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Polychaete worms (Annelida) collected in Golfo Dulce, during the Victor Hensen Costa Rica expedition (1993/1994)

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Abstract: A total of forty seven species of benthic polychaetes belonging to twenty five families have been identified from bottom samples taken in Golfo Dulce, Costa Rica, by the RV Victor Hensen. Only those stations collected in waters less than 100 m depth contained polychaetes. The major feeding type of these polychaete species was surface deposit feeding with slightly fewer species recognized as carnivores. Comparison of the species identified from the RV Victor Hensen material with those of the RV. T.G. Thompson material collected in 1969 reveals very few that are common to the two studies, indicating that the polychaetes of Golfo Dulce are probably quite diverse and poorly known. An estimated total of eighty five species of polychaetes have been identified from Golfo Dulce in the two studies.

Key words: Polychaeta, Golfo Dulce, Costa Rica, Pacific Ocean, feeding type, anoxic basin.

Golfo Dulce is an embayment approximately 50 km long and 10-15 km wide centered at 8° 30' N and 83° 16' W. on the southern Pacific coast of Costa Rica. It is a very unusual tropical bay as it is quite deep at its center (more than 200 meters; however, its opening to the ocean is protected by a shallow sill of about 60 meters). Richards *et al.* (1971) reported that as a result of this topography Golfo Dulce most likely receives ocean water only intermittently during the dry season, controlled primarily by the local wind regime. As a result of the reduced exchange of water with the sea, Golfo Dulce most resembles a fjord with anoxic conditions in its deeper sediments.

Despite being one of the few known tropical embayments containing appreciable anoxic waters (Richards *et al.* 1971) there have been few studies of the communities of marine organisms inhabiting this intriguing marine ecosystem. Nichols-Driscoll (1976) was the first to characterize the benthic fauna of this area from material collected in a Van Veen grab survey of Golfo Dulce by the RV T.G. Thompson. More recently the coral reef community of Golfo Dulce has been studied by Cortés (1990, 1991, 1992) and has been found to be quite degraded by siltation due to soil erosion of the surrounding land areas. More recently, greater knowledge of the Golfo Dulce ecosystem has become a necessity for the establishment of policies regarding the proper maintenance and utilization of this marine embayment and its surrounding areas. Thus, a detailed study of the plankton,benthos, microbiology, water chemistry and geology of Golfo Dulce was conducted during the RV. Victor Hensen expedition to Pacific Costa Rica (December 1993 to February 1994).

The purpose of this paper is to report on the polychaete species types identified from the box corer samples taking by the RV. Victor Hensen, and to compare and contrast these species with those identified in the RV. T.G. Thompson material by Nichols-Driscoll (1976).

MATERIAL AND METHODS

The 1993-1994 RV. Victor Hensen expedition was part of an integrated study of this marine ecosystem conducted jointly by the Centro de Investigación en Ciencias del Mar y Limnología (CIMAR), Universidad de Costa Rica and the Zentrum für Marine Tropenokologie (ZMT) of Bremen, Germany. As part of this study a series of box corer samples were taken at sites within the gulf selected to replicate as well as possible the station sites collected by the RV. T.G. Thompson (Table 1). Samples were collected with a box corer, preserved in sea water formalin stained with Rose Bengal, and sieved thru a 500 micrometer mesh screen. More details on collection methods, sample preparation and methods of analyses may be found in Cordoba & Vargas (1994). Voucher specimens are deposited at the Museo de Zoología, Universidad de Costa Rica, Worm Catalogue numbers 86 thru 133.

RESULTS

The forty seven polychaete species of Golfo Dulce identified from the Victor Hensen material (VH) may be found in Table 2 and the polychaetes identified in the T.G. Thompson cruise material (Th) by Nichols-Driscoll (1976) may be found in Table 3. Some of the species names and familial designations by Nichols-Driscoll have been modified to reflect subsequent taxonomic revisions. Table 4 lists the general

TABLE 1

Station locations for the benthic box corer samples taken by the RV Victor Hensen in Golfo Dulce, 1993-1994

Station	Latitude	Longitude	Sample date	Depth
GD-01	08 42 N	83 24 W	Dec 08, 1993	200 m
GD-03	08 35	83 16	Dec 08, 1993	200 m
GD-07	08 39	83 24	Dec 08, 1993	100 m
GD-08	08 43	83 29	Dec 08, 1993	50 m
GD-09	08 39	83 26	Dec 08, 1993	43 m
GD-11	08 27	83 13	Dec 07, 1993	75 m
GD-12	08 21	83 14	Dec 09, 1993	200 m
GD-24	08 20	83 14	Jan 24, 1994	200 m
GD-26	08 23	83 14	Jan 24, 1994	100 m

TABLE 2

List of polychaete species recovered from box corer samples collected by the RV Victor Hensen in Golfo Dulce, 1993-1994

Family	Species
AMPHARETIDAE	*Amphicteis scaphobranchiata* Moore
AMPHINOMIDAE	*Linopherus kristiani* Salazar-Vallejo
CAPITELLIDAE	*Mediomastus californiensis?* Hartman *Mediomastus ambiseta?* Hartman *Parheteromastides* sp.
CIRRATULIDAE	*Chaetozone corona* Berkeley & Berkeley *Aphelochaeta longisetosa* Hartmann-Schroeder
COSSURIDAE	*Cossura brunnea* Fauchald
DORVILLEIDAE	*Pettiboneia duofurca* Wolf *Pettiboneia* sp.
EUNICIDAE	*Eunice vittatopsis* Fauchald *Marphysa conferta* Moore
FLABELLIGERIDAE	*Pherusa capulata* (Moore) *Pherusa* sp.
GLYCERIDAE	*Glycera capitata* Oersted
GONIADIDAE	*Glycinde pacifica* Monro
HESIONIDAE	*Podarkeopsis brevipalpa*
LUMBRINERIDAE	*Ninoe chilensis* Kinberg *Ninoe foliosa* Fauchald *Scoletoma platylobata* (Fauchald)
MAGELONIDAE	*Magelona pacifica* Moore *Magelona* sp B.
NEPHTYIDAE	*Aglaophamus dicirris* Hartman
NEREIDIDAE	*Ceratocephale crosslandi* (Monro)
ONUPHIDAE	*Diopatra farallonensis* Fauchald *Diopatra ornata* Moore
OPHELIIDAE	*Armandia brevis* (Moore)
PARAONIDAE	*Aricidea (Acesta) catherinae* Laubier. *Aricidea (Allia)* sp. *Levinsenia gracilis* (Tauber)
PHYLLODOCIDAE	*Gyptis brunnea* (Hartman) *Paranaitis* sp. *Phyllodoce madeirensis* Langerhans
PILARGIIDAE	*Ancistargis hamata* (Hartman) *Sigambra tentaculata* (Treadwell)
SIGALIONIDAE	*Sthenelanella uniformis* Moore
SPIONIDAE	*Laonice* sp. *Prionospio ehlersi* Fauvel *Prionspio (Minuspio) lighti* Maciolek *Prionospio (Aquilaspio)* sp. *Prionospio (Minuspio)* sp. *Paraprionospio pinnata* (Ehlers) *Spiophanes kroyeri* Grube
SYLLIDAE	*Langerhansia cornuta* (Rathke)
TEREBELLIDAE	*Eupolymnia nebulosa* (Montagu) *Scionides* sp.
TRICHOBRANCHIDAE	*Terebellides californica* Williams

TABLE 3

Revised polychaete species list from Nichols-Driscoll's (1976) report on benthic invertebrates collected in Golfo Dulce by the RV T.G. Thompson

Family	Species
ACROCIRRIDAE	*Acrocirrus* sp.
ARABELLIDAE	*Arabella* sp. *Notocirrus californiensis*
CAPITELLIDAE	*Mediomastus* sp.
CIRRATULIDAE	*Chaetozone* sp. *Cirratulus cirratus* *Cirratulus* sp. A *Cirratulus* sp. B *Cirriformia spirabrancha* *Tharyx epitoca* *Tharyx marconi* *Tharyx monilaris* *Tharyx multifilis*
COSSURIDAE	Cossuridae sp.
DORVILLEIDAE	Dorvilleidae sp.
EULEPETHIDAE	*Pareulepis* sp.
EUNICIDAE	*Eunice schemacephala*
FLABELLIGERIIDAE	*Pherusa* sp.
GONIADIDAE	*Glycinde armigera*
LUMBRINERIDAE	*Augeneria* sp. *Lumbrineris acuta* *Lumbrineris inflata* *Lumbrineris latreilli* *Lumbrineris moorei* *Lumbrineris zonata* *Ninoe fusca* *Ninoe* sp. A *Ninoe* sp. B
NEPTHYIDAE	*Nephtys* sp.
NEREIDIDAE	*Ceratonereis* sp. *Nereis* sp.
ONUPHIDAE	*Onuphis* sp.
PARAONIDAE	*Paraonis lyra* *Paraonis* sp. A *Paraonis* sp. B
PHYLLODOCIDAE	*Eteone* sp.
PILARGIIDAE	*Sigambra tentaculata*
QUESTIDAE	Questidae sp.
SABELLARIIDAE	*Sabellida* (?) sp.
SERPULIDAE	c.f. *Vermiliopsis multiannulata*
SPIONIDAE	*Pygospio* sp. *Spionidae* sp. *Spionidae* sp. *Nerinides maculata*
SYLLIDAE	*Exogone* sp.
TEREBELLIDAE	*Polycerine* sp.

methods of feeding, for the families encountered in this study based upon the polychaete feeding guilds of Fauchald and Jumars (1979).

DISCUSSION

Of the nine benthic stations sampled in Golfo Dulce by the RV. Victor Hensen cruise (Table 1), polychaetes occurred in only three (VH-8, VH-9 and VH-11) (Vargas, pers. comm.). Samples at the remaining six stations, which were all located in waters deeper than 100 m depth, yielded fine, soupy muds with a consistency of "black yogurt" and were essentially devoid of macroinvertebrates (Vargas, pers. comm.). Nichols-Driscoll (1976) noted similar results in the thirteen stations sampled in Golfo Dulce by the T.G. Thompson cruise as polychaetes (and most other invertebrate groups) were absent from nine stations located deeper than 100 m. Pearson and Rosenberg (1978) and Rosenberg (1980) have reviewed data on organic enrichment and oxygen concentrations in the marine environment and have reported several similar defaunated deep water zones in temperate fjords believed to be primarily the result of low oxygen concentrations. The high proportion of fine sediments ("black yogurt") reported for the deeper stations in Golfo Dulce reflects the low current velocities which act to restrict oxygen renewal in stagnant bodies of water. The shallower waters of Golfo Dulce (approximately the upper 100m) have been shown to have somewhat higher oxygen concentrations (Richards *et al.* 1971, Thamdrup *et al.* 1996), high enough, apparently, to permit the establishment of an appreciably diverse benthic community.

A review of the feeding strategies of the species identified in Table 2 (based upon the designations in Table 4) reveals that the subtidal polychaetes in Golfo Dulce are predominantly surface deposit feeders or carnivores. Thirteen families identified as being mainly carnivores, nine families recognized as being surface deposit feeders, and three families recognized as subsurface deposit feeders were encountered in the Golfo Dulce material. Although there were more families of polychaetes associated with carnivorous feeding, twenty two of the forty seven species encountered were surface deposit feeders while twen-

TABLE 4

Recognized general feeding types for the polychaete families recovered from box corer samples collected by the RV Victor Hensen in Golfo Dulce, 1993-1994

Family	General Feeding Type
AMPHARETIDAE	Surface Deposit Feeder
AMPHINOMIDAE	Carnivore
CAPITELLIDAE	Subsurface Deposit Feeder
CIRRATULIDAE	Surface Deposit Feeder
COSSURIDAE	Subsurface Deposit Feeder
DORVILLEIDAE	Surface Deposit Feeder
EUNICIDAE	Carnivore
FLABELLIGERIDAE	Surface Deposit Feeder
GLYCERIDAE	Carnivore
GONIADIDAE	Carnivore
HESIONIDAE	Carnivore
LUMBRINERIDAE	Carnivore
MAGELONIDAE	Surface Deposit Feeder
NEPHTYIDAE	Carnivore
NEREIDIDAE	Carnivore
ONUPHIDAE	Carnivore
OPHELIIDAE	Subsurface Deposit Feeder
PARAONIDAE	Surface Deposit Feeder
PHYLLODOCIDAE	Carnivore
PILARGIDAE	Carnivore
SIGALIONIDAE	Carnivore
SPIONIDAE	Surface Deposit Feeder
SYLLIDAE	Carnivore
TEREBELLIDAE	Surface Deposit Feeder
TRICHOBRANCHIDAE	Surface Deposit Feeder

ty of these species were carnivorous. The elevated species diversity of the surface deposit feeders, many of which feed upon the abundant bacteria and organic debris of an organic sink such as Golfo Dulce, is not unexpected.

Comparisons of the polychaete species identified in the Victor Hensen material with those of the T G Thompson material must be made very cautiously. While three of the four stations in which Nichols-Driscoll reported the occurrence of polychaetes (Th-7, Th-11, Th-12) were also sampled by the Victor Hensen cruise, the fourth station (Th-95) was very close to, but not entirely analogous to station Th-9 of the Victor Hensen cruise (Cordoba & Vargas, 1994). Additionally, stations VH-24 and VH-26 of the Victor Hensen cruise were near, but slightly more landward, of Nichols-Driscoll's stations Th-11 and Th-12 respectively. The sampling gear used in the two studies also differed and this difference may have also introduced another source of sample difference. While a Van Veen grab was used in the T. G. Thompson sampling, a box corer was used in the Victor Hensen cruise (Córdoba & Vargas, 1994). In summary, some of the station locations sampled by the Victor Hensen cruise differ slightly from those of the T.G. Thompson cruise therefore some of the differences seen in the two species lists may be a reflection of local environmental differences at dissimilar station sites.

Despite these slight differences in sample site locations, a comparison of the two species lists is revealing. For example, both the number of families (23 in Table 1 and 25 in Table 2) and the number of species (46 in Table 1 and 47 in Table 2) are of comparable magnitude. Despite these superficial similarities, however, there are only seventeen polychaete families common to both lists. Overall, there has been a total of thirty-one families of polychaetes identified from the subtidal of Golfo Dulce despite the rather inadequate sampling effort.

Although any definitive comparison of the two polychaete species lists is tenuous without the direct analysis of Nichols- Driscoll's polychaete specimens, there seems is little congruence between the species collected in these two studies. Being very liberal about possible species similarities between the two lists (ex. assume that the Spionid sp. of Nichols-Driscoll was one of the spionid species identified from the Victor Hensen material), there are only eight polychaete species common to both lists. Based on the reasonable assumption that the species identifications of the polychaetes collected by the T.G. Thompson are correct at least to the genus level, approximately eighty-five species of polychaetes have been identified from Golfo Dulce in the two studies.

The estimated eighty five benthic polychaete species identified from the shallower waters of Golfo Dulce is higher than expected for an anoxic environment. Nichols (1976) has reported a similar unexpectedly high diversity of benthic invertebrates in Fosa de Cariaco, an anoxic basin off the coast of Venezuela. She attributed this high species diversity despite harsh anoxic conditions to the overall environmental stability of the ecosystem. A similar situation may occur in Golfo Dulce. In the shallower waters, where conditions are not as harsh as in deeper waters, a suite of polychaete species are capable of taking advantage of the large input of organic materials despite relatively low oxygen availability.

A more thorough discussion of invertebrate benthic diversity will be provided by Leon and Vargas (in prep.) but it is apparent that a diverse group of polychaete species inhabits the shallower sediments of Golfo Dulce. The lack of agreement between the list of polychaetes collected by the Victor Hensen cruise with that of the T. G. Thompson cruise indicates that there is still much more work to be done in order to characterize the benthic fauna of Golfo Dulce.

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RESUMEN

Se identificó cuarenta y siete especies de poliquetos bentónicos (veinticinco familias) del fondo del Golfo Dulce, Costa Rica, recolectadas por el barco Victor Hensen. Solo se halló poliquetos a menos de 100 m de profundidad. La mayoría eran alimentadores de depósito superficial; hubo unas pocas especies carnívoras.

Comparando las especies halladas en esta expedición con las recolectadas por el barco T. G. Thompson en 1969 hay pocas comunes a ambos estudios, indicando que los poliquetos del Golfo Dulce son probablemente bastante diversos y pobremente conocidos. En total se estima que hay 85 especies de poliquetos identificadas del Golfo Dulce.

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