14,4
			Symphurus leei	24,3	0,011663	3	0,001440	0,006630	8,9...12	8,1
			sum	53	0,025437965	5	0,00239981	0,013340372		
10.02.1994	D	bk	Bellator xenisma	5	0,002400	1	0,000480	0,001554	7,3	5,0
			Bollmannia chlamydes	6	0,002880	4	0,001920	0,002581	4,8...7,6	1,5
			Diapterus perivianus	1300	0,623950	8	0,003840	0,157841	20,2...24,5	162,5
			Diplectrum macropoma	62	0,029758	5	0,002400	0,015079	8,2...13,1	12,4
			Eucinostomus argenteus	125	0,059995	3	0,001440	0,021917	15,4...15,7	41,7
			Gymnothorax equatrialis	350	0,167987	5	0,002400	0,053346	27,5...47	70,0
			Porichthys greeni	38	0,018239	6	0,002880	0,011080	5,5...10,8	6,3
			Symphurus atramentatus	9,3	0,004464	1	0,000480	0,002445	11,4	9,3
			Symphurus melastomateca	24	0,011519	6	0,002880	0,007922	7,8...9,6	4,0
			Synodus evermanni	25	0,011999	3	0,001440	0,006769	9,5...12	8,3
			Synodus scituliceps	150	0,071994	8	0,003840	0,032628	9,8...18,5	18,8
			sum	2094,3	1,005183585	50	0,02399808	0,313161305		
10.02.1994	E	bk	Diplectrum eumelum	6,6	0,003168	1	0,000480	0,001903	8,7	6,6
			Diplectrum macropoma	91	0,043677	1	0,000480	0,012921	19,8	91,0
			sum	97,6	0,046844252	2	0,00095992	0,014824467		
10.02.1994	F	bk	Syacium latifrons	35	0,016799	2	0,000960	0,007756	11,9...13,4	17,5
			Symphurus atramentatus	15	0,007199	3	0,001440	0,004662	8,4...9,4	5,0
			sum	50	0,02399808	5	0,00239981	0,012418333		
10.02.1994	G	bk	Bollmannia chlamydes	59	0,028318	8	0,003840	0,016511	9,2...9,7	7,4
			Gymnothorax sp. (new species)	125	0,059995	1	0,000480	0,016291	45	125,0
			Hemanthias peruanus	78	0,037437	2	0,000960	0,013922	16,1...16,7	39,0
			Kathetostoma averruncus	47	0,022558	2	0,000960	0,009619	9,3...9,8	23,5
			Lophiodes spirulus	28	0,013439	2	0,000960	0,006590	10...10,3	14,0
			Monolene asaedai	44	0,021118	6	0,002880	0,012332	9,2...11	7,3
			Monolene maculipinna	300	0,143988	28	0,013439	0,075899	...	10,7
			Neobythes stelliferoides	130	0,062395	15	0,007199	0,034828	7,6...12,6	8,7
			Ophichthys sp. b	50	0,023998	1	0,000480	0,008346	37	50,0
			Ophistoma prorigerum	58	0,027838	2	0,000960	0,011215	21,8...24,1	29,0
			Peristedion barbiger	10	0,004800	2	0,000960	0,003108	9,7...10,3	5,0
			Peristedion crustosum	29	0,013919	6	0,002880	0,009096	7,3...11,6	4,8
			Physiculus nematopus	600	0,287977	50	0,023998	0,147224	...	12,0
			Pontinus sierra	950	0,455964	82	0,039357	0,235328	...	11,6
			Porichthys greeni	20	0,009599	5	0,002400	0,006602	7,1...8,5	4,0
			Pronotogrammus eos	723	0,347012	32	0,015359	0,149544	...	22,6
			Rhynchoconger nitens	75	0,035997	11	0,005280	0,021438	14...20	6,8
			Symphurus callopterus	39	0,018719	3	0,001440	0,009365	11,8...13,9	13,0
			Symphurus gorgonae	3,47	0,001665	1	0,000480	0,001190	8,6	
			Symphurus leei	28	0,013439	2	0,000960	0,006590	9,6...16,8	14,0
			Symphurus oligomerus	750	0,359971	58	0,027838	0,180354	...	12,9
			Synchiropus atrilabiatus	8	0,003840	4	0,001920	0,003184	5,4...6,2	2,0
			sum	4154,47	1,993986081	323	0,1550276	0,978577053		
10.02.1994	H	bk	Achirus scutum	11	0,005280	1	0,000480	0,002763	8,3	11,0
			Cyclopsetta panamensis	2500	1,199904	1	0,000480	0,145112	6,5	2500,0
			Rypticus nigripinnis	17	0,008159	1	0,000480	0,003797	11,9	17,0
			Sphaeroides lobatus	400	0,191985	1	0,000480	0,038081	24,7	400,0
			Syacium latifrons	42	0,020158	30	0,014399	0,018408	1,6...8	1,4
			Synchiropus atrilabiatus	4	0,001920	2	0,000960	0,001592	5...6,7	2,0
			Synodus scituliceps	72	0,034557	5	0,002400	0,016818	4,7...18	14,4
			sum	3046	1,461963043	41	0,01967843	0,226571374		
11.02.1994	H	gsn	Albula nemoptera	2800	0,034557	6	0,000074	0,006575	37,4...43,6	466,7
			Antennarius avalonis	47	0,000580	1	0,000012	0,000205	11,5	47,0
			Arius platypogon	750	0,009256	1	0,000012	0,001549	48,3	750,0
			Caranx caballus	225	0,002777	1	0,000012	0,000643	27,7	225,0
			Caranx otrynter	10500	0,129590	16	0,000197	0,022489	...	656,3
			Caranx speciosus	7850	0,096884	2	0,000025	0,010373	67...70,5	3925,0
			Cyclopsetta panamensis	525	0,006479	6	0,000074	0,001937	12,1...26,7	87,5
			Dasyatis longus	6866,13	0,084741	1	0,000012	0,007802	76 (width)	6866,1
			Diodum histrio	1300	0,016044	1	0,000012	0,002315	22,5	1300,0
			Diplectrum pacificum	500	0,006171	5	0,000062	0,001780	17,9...21,6	100,0
			Eosinistomus argentinus	200	0,002468	49	0,000605	0,001688	...	4,1
			Lutjanus guttatus	3900	0,048133	13	0,000160	0,010319	...	300,0
			Narcine brasiliensis	7600	0,093798	4	0,000049	0,012216	44,5...58,5 (width)	1900,0
			Pomadasys branickii	2200	0,027152	12	0,000148	0,006649	...	183,3
			Prionotus birrostratus	...		1	0,000012	0,000000	...	
			Prionotus ruscarius	550	0,006788	3	0,000037	0,001662	18,3...29,8	183,3
			Rhipticus negropinnis	375	0,004628	8	0,000099	0,001638	10,9...19	46,9
			Sphaeroides annulatus	1500	0,018513	2	0,000025	0,003099	7,7...41,6	750,0
			Sphaeroides lobatus	6400	0,078988	14	0,000173	0,015113	...	457,1
			Synodus sechurae	130	0,001604	6	0,000074	0,000699	8,7...19,7	21,7
			sum	54218,13	0,669153101	152	0,00187596	0,108751229		

date	sta.	gear	species	B(t) [g]	B [g/m2]	A (t)	A [/m2]	P [g/m2]	size range [cm]	m. w. [g]
12.02.1994	I(2)	gsn	Bollmannia chlamydes	6	0,000074	1	0,000012	0,000046	10,3	6,0
			Bregmacerus batimaster	1,5	0,000019	1	0,000012	0,000017	4,6	1,5
			Lophiodes caulinaris	350	0,004320	5	0,000062	0,001372	25,7	70,0
			Peristedion barbiger	400	0,004937	27	0,000333	0,002384	8,9...15,2	14,8
			Peristedion crustosum	26	0,000321	5	0,000062	0,000206	7,8...11,4	5,2
			Physiculus nematopus	7	0,000086	1	0,000012	0,000051	9,3	7,0
			Pontinus sierra	28	0,000346	3	0,000037	0,000189	6,9...11,5	9,3
			Raja velezi	1800	0,022215	6	0,000074	0,004762	32,8...41,4	300,0
			Umbrina bussingii	300	0,003703	1	0,000012	0,000794	32	300,0
			sum	**2918,5**	**0,036019747**	**50**	**0,00061709**	**0,0098202**		
11.02.1994	M	gsn	Bellator xenisma	4,3	0,000053	1	0,000012	0,000036	6,6	4,3
			Citharichthys platophrys	7	0,000086	1	0,000012	0,000051	9,2	7,0
			Cyclopsetta panamensis	250	0,003085	1	0,000012	0,000695	28,4	250,0
			Dasyatis longus	3600	0,044431	1	0,000012	0,004869	53 (width)	3600,0
			Diplectrum labarum	175	0,002160	4	0,000049	0,000779	12,3...17	43,8
			Epinephelus niphobles	1125	0,013885	7	0,000086	0,003523	19,2...24	160,7
			Hippocampus ingens	9,5	0,000117	1	0,000012	0,000064	16	9,5
			Monolene maculipinna	50	0,000617	1	0,000012	0,000215	14	50,0
			Mustelus lunulatus	4250	0,052453	5	0,000062	0,008488	76...106	850,0
			Narcine brasiliensis	225	0,002777	1	0,000012	0,000643	14,5 (width)	225,0
			Peprilus snyderi	500	0,006171	3	0,000037	0,001550	22,5...25,7	166,7
			Porichthys greeni	2,5	0,000031	1	0,000012	0,000024	6,9	2,5
			Raja velezi	3975	0,049059	4	0,000049	0,007611	16,2...71,5 (width)	993,8
			Synodus evermanni	34	0,000420	2	0,000025	0,000195	13,3...15,2	17,0
			Zapteryx exasperata	225	0,002777	1	0,000012	0,000643	16,2 (width)	225,0
			sum	**14432,3**	**0,178121567**	**34**	**0,00041962**	**0,029387376**		

Species	Golfo Dulce											Sierpe Terraba							Golfo de Nicoya											
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	31	51	54	52	53	6	60	30	35	1	45	43
CRUSTACEA REPTANTIA																														
Calappa saussurei																							X							
Callinectes arcuetus				X																								X	X	X
Callinectes toxotes																													X	
Darcanus sinistripes						X														X				X				X		
Ethuba cilliatifrons																					X		X	X						
Euphylax robustus																	X													
Evibacus princeps																			X											
Hepatus kossmanni																			X					X		X		X		
Hypoconcha panamensis																			X										X	X
Kiacantha hancocki																				X										
Kiacantha schmitti																			X					X						
Leiolambrus punctatissimus														X																
Lithadia sp.																			X											
Maiopsis panamensis																						X								
Microphrys sp.																										X				X
Mitrax sinensis																				X										
Munida sp. 1				X	X		X				X			X															X	
Pagurus gladius																														X
Pagurus sp.																			X											
Paradasygius depressus														X			X		X					X						
Parthenope exilipes																				X		X	X							
Parthenope sp.																			X	X										
Persephona orbicularia																				X				X				X		
Petrochirus californiensis																				X										
Pilumnus townsendi																							X							
Pinnixa sp.1																			X							X				
Pinnixa sp.2																							X							
Pinnixa sp.3					X																									
Portunus arcatus																										X				
Portunus asper				X										X					X				X			X		X		X
Portunus iridescens				X			X						X								X	X						X		
Portunus xanthusi				X																										
Pylopagurus sp.1													X							X										
Pylopagurus sp.2																				X				X						
Pyromaia sp.																						X								
Quadrelle nitida																				X										
Randallia bulligera																			X	X										
Ranonoides benedicci														X					X					X		X				
Solenolambrus arcuatus																			X	X										
Stenocionops sp.																						X								
Stenocionops triangulara																				X										
Stenorhynchus debilis																			X									X		
.... trias sp.																										X				
CRUSTACEA STOMATOPODA																														
Lysiosquilla swetti																			X									X		
Pseudorasquilla similis																					X									
Squilla aculeata																			X							X	X	X	X	X
Squilla biformis					X							X	X				X				X					X				
Squilla bigelowi				X										X								X		X						
Squilla mantoidea																											X	X		
Squilla panamensis																	X													

Species	Golfo Dulce											Sierpe Terraba							Golfo de Nicoya											
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	31	51	54	52	53	6	60	30	35	1	45	43
CRUSTACEA NATANTIA																														
PENEIDOS																														
Penaeus stylirostris																												X		
Sicyonia picta													X							X	X	X							X	
Solenocera agassizii					X									X							X	X							X	
Solenocera mutator	X																					X							X	
Trachipenaeus facea																														X
Trachipenaeus pacificus																												X		
CRUSTACEA NANTANTIA																														
CARIDEOS																														
Lysmata californica																														X
Pantomus affinis																													X	
Plesionika mexicana																					X	X							X	
Lismata sp.																						X								
CRUSTACEA REPTANTIA																														
Acanthocarpus sp.																						X								
Munida sp.1					X									X															X	
Munida sp.2							X							X																
Microphrys sp.																														X
Collodes sp.																												X		
Heterocrypta macrobrachia																														X
Hypoconcha pawamensis																														X
Portunus iridescens													X																	
Portunus asper																														X
Mursia gaudichandi																					X	X								
Cancer johngarthi							X																							
Hepatus kossmanni																												X		
Persephona orbicularia																												X		
Porcellana cancrisocialis																												X		
Callinectes arcuatus																														X
Dardanus sinitripes																												X		
Pylopagurus sp.1																				X										
Pylopagurus sp.2																				X										
CRUSTACEA																														
STOMATOPODA																														
Squilla biformis					X																									
Squilla bigelowi				X																										

No.	species	frequency
1	Achirus scutum	1
2	Albula nemoptera	1
3	Antennarius avalonis	1
4	Arius platypogon	1
5	Bellator xenisma	2
6	Bollmannia chlamydes	3
7	Bregmacerus batimaster	1
8	Caranx caballus	1
9	Caranx otrynter	1
10	Caranx speciosus	1
11	Citharichthys platophrys	1
12	Cyclopsetta panamensis	3
13	Cynoscion nannus	1
14	Dasyatis longus	2
15	Diapterus perivianus	1
16	Diodum histrio	1
17	Diplectrum eumelum	1
18	Diplectrum labarum	1
19	Diplectrum macropoma	2
20	Diplectrum pacificum	1
21	Eosinistomus argentinus	1
22	Epinephelus niphobles	1
23	Eucinostomus argenteus	1
24	Gymnothorax equatrialis	1
25	Gymnothorax sp. (new species)	1
26	Hemanthias peruanus	1
27	Hippocampus ingens	1
28	Kathetostoma averruncus	1
29	Lophiodes caulinaris	1
30	Lophiodes spirulus	1
31	Lutjanus guttatus	1
32	Monolene asaedai	2
33	Monolene maculipinna	1
34	Mustelus lunulatus	2
35	Narcine brasiliensis	1
36	Neobythes stelliferoides	1
37	Ophichthys sp. b	1
38	Ophistoma prorigerum	1
39	Peprilus snyderi	2
40	Peristedion barbiger	2
41	Peristedion crustosum	2
42	Physiculus nematopus	1
43	Pomadasys branickii	2
44	Pontinus sierra	4
45	Porichthys greeni	1
46	Prionotus birrostratus	1
47	Prionotus ruscarius	1
48	Pronotogrammus eos	2
49	Raja velezi	1
50	Rhipticus negropinnis	1
51	Rhynchoconger nitens	1
52	Rypticus nigripinnis	1
57	Symphurus atramentatus	
58	Symphurus callopterus	
59	Symphurus gorgonae	
60	Symphurus leei	
61	Symphurus melastomateca	
62	Symphurus oligomerus	
63	Synchiropus atrilabiatus	
64	Synodus evermanni	
65	Synodus scituliceps	
66	Synodus sechurae	
67	Umbrina bussingii	
68	Zapteryx exasperata	

No.	species	frequency
1	Achirus lucinerae	1
2	Achirus mazaflatus	2
3	Achirus scutum	2
4	Albula nemoptera	1
5	Anchoa lucida	1
6	Anchoa nasus	1
7	Anchoa walkeri	1
8	Ancylopsetta dendritica	1
9	Anisostremus dovii	3
10	Antennarius avalones	2
11	Antennarius sp.	1
12	Argentina alicea	1
13	Arius dovii	1
14	Arius kessleri	2
15	Arius osculus	1
16	Arius platypogon	2
17	Arius sp. a	1
18	Arius sp. b	1
19	Arius troschelli	1
20	Auxis sp.	1
21	Batrachoides sp.	1
22	Bellator gymnostethus	4
23	Bellator loxias	3
24	Bellator xenisma	5
25	Bollmannia (new species)	1
26	Bollmannia chlamydes	7
27	Bollmannia stygmatura	3
28	Calamus brachisomis	1
29	Caranx caballus	1
30	Caranx caninus	1
31	Caranx otrynter	1
32	Caranx speciosus	1
33	Caranx vinctus	1
34	Catherops tuyra	1
35	Caulolatius affinis	1
36	Cetengraulis mysticetus	1
37	Chrophthalmus mento	1
38	Citharichthys platophrys	7
39	Coryphaenoides leucophaeus	1
40	Cyclopsetta panamensis	1
41	Cyclopsetta querna	3
42	Cyclopsetta sp.	1
43	Cyclopsetta sp. (juv.)	1
44	Cynoscion albus	1
45	Cynoscion phoxocephalus	5
46	Cynoscion sp.	1
47	Dasyatis longus	2
48	Decodon melasma	1
49	Diaperus aureolus	1
50	Diapterus peruvianus	1
51	Diplectrum maximum	1
52	Diplectrum pacificum	1
53	Diplectrum rostrum	1
54	Diplobates ommata	2
55	Engyophris sanctilaurentii	2
56	Epinephelus nigritus	1
57	Epinephelus niphobles	1
58	Etropus crossotus	1
59	Etropus sp.	1
60	Etropus sp.	1
61	Eucinostomus argenteus	1
62	Eucinostomus gracilis	2
63	Gerres cinereus	1
64	Gymnothorax equatorialis	3
65	Gymnothorax sp.	1
66	Haemulon scuderi	1
67	Haemulopsis elongatus	1
68	Haemulopsis leuciscus	1
69	Hemanthias peruanus	2
70	Hemanthias signifer	4
71	Himantura pacifica	1
72	Hippoglossina tetraophthalmus	2
73	Hoplopagrus guntheri	1
74	Isopisthus altipinnis	1
75	Kathetostoma averuncus	2
76	Lophiodes caulinaris	5
77	Lophiodes spirulus	1
78	Lutjanus argentriventis	1
79	Lutjanus guttatus	2
80	Lutjanus peru	1
81	Menthicirrus nasus	2
82	Microgobius erectus	2
83	Monolene maculipinna	1
84	Mulloides dentatus	1
85	Mustelus lunulatus	1
86	Myrichthys sp.	1
87	Narcine brasiliensis	1
88	Neobithes stelliferoides	2
89	Neopisthopterus tropicus	1
90	Ophichthys sp.	1
91	Ophictus (new species)	1
92	Ophioscon sciera	1
93	Ophioscon sp.	1
94	Ophistoma prorigerum	1
95	Opisthopterus dovii	1
96	Paralabrax loro	1
97	Paralichthys wodmani	2
98	Paralonchurus dumerilli	1
99	Peprilus snyderi	3
100	Perissias taeniopterus	1
101	Peristedion barbiger	5
102	Peristedion crustosum	1
103	Physiculus nematopus	4
104	Physiculus rastrelliger	1
105	Polydactylus approximans	2
106	Pomadasys sp.	1
107	Pontinus sierra	5
108	Pontinus sierra (amarilla)	2
109	Pontinus sierra (rojo)	3
110	Porichthys greeni	4

No.	species	frequency
111	Porichthys margaritatus	8
112	Prionotus albirostris	2
113	Prionotus horrens	5
114	Prionotus sp.	1
115	Prionotus teaguei	1
116	Pronotogrammus eos	1
117	Raja equatorialis	1
118	Raja velezi	3
119	Rhinobatus leucorhynchus	1
120	Rhynchoconger nitens	2
121	Rya equatorialis	1
122	Sciaenidae	1
123	Scorpaena histrio	1
124	Scorpaena russula	4
125	Seiadeaps troschelli	1
126	Selene brevortii	1
127	Selene oerstedii	1
128	Selene peruviana	2
129	Serranus aequidanus	2
130	Sphaeroides annulatus	2
131	Sphaeroides lobatus	4
132	Stellifer cestocarus	1
133	Stellifer chrysoleuca	1
134	Stellifer illecebrosus	3
135	Stellifer mancorensis	1
136	Stellifer oscitans	1
137	Stellifer sp.	1
138	Stellifer sp.	1
139	Stellifer sp.	1
140	Syacium latifrons	4
141	Syacium ovale	5
142	Syacium sp.	1
143	Syacium sp.	1
144	Symphurus atramentatus	2
145	Symphurus callopterus	8
146	Symphurus chabaunadi	4
147	Symphurus elongatus	3
148	Symphurus gorgonae	3
149	Symphurus leei	1
150	Symphurus melanurus	1
151	Symphurus oligomerus	5
152	Symphurus sp.	1
153	Symphurus sp.	1
154	Symphurus sp.	1
155	Synchiropus atrilabiatus	6
156	Synodus evermanni	8
157	Synodus scituliceps	6
158	Synodus sechurae	
159	Synodus sechurae	2
160	Torpedo clemens	1
161	Trichiurus nitens	2
162	Trinectes fonsecensis	1
163	Trinectes sp.	1
164	Umbrina bussingii	2
165	Urotrygon chilensis	2
166	Urotrygon nana	2
171	Urotrygon sp. ?	1
172	Urotrygon sp. b	1
173	Zalieutes elater	6
174	Zapteryx exasperata	2

No.	species	frequency
1	Antennarius avalones	1
2	Bellator gymnostethus	1
3	Bollmannia chlamydes	1
4	Bollmannia sp. (new species)	1
5	Bollmannia stigmatura	2
6	Chlorophthalmus mento	1
7	Cycloopsetta sp.	1
8	Cyclopsetta querna	1
9	Cyclopsetta sp.	1
10	Cyclopsetta sp.	1
11	Decodon melasma	1
12	Diplectrum euryplectrum	1
13	Diplectrum macropoma	1
14	Diplectrum sp.	1
15	Engraulidae	1
16	Engyophrys sanctilaurentii	1
17	Gymnothorax equatorialis	1
18	Gymnothorax sp.	1
19	Gymnothorax sp. (new species)	1
20	Hemanthias signifer	2
21	Lophiodes caulinaris	2
22	Lophiodes sp.	1
23	Monolene asaedai	1
24	Monolene maculipinna	2
25	Paralichthyidae	1
26	Physiculus nematopus	2
27	Physiculus rastrelliger	1
28	Pikae longilepis	1
29	Polylepion cruentum	1
30	Pontinus furcirhinus	1
31	Pontinus sierra	2
32	Porichthys margaritatus	3
33	Prionotus teauei (juv.)	1
34	Pronotogrammus eos	2
35	Rhynchoconger nitens	2
36	Scorpaena russula	1
37	Sphaeroides annulatus	1
38	Sphaeroides lobatus	1
39	Syacium latifrons	1
40	Syacium ovale	1
41	Syacium sp.	1
42	Symphurus callopterus	2
43	Symphurus gorgonae	2
44	Symphurus leei	1
45	Symphurus oligomerus	1
46	Synchiropus atrilabiatus	1
47	Synodus evermanni	2
48	Synodus scituliceps	1
49	Synodus sechurae	1
50	Zalieutes elater	2

No.	Species						
1	Achirus lucinerae	53	Cynoscion sp.	105	Narcine brasiliensis	157	Selene peruviana
2	Achirus mazaflatus	54	Dasyatis longus	106	Neobythes stelliferoides	158	Serranus aequidanus
3	Achirus scutum	55	Decodon melasma	107	Neopisthopterus tropicus	159	Stellifer cestocarus
4	Albula nemoptera	56	Diaperus aureolus	108	Ophichthys sp. a	160	Stellifer chrysoleuca
5	Anchoa lucida	57	Diapterus peruvianus	109	Ophichthys sp. b	161	Stellifer illecebrosus
6	Anchoa nasus	58	Diodum histrio	110	Ophictus (new species)	162	Stellifer mancorensis
7	Anchoa walkeri	59	Diplectrum eumelum	111	Ophioscon sciera	163	Stellifer oscitans
8	Ancylopsetta dendritica	60	Diplectrum euryplectrum	112	Ophioscon sp.	164	Stellifer sp. (1?)
9	Anisostremus dovii	61	Diplectrum labarum	113	Ophistoma prorigerum	165	Stellifer sp. (2?)
10	Antennarius avalonis	62	Diplectrum macropoma	114	Opisthopterus dovii	166	Stellifer sp. (3?)
11	Antennarius sp.	63	Diplectrum maximum	115	Paralabrax loro	167	Sphaeroides annulatus
12	Argentina alicea	64	Diplectrum pacificum	116	Paralichthyidae	168	Sphaeroides lobatus
13	Arius dovii	65	Diplectrum rostrum	117	Paralichthys wodmani	169	Syacium latifrons
14	Arius kessleri	66	Diplectrum sp.	118	Paralonchurus dumerilli	170	Syacium ovale
15	Arius osculus	67	Diplobates ommata	119	Peprilus snyderi	171	Syacium sp. (1?)
16	Arius platypogon	68	Engraulidae	120	Perissias taeniopterus	172	Syacium sp. (2?)
17	Arius sp. a	69	Engyophrys sanctilaurentii	121	Peristedion barbiger	173	Symphurus atramentatus
18	Arius sp. b	70	Eosinistomus argentinus	122	Peristedion crustosum	174	Symphurus callopterus
19	Arius troschelli	71	Epinephelus nigritus	123	Physiculus nematopus	175	Symphurus chabaunadi
20	Auxis sp.	72	Epinephelus niphobles	124	Physiculus rastrelliger	176	Symphurus elongatus
21	Batrachoides sp.	73	Etropus crossotus	125	Pikae longilepis	177	Symphurus gorgonae
22	Bellator chlamydes	74	Etropus sp.	126	Polydactylus approximans	178	Symphurus leei
23	Bellator batimaster	75	Eucinostomus argenteus	127	Polylepion cruentum	179	Symphurus melanurus
24	Bellator gymnostethus	76	Eucinostomus gracilis	128	Pomadasys branickii	180	Symphurus melastomateca
25	Bellator loxias	77	Gerres cinereus	129	Pomadasys sp.	181	Symphurus oligomerus
26	Bellator xenisma	78	Gymnothorax equatorialis	130	Pontinus furcirhinus	182	Symphurus sp. (1?)
27	Bollmannia (new species)	79	Gymnothorax sp.	131	Pontinus sierra	183	Symphurus sp. (2?)
28	Bollmannia chlamydes	80	Gymnothorax sp. (new species)	132	Pontinus sierra (amarilla)	184	Symphurus sp. (3?)
29	Bollmannia sp. (new species)	81	Haemulon scuderi	133	Pontinus sierra (rojo)	185	Synchiropus atrilabiatus
30	Bollmannia stigmatura	82	Haemulopsis elongatus	134	Porichthys greeni	186	Synodus evermanni
31	Bregmacerus batimaster	83	Haemulopsis leuciscus	135	Porichthys margaritatus	187	Synodus scituliceps
32	Calamus brachisomis	84	Hemanthias peruanus	136	Prionotus albirostris	188	Synodus sechurae
33	Caranx caballus	85	Hemanthias signifer	137	Prionotus birrostratus	189	Torpedo clemens
34	Caranx caninus	86	Himantura pacifica	138	Prionotus horrens	190	Trichiurus nitens
35	Caranx otrynter	87	Hippocampus ingens	139	Prionotus ruscarius	191	Trinectes fonsecensis
36	Caranx speciosus	88	Hippoglossina tetraophthalmus	140	Prionotus sp.	192	Trinectes sp.
37	Caranx vinctus	89	Hoplopagrus guntheri	141	Prionotus teaguei	193	Umbrina bussingii
38	Catherops tuyra	90	Isopisthus altipinnis	142	Prionotus teaguei (juv.)	194	Urotrygon chilensis
39	Caulolatius affinis	91	Kathetostoma averuncus	143	Pronotogrammus eos	195	Urotrygon nana
40	Cetengraulis mysticetus	92	Lophiodes caulinaris	144	Raja equatorialis	196	Urotrygon sp. (1?)
41	Chlorophthalmus mento	93	Lophiodes sp.	145	Raja velezi	197	Urotrygon sp. (2?)
42	Citharichthys platophrys	94	Lophiodes spirulus	146	Rhinobatus leucorhynchus	198	Zalieutes elater
43	Coryphaenoides leucophaeus	95	Lutjanus argentriventis	147	Rhipticus negropinnis	199	Zapteryx exasperata
44	Cyclopsetta panamensis	96	Lutjanus guttatus	148	Rhynchoconger nitens		
45	Cyclopsetta querna	97	Lutjanus peru	149	Rya equatorialis		
46	Cyclopsetta sp. (1?)	98	Menthicirrus nasus	150	Rypticus nigripinnis		
47	Cyclopsetta sp. (2?)	99	Microgobius erectus	151	Sciaenidae		
48	Cyclopsetta sp. (3?)	100	Monolene asaedai	152	Scorpaena histrio		
49	Cyclopsetta sp. (juv.)	101	Monolene maculipinna	153	Scorpaena russula		
50	Cynoscion albus	102	Mulloides dentatus	154	Seiadeaps troschelli		
51	Cynoscion nannus	103	Mustelus lunulatus	155	Selene brevortii		
52	Cynoscion phoxocephalus	104	Myrichthys sp.	156	Selene oerstedii		

Systematic classification of the copepods found during the Victor Hensen Expedition in the pacific coast of Costa Rica. December 1993-February 1994.

Orden Calanoidea Sars 1903 Family Calanidae *Canthocalanus pauper Giesbrecht 1888* *Undinula vulgaris Dana 1852* Family Paracalanidae *Acrocalanus gibber Giesbrecht 1888* *Paracalanus parvus Claus 1863* *P. crassirostrris Dahl 1894* Family Calocalanidae *Calocalanus sp. Giesbrecht 1888* Family Clausocalanidae *Clausocalanus sp. Giesbrecht 1888* Family Eucalanidae *Eucalanus monachus Griesbrecht 1888* *E. elongatus Dana 1849* *E. attenuatus Dana 1849* Family Euchaetidae *Euchaeta wolfendeni Scott A. 1909* *Euchaeta sp. Philippi 1843* Family Metridinidae *Pleuromamma gracilis Claus 1863* Family Centropagidae *Centropages furcatus Dana 1949* Family Pseudodiaptomidae G.O. Sars 19 *Pseudodiaptomus wrigthi Johnson 1964* *P. panamensis Walter 1989* Family Temoridae *Temora discaudata Giesbrecht 1889* Family Lucicutiidae *Lucicutia ovalis Wolfenden 1891* Family Candaciidae *Candacia catula Giesbrecht 1889* Family Augptilidae *Haloptilus sp. Giesbrecht & Schmeil 189* Family Pontellidae *Labidocera acuta Dana 1849* *L. lubbocki Griesbrecht 1889*	Family Acartiidae *Arcatia danae Giesbrecht 1889* *A. Lilljeborgii Griesbrecht 1889* *A. negligens Dana 1852* Orden Cyclopoidea Burmeister 1834 Family Oithonidae *Oithona spp. Baird 1843* Orden Harparticoida G.O. Sars 1903 Family Tachidiidae Sars 1909 *Euterpina acutifrons Dana 1852* Family Clytemnestridae S. Scott 1909 Clytemnestra rostrata Brady 1883 Family Miraciidae *Macrosetella gracilis Dana 1852* Orden Poecilostomatoida Thorell 1859 Family Oncaedae *Oncaea spp. Philipe 1843* *Oncaea conifera Giesbrech 1891* Family Corycaeidae *Corycaeus spp. Dana 1849* *Corycaeus flacus Griesbrecht 1891* *C. speciosus Dana 1849* *Copilia sp. Dana 1849* Familia Clauidiidae Emblenton 1901 *Hemicyclops thalasius Verv. & Ram. 1966* Familia Clauidiidae Emblenton 1901 *Hemicyclops thalasius Verv. & Ram. 1966* Family Sapphirinidae *Sapphirina sp. J.V. Thompson 1829*

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Koch, Volker, Cand.nat.	ZMT
Lopez, Myrna L., Lic.	CIMAR-UCR
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