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Department of Geology and Mineral Industries
910 State Office Building
1400 SW Fifth Avenue
Portland, OR 97201

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SOFT-SEDIMENT HYDROTHERMAL VENT COMMUNITIES OF ESCANABA TROUGH: COMPARISON WITH OTHER VENT AND NON-VENT COMMUNITIES FROM SIMILAR DEPTHS IN THE DEEP SEA AND THE INFLUENCE OF CHEMOSYNTHETIC PRODUCTION ON THE SURROUNDING DEEP-SEA BENTHIC COMMUNITY

by

J. Frederick Grassle
and
Cindy Lee Van Dover
Woods Hole Oceanographic Institution
Woods Hole, MA

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NOTICE

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CONTENTS

ILLUSTRATIONS

Figures

Tables

INTRODUCTION

All three major objectives of our proposed research using ALVIN on the Gorda Ridge Escanaba Trough were accomplished. The cruise was sponsored by the National Science Foundation for studies of chemistry of hot springs and John Edmond of MIT was Chief Scientist. Sulfide mounds had been observed by U. S. Geological Survey scientists but it was unknown if any would prove to be active. The first hydrothermal vents to be discovered on the Gorda Ridge were seen at 3200-3300 m depth on the fourth of our ten ALVIN dives, June 3-12, 1988. Sediment-hosted massive sulfide mounds were observed on every dive and both active and inactive mounds were sampled for fauna. On the final dive of the series (ALVIN 2042) an area of hydrothermal flux through sediments was discovered with large clams protruding from the sediments. General characteristics of the hydrothermal vent fauna are described in Van Dover et al. (in press) attached as Appendix A. Results of research related to our three objectives are discussed separately.

OBJECTIVE I--SOFT-SEDIMENT FAUNA.

We proposed quantitative comparison of soft-sediment animal communities of the Escanaba Trough with hydrothermal vent communities (Guaymas Basin, 13° N, 21° N, Galapagos Mounds), Florida Escarpment seeps and background communities from similar deep-sea depths. We obtained and processed 12 sediment samples including representatives of near-field, peripheral and non-vent habitats as proposed. In addition, we sampled sediment next to a piece of wood for comparison of fauna with that at the vents.

Materials and Methods

Stainless-steel 225-cm^2 box cores designed for use by ALVIN were taken on all but the first dive which was shortened because of late arrival at the site. Each of the cores was equipped with the wrist-rotate instead of the spring-loaded tops. Five samples of the non-vent community were taken on dives 2035, 2038 and 2042. Four samples were taken in sediments containing sulfides at the base of hydrothermally active mounds. One core was taken immediately adjacent to a piece of wood containing a rich fauna and one was taken 3 m away. The soft-sediment hydrothermal area was discovered on the last dive after the box cores had been taken. The pilot, Ralph Hollis, was able to obtain a large qualitative sample by using a tube core to scoop sediments into a collection box on ALVIN's basket.

All samples were sieved through 300-micron and 63-micron screens and all samples were fixed in 10% formalin and subsequently transferred to 80% ethanol. This report includes only the macrofauna retained by the 300-micron screen.

Results

Non-vent and near-field fauna.

Samples taken at the base of the mounds did not differ from those taken tens of meters away. The four samples in sediments containing sulfides at the base of mounds had similar densities of animals and very similar species composition. Only 15 of 131 individuals in these samples belonged to species that did not occur in other non-vent samples. The sample taken adjacent to a piece of wood had a very unusual fauna but the sample 3 m away from the wood was also like the non-vent fauna with only 4 of 37 individuals belonging to species not found in the non-vent samples. Because of this similarity, these five samples were combined with the five non-vent samples to characterize the ambient soft-sediment fauna.

The mean density of individuals per box core was 45.4 +/- 6.5 (S.E.) per 225 cm^2 or 2018 individuals per m^2. The mean density of species was 22.5 +/- 2.2 (S.E.) per 225 cm^2 core. The relative abundance of species was very even, with the most common species contributing 7% of the fauna. Ten species had an average abundance of one or more individuals per core and these are shown in Table 1.

Table 1. The ten most common species in ten 225 cm^2 box-core samples from the non-vent Escanaba Trough soft-sediment communities.

Species	Number /225 cm^2	Number /m^2	% contribution
Chaetozone setosa (polychaete)	3.2	142	7%
Aurospio dibranchiata (polychaete)	2.6	116	6%
Paraonis sp. (polychaete)	1.7	76	4%
Microstylis sp. (isopod)	1.3	58	3%
Cossura sp. (polychaete)	1.2	53	3%
Prionospio sp. A (polychaete)	1.1	49	2%
Prionospio sp. B (polychaete)	1.0	44	2%
Chelator sp. (isopod)	1.0	44	2%
Pseudoscalibregma sp. (polychaete)	1.0	44	2%
Maldanidae sp. (polychaete)	1.0	44	2%
TOTAL FAUNA	45.4	2018/m^2	

The ten cores from the non-vent soft sediments contained 87 species; the final number of species recovered will be higher once specialists in each of the major faunal groups have completed their taxonomic studies.

Hydrothermal-vent, soft-sediment fauna

We have only a qualitative sample of the soft-sediment hydrothermal site observed on the final dive of the series. Large clams (about 10-12 cm long) were seen protruding from the sediment and most had an anemone attached. The clam has been identified as Calyptogena phaseoliformis by Ruth Turner at Harvard. The previous known distribution of this animal is from abyssal depths off Japan.

In the sediments adjacent to the clam we obtained 102 macrofaunal individuals in 13 species. The number of individuals is higher and the number of species lower in this qualitative sample relative to the non-vent quantitative samples which had an average of 45 individuals and 24 species per core. Three species contribute 76% of the individuals collected in the clam field. These have been examined by James Blake of Science Applications, Inc. (Woods Hole) and are new species. One of the two most common species, *Amphisamytha* n. sp., is similar to *Amphisamytha galapagensis* common in other hydrothermal vent and seep environments. The nine most abundant species are shown in Table 2.

Table 2. Abundance of nine most common species from the Escanaba Trough soft-sediment hydrothermal qualitative sample.

Species	Number /sample	% contribution
Amphisamytha n. sp. (polychaete)	35	34.3
Leitoscoloplos n. sp. (polychaete)	35	34.3
Prionospio n. sp. (polychaete)	8	7.8
Calyptogena phaseoliformis (bivalve)	6	5.9
Archaegastropoda sp. A (gastropod)	5	4.9
Archaegastropoda sp. B (gastropod)	3	2.9
Thyasiridae sp. (bivalve)	2	2.0
Harpinia sp. (amphipod)	2	2.0
anemone	2	2.0
TOTAL	102 Individuals	

Adjacent-to-wood, soft-sediment fauna

The sample 3 m from the wood was indistinguishable from the ambient non-vent fauna. Beside the wood, the sediments supported a community of 380 macrofaunal individuals per 225 cm^2 (16,889 per m^2) This density of individuals is nearly an order of magnitude (8.4X) greater than that of the normal fauna. The density of species is similar to that in the ambient sediments, with 28 species in the core. Tanaids are very abundant in this sample but we have not yet identified them to species. Table 3 shows the seven most common species.

Some of the species in the sediments occurred on the wood as well. One species of polychaete indistinguishable from those described from hydrothermal vent areas of the East Pacific Rise and Galapagos Spreading Center was found on the wood: *Nereis sandersi*.

Table 3. The seven most common species in a single 225-cm^2 box-core sample taken adjacent to a piece of wood.

Species	Number /225 cm^2	Number /m^2	% contribution
Hesionidae sp. (polychaete)	49	2178	12.9
Dorvilleidae sp. (polychaete)	44	1956	11.6
Cauleriella sp. (polychaete)	41	1822	10.8
Ampharetidae sp. (polychaete)	41	1822	10.8
Opheliidae sp. (polychaete)	34	1511	9.0
Fauveliopsis sp. (polychaete)	29	1289	7.6
Paraonis sp. (polychaete)	16	711	4.2
TOTAL	380	16889	

DISCUSSION

The hydrothermal vent community in soft sediments is similar to that found in association with *Vesicomya gigas* (formerly called *Calyptogena pacifica*) in Guaymas Basin, Gulf of California (Grassle et al. 1985). These are low-temperature vents; high-temperature soft-sediment vents like those found in Guaymas Basin have not been observed in the Escanaba Trough. The Gorda soft-sediment vent fauna consists of large *Calyptogena phaseoliformis* and at least three very abundant new polychaete species not found at any other vent site. *C. phaseoliformis* was previously known only from abyssal areas associated with seeps near Japan. One of the abundant polychaetes, *Amphisamytha* n. sp. is very similar to *Amphisamytha galapagensis* from Guaymas Basin and many other vent and seep areas including the Juan de Fuca Ridge which is the next ridge north of Gorda Ridge. None of the species occurring in association with the vents were found in the ten samples from the ambient deep-sea community. The fauna in sediments associated with wood is completely different from the vent fauna and shares very few species with the ambient fauna.

Although we do not have precisely comparable samples, the density of life next to the wood appears to be much greater than in the vents. *Nereis sandersi*, or at least a close relative, was found on the wood. This is an important find since it is the first example of a vent species found in association with wood. If other vent species are found on pieces of wood, this may help to explain their zoogeographic distribution.

The ambient community is similar to other deep-sea communities in having the most common species comprise about 7% of the fauna (Grassle and Morse-Porteous 1987). One of the abundant species, *Aurospio dibranchiata*, is among the most common species in soft-sediment communities of the Atlantic and Pacific Oceans (Grassle and Morse-Porteous 1987). As in all vent areas studied thus far, the diversity of species declines in the vents, with a few common species dominating the fauna.

OBJECTIVES II and III --
STABLE ISOTOPIC COMPOSITIONS OF VENT FAUNA, FOOD WEB RELATIONSHIPS, AND CONTRIBUTION OF CHEMOSYNTHETIC CARBON TO THE SURROUNDING SEAFLOOR COMMUNITY.

We employed a dual tracer approach using $\delta^{13}C$ measurements to identify important sources of carbon at vent sites and $\delta^{15}N$ measurements to determine the number of trophic levels present. Our interpretations depend on the assumption that the $\delta^{13}C$ value of a consumer corresponds to the $\delta^{13}C$ composition of its diet (DeNiro and Epstein 1978) or is heavier by about 1 $^{o}/oo$ (Fry and Sherr 1984). This relative fidelity of the carbon isotope signal makes it a good source indicator. The nitrogen isotopic measurements are more valuable as trophic level indicators. $\delta^{15}N$ values of consumers are systematically heavier (by 2-4 $^{o}/oo$) than the $\delta^{15}N$ value of their diet. Heaviest $\delta^{15}N$ values are found for top carnivores in marine systems (Rau 1982); lowest values are found in herbivores and detritivores feeding on phytoplankton and bacteria (Wada 1987; Fry 1988). We combined use of $\delta^{13}C$ and $\delta^{15}N$ values with a knowledge of consumer feeding modes and anatomy to estimate food web structure at Gorda Ridge vent sites. For reference, we also measured $\delta^{13}C$ and $\delta^{15}N$ values of deep-sea consumers collected away from vent sites but within the NESCA region.

Materials and Methods

During field explorations of the NESCA hydrothermal field, we identified and sampled the fauna of 5 distinct habitats:

1) active sulfide vents (3 sites)
2) active soft-sediment vent (1 site)
3) 'inactive' sulfide mounds
4) basalt
5) non-vent soft sediment

Faunal communities associated with each habitat are described in Appendix A and in more detail under Objective I above.

Specimens of dominant megafaunal and macrofaunal invertebrate populations within the vent communities were collected and analyzed to assess the range and variability of isotopic compositions of the constituents. At active sulfide vents, we also sampled and analyzed bacterial mats collected from clumps of tubeworms.

Invertebrates collected in areas away from hydrothermal sites were used to establish the isotopic composition of fauna dependent exclusively on photosynthetically-derived carbon through oceanic detrital food webs and to determine the contribution of chemosynthetic carbon to the surrounding seafloor community based on isotopic composition.

All specimens were stored frozen until prepared for isotopic analysis. Frozen tissues were thawed and acidified with 0.1 N HCl to remove contaminating carbonates, dried, and analyzed for carbon and nitrogen stable isotopic compositions following the methods of Minagawa et al. (1984). CO_2 and N_2 gases were analyzed separately with a Finnigan MAT 251 isotope-ratio mass spectrometer for isotopic determinations, expressed as $^{o}/oo$ differences from a standard, where:

$$\delta X = [(R_{sample}/R_{standard}) - 1] \times 10^3\ (^{o}/oo), \text{ and}$$

$$X = {}^{13}C \text{ or } {}^{15}N$$

$$R = {}^{13}C/{}^{12}C \text{ or } {}^{15}N/{}^{14}N.$$

The standards used were PeeDee Belemnite (PDB) and air, respectively; based on replicate analyses, precision of measurements was +/- 0.1 $^{o}/oo$ or better.

Results and Discussion

Carbon and nitrogen isotopic data are presented in Tables 1 and 2 and in Figure 1.

Invertebrate species from non-vent basalt and soft-sediment environments (habitats 4 and 5 above) have tightly constrained $\delta^{13}C$ values (-20.1 to -25.2 $^{o}/oo$) that fall within the range of values observed elsewhere in the deep-sea (Van Dover and Fry submitted; Williams et al. 1987; Southward et al. 1981; Brooks et al. 1987). Heavy $\delta^{15}N$ values (> +14.7 $^{o}/oo$) and the narrow $^{o}/oo$ range of $\delta^{15}N$ values ($\Delta\delta^{15}N$) for the non-vent faunal assemblage (1.8 $^{o}/oo$) are consistent with a single, detritivorous trophic strategy for the sabellid polychaete, sponge, pennatulacean, anemone and echinoid. Our collections of non-vent fauna included specimens from within 25 m of known sites of hydrothermal activity. We could not resolve a contribution of chemosynthetic production to any of the non-vent fauna using isotopic compositions. This suggests that the horizontal advection of chemosynthetic production and its incorporation into the non-vent benthic community at NESCA cannot easily be measured by analysis of natural carbon and nitrogen isotopic abundances at this scale.

$\delta^{15}N$ values of all taxa collected from areas of hydrothermal activity were significantly lighter (by > 7.8 $^{o}/oo$) than $\delta^{15}N$ values of non-vent fauna. We interpret this as evidence for the availability of non-detrital food resources to consumers within vent communities.

Two symbiont taxa, the vestimentiferan tubeworms and the vesicomyid clams, were collected from areas of hydrothermal activity. As in other vent species of Vestimentifera, NESCA tubeworm $\delta^{13}C$ values were relatively

Table 1. $\delta^{13}C$ and $d^{15}N$ values of fauna collected at the NESCA site, Gorda Ridge.

	$\delta^{13}C$ (°/oo)	$\delta^{15}N$ (°/oo)
220°C Vent (Dive 2036)		
Vestimentiferan		
(trophosome)	-13.6	-1.5
(vestimentum)	-12.7	+1.2
Lepetodrilus sp.		
(5 entire)	-20.7	10.2
Coiled gastropods		
(25 pooled)	-28.4	-9.0
Paralvinellid		
(2 entire)	-19.9	-4.6
Polynoid polychaete (4 pooled)	-21.5	-2.8
Bacteria and mucous	-19.4	-9.6
110°C Vent (Dive 2040)		
Vestimentiferan		
(1 entire)	-16.6	-2.1
Anemone sp. 1		
(3 pooled)	-24.7	+6.9
Anemone sp. 2		
(1 entire)	-26.2	+3.4
Amphisamytha sp.		
(30 pooled)	-37.1	+0.4
Limpet (Cocculinid form)		
(5 pooled)	-43.7	-3.9
Bacteria and mucous	-41.6	+1.6
15°C Vent (Dive 2037)		
Vestimentiferan		
(1 trophosome)	-15.2	-2.6
(1 vestimentum)	-13.7	-3.9
Amphisamytha sp.		
(3 pooled)	-26.1	-5.5
Polynoid		
(1 entire)	-13.2	+0.2
Paralvinellid		
(1 entire)	-19.1	-4.2
Bacteria and mucous	-16.8	-7.5

Table 1 (continued). δ^{13}C and δ^{15}N values of fauna collected at the NESCA site, Gorda Ridge.

	δ^{13}C (°/oo)	δ^{15}N (°/oo)
Soft-sediment Vent (D2042)		
Calyptogena phaseoliformis		
(mantle)	-35.9	-10.1
Anemone sp. 3		
(2 pooled)	-31.1	+2.1
Orbiniid polychaete		
(6 pooled)	-39.8	-4.0
Sulfides		
Dive 2035		
Anemone sp. 4		
(entire)	-17.3	+16.8
Limpet		
(5 pooled)	-16.6	+6.6
Holothurian		
(gonad)	-23.0	+12.0
(muscle)	-18.0	+14.5
Asteroid		
(arm)	-17.5	+14.9
Tunicate		
(tunic)	-26.3	+10.1
Dive 2033		
Brisingid		
(female gonad)	-20.9	+17.5
Anemone sp. 5		
(entire)	-22.3	+16.3
Sponge		
(2 entire)	-24.9	+14.7
Dive 2039		
Tunicate		
(tunic)	-28.6	+13.1
Dive 2040		
Brisingid		
(female gonad)	-20.2	+17.6
Basalt (Dive 2039)		
Sabellid polychaete		
(1 entire)	-20.4	+15.7
Sponge		
(encrusting; piece)	-25.2	+16.5

Table 1 (continued). $\delta^{13}C$ and $\delta^{15}N$ values of fauna collected at the NESCA site, Gorda Ridge.

	$\delta^{13}C$ ($^{o}/oo$)	$\delta^{15}N$ ($^{o}/oo$)
Soft-sediment Non-Vent (D2038)		
Anemone		
(1/2)	-20.1	+15.5
Pennatulacean	-20.8	+16.3
Echinoid		
(gonad)	-21.6	+14.7

FIGURE LEGEND

Figure 1. δ^{13}C vs. δ^{15}N for fauna of the NESCA site, Gorda Ridge. Symbols correspond to data in Table 1 for taxa belonging to discrete microhabitats:

220°C Sulfide Vent -- open circles
110°C Sulfide Vent -- filled circles
15°C Sulfide Vent -- open triangle
Soft-sediment Vent -- filled squares
'Inactive' Sulfide -- filled triangle
Non-Vent basalt and soft sediment -- open square

For tubeworms where more than one tissue was analyzed, data plotted correspond to isotopic composition of vestimentum.

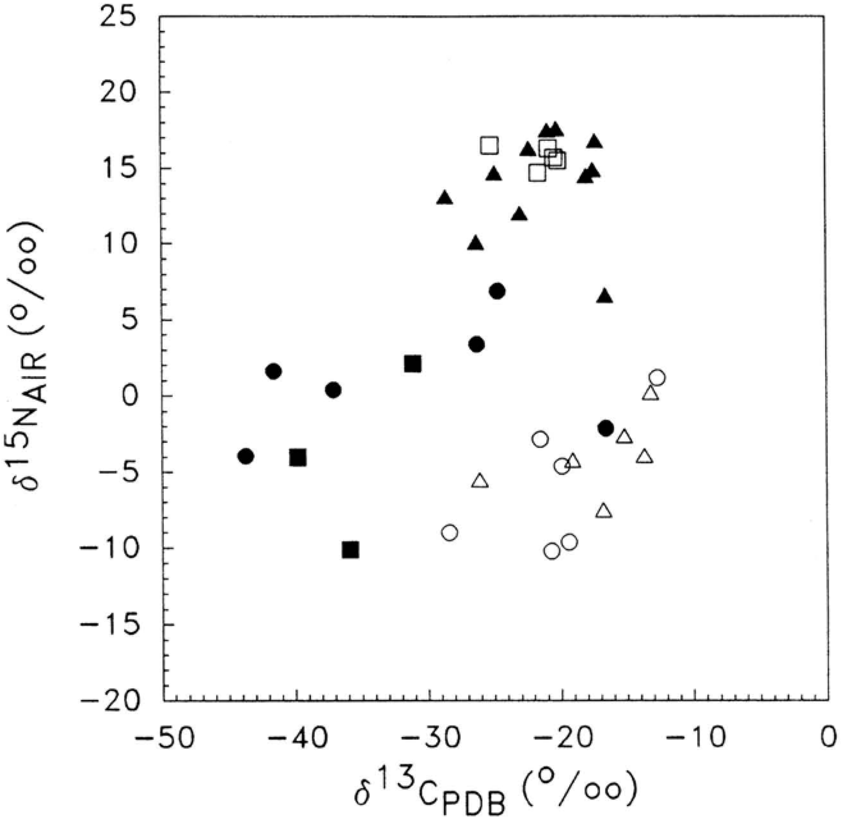
25
20
15
10
5
0
−5
−10
−15
−20
−50
−40
−30
−20
−10
0
$\delta^{15}N_{AIR}$ (°/oo)
$\delta^{13}C_{PDB}$ (°/oo)

Figure 1

heavy (-12.7 to -16.6 ^{o}/oo for various tissues and individuals). Within each of the three discrete microhabitats dominated by tubeworms, $\delta^{13}C$ values of tubeworm tissues were consistently among the heaviest values measured. The light carbon isotopic composition of the vesicomyid clam (-35.9 ^{o}/oo) matches that of its congeners from hydrothermal vent sites throughout the Pacific. The identical species of clam collected from cold water seeps in Sagami Bay off Japan had $\delta^{13}C$ values of -36.7 to -40.1 in various tissues (Boulegue et al. 1987; Saino and Ohta, in press). Carbon isotopic compositions of vent symbiont taxa are distinct from $\delta^{13}C$ compositions of deep-sea fauna dependent on surface-derived photosynthetic carbon and are indicative of chemosynthetic processes at vents.

Table 2. Summary of nitrogen isotopic data for NESCA communities.

Site	Range $\delta^{15}N$ (^{o}/oo)	$\Delta\delta^{15}N$
220^{o}C Sulfide Vent	-10.2 to +1.2	11.4
110^{o}C Sulfide Vent	-3.9 to +6.9	10.8
15^{o}C Sulfide Vent	-7.5 to +0.2	7.7
Soft-sediment Vent	-10.1 to +2.1	12.2
'Inactive Sulfide'	+6.6 to +17.6	11.0
Non-Vent (basalt and soft-sediment)	+14.7 to +16.5	1.8

Variability in $\delta^{15}N$ values among non-symbiont species at vent sites reflects trophic relationships, with primary producers (bacterial mat) typically having the lightest $\delta^{15}N$ value. Filter-feeding anemones and predacious polychaetes (e.g. polynoids) typically had the heaviest $\delta^{15}N$ values, consistent with their presumed secondary consumer status. Grazers (primary consumers) such as the polychaetes *Amphisamytha* sp. and *Paralvinella* sp. and the limpet and coiled gastropod typically had $\delta^{15}N$ values intermediate between producers and secondary consumers. $\Delta\delta^{15}N$ values (Table 2) for each vent site are consistent with 2.5 ($\Delta\delta^{15}N$ = 7.7 ^{o}/oo) to 3 ($\Delta\delta^{15}N$ = 12.2^{o}/oo) trophic levels within each community.

Fauna of two of the 3 vent sites dominated by tubeworms had carbon and nitrogen isotopic compositions that overlapped quite closely. The third site (110^{o}C) is characterized by a shift toward heavier $\delta^{15}N$ values and lighter $\delta^{13}C$ values. Bacterial mats at each site probably serve as the major source of organic carbon within each food web; the isotopic composition of bacterial mats collected at each site match the isotopic trends of the consumers and are consistent with this thesis.

Isotopic compositions of fauna colonizing 'inactive' sulfide mounds are intriguing. None of the symbiont fauna associated with and diagnostic of active hydrothermal venting occur at the mound sites. But in some locations, the mound fauna is luxuriant, dominated by large tunicates. Several taxa were collected from sulfide mounds and analyzed for carbon and nitrogen isotopic composition. Several of the filter-feeding species that comprise this fauna have $\delta^{13}C$ and $\delta^{15}N$ values that match those of non-vent deep-sea fauna (e.g. the brisingids, sponge and anemones). The holothurian and the asteroid extend the range of isotopic compositions for 'non-vent' fauna at NESCA. The grazing limpet and the filter-feeding tunicates are isotopically distinct from the expected composition of non-vent fauna. $\delta^{15}N$ values for the limpet (+6.6 $^{o}/oo$) and the tunicates (+10.1, +13.1 $^{o}/oo$) are light, arguing for their reliance on an organic food source that has undergone less recycling than surface-derived organic material. $\delta^{13}C$ values for the limpet (-16.6 $^{o}/oo$) and tunicates (-26.3, -28.6 $^{o}/oo$) are outside the range of values observed in NESCA fauna dependent on surface-derived photosynthetic carbon. Several hypotheses may account for these observations:

1) 'Inactive' sulfide mounds express some low level of hydrothermal flux, sufficient to support primary production by free-living chemosynthetic bacteria (on surfaces and in effluents) but insufficient to support symbiotic associations in larger invertebrates. This low-level flux is too dilute to be toxic to certain 'non-vent' fauna - hence we see luxuriant colonies of tunicates and relatively abundant limpets that feed on chemosynthetic bacteria where diffuse hydrothermal fluids escape from the porous sulfides.

2) Sulfide mounds are hydrothermally inactive but are colonized by chemosynthetic bacteria capable of mobilizing and oxidizing metallic sulfides. These bacteria in turn support 'non-vent' fauna including the tunicates and limpets.

3) The topographic relief provided by inactive sulfide mounds creates current regimes that carry and concentrate chemosynthetic carbon produced at active sites (or in plumes), making organic-rich water and deposits with isotopic compositions associated with chemosynthetic production available to non-vent fauna.

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Appendix A

Hydrothermal vent fauna of Escanaba Trough (Gorda Ridge)

Cindy Lee Van Dover[1]

J. Frederick Grassle[1]

and

Michel Boudrias[2]

[1] Woods Hole Oceanographic Institution
Woods Hole, MA 02543

[2] Scripps Institution of Oceanography
La Jolla, CA 92093

Biota of the NESCA site, Escanaba Trough

Hydrothermal vent communities on Gorda Ridge were discovered and documented during 1988 field programs using the deep-diving submersibles *Alvin* and *Sea Cliff*. Venting was associated with large sulfide mounds that comprise the NESCA site in the Escanaba Trough of Gorda Ridge (41°00'N; 127°29'W; 3200-3250 m). Details of the geological setting are presented elsewhere in this symposium volume.

Within the study area, we identified 5 principle habitats:

1) Active hydrothermal venting associated with massive sulfide deposits (temperatures ranged from a few degrees above ambient to a maximum of 220°C);
2) A low-temperature site associated with soft sediment deposits at the base of sulfide mounds;
3) 'Inactive' sulfide mounds;
4) Non-vent soft sediment;
5) Non-vent basalt lava.

The fauna of active hydrothermal vents associated with sulfide deposits was lush, dominated by slender vestimentiferan tubeworms in the family Ridgeiidae. Tubeworm tubes were heavily fouled by paralvinellid and ampharetid polychaetes. We noted local differences in the composition of macrofaunal species associated with different tubeworm clumps: At some sites, the distal ends of the tubeworm tubes were ornamented with one or two white-bodied anemones with pink-fringed tentacles. Some clumps of tubeworms were colonized by abundant lepetodrilid limpets and small, coiled gastropods; in other clumps, these mollusks were rare or absent. At the vent site designated

6X, three arthropod taxa were abundant within the tubeworm clumps: Pycnogonids of all size classes, including gravid females and juveniles were found attached to tubeworm tubes; red copepods were found in mucous and washings of tubeworm clumps; large tanaid crustaceans encased in thin mud tubes also fouled tubeworm tubes. The tanaids belong to the family Neotanaidae and represent, to our knowledge, the first recorded collection of a vent-associated tanaid species. Tanaids of all size classes were collected, from small ~3 mm juveniles to large ~1.5 cm adult males. Polynoid polychaetes were common but not abundant in all clumps of tubeworms. Copious mucous secretions by paralvinellid polychaetes at the base of tubeworm clumps appeared to form a matrix within which filamentous bacteria thrived. Populations of paralvinellid worms were also observed in tubes within sulfides adjacent to active vents where tubeworms were absent. Disk-like sponges (1-2 cm diameter) were abundant on sulfides surrounding areas of hydrothermal venting. A sample of fossilized worm tubes embedded in iron oxides near a 110°C vent was colonized by dense populations of small ampharetid polychaetes and aplacophoran mollusks. Small vestimentiferan tubeworms, anemones, limpets, pycnogonids, and folliculinid protozoans also colonized this substrate. Galatheid crabs reached their greatest densities in the vicinity of active venting on sulfide mounds.

One site of low-temperature venting in soft sediment was observed at the base of a sulfide mound. The area (< 10 m^2) was colonized by elongate vesicomyid clams identified as *Calyptogena phaseoliformis* by R.D. Turner. Live clams were oriented half-buried, with their long axes at about 45° angles with respect to the sediment surface. The exposed anterior ends of live clams were often colonized by anemones. A number of empty valves lying on the surface of the sediment were noted, but no obvious explanation for mortality was observed. Qualitative samples of the sediment at this site contained large populations of undescribed species of orbiniid, ampharetid, and spionid polychaetes.

'Inactive' sulfide mounds were often colonized by remarkably dense concentrations of suspension-feeding deep-sea fauna. This fauna included aggregations of large, solitary tunicates plus brisingid seastars, crinoids, sponges, anemones, and brachiopods. While these organisms are common elements of the local non-vent fauna (Cary, this volume), their unusual abundance on sulfide mounds suggests that there may be some low-level venting of hydrothermal fluids at these 'inactive' sites that supports chemosynthetic production within the overlying water column, or that the acid-labile sulfides are mobilized by microbial activity to support primary production. Alternatively, the topographic relief of the sulfide mounds may modify the local flow regime, concentrating suspended particulates on which the biota feed.

Non-vent soft sediments were heavily bioturbated. Echinoderms, including asteroids, ophiuroids, holothurians, and urchins were conspicuous elements of the megafauna, as were xenophyophores and anemones. Occasional pennatulaceans and galatheid squat lobsters were also observed. The infauna of the sediments was dominated by several small species of polychaetes and an isopod.

Fauna of non-vent basalt substrates included sponges, brachiopods, and sabellid polychaetes.

Faunal Affinities

Specific identifications of most of the Gorda Ridge biota remain to be confirmed by taxonomic specialists. Nevertheless, we can consider the general nature of the fauna and relate it to the fauna of vent communities described from other oceanic spreading centers. Not unexpectedly, the fauna of NESCA hydrothermal vents most closely resembles that of Juan de Fuca and Explorer Ridge vent communities. The Northeast Pacific assemblage of Tunnicliffe (1988) can be extended to embrace the Gorda Ridge fauna. Ridgeiid vestimentiferans, lepetodrilid limpets, paralvinellid, polynoid and ampharetid polychaetes, pycnogonid arthropods and the small coiled gastropod are important components of this assemblage. Common and abundant faunal types present at vents on Juan de Fuca and Explorer Ridges but so far characterized as absent or rare at the NESCA site on Gorda Ridge include maldanid polychaetes and ostracods. The majid crab, *Macrooregonia macrochira*, while not strictly a vent-associated species, was not observed at NESCA, though it is common at Juan de Fuca and Explorer vents. Tanaid crustaceans occur at the NESCA site but have not been noted at Juan de Fuca or Explorer Ridge vents.

The fauna of the low-temperature soft-sediment site at NESCA, dominated by *Calyptogena phaseoliformis*, is not part of Tunnicliffe's Northeast Pacific assemblage. The same species of clam is known from cold water seeps in soft-sediment off Japan (Metivier et al. 1986; Juniper & Sibuet 1987) and was recently identified from sites in Monterey Canyon off California (R.D. Turner, pers. comm.). Soft-sediment vent fauna is best known from Guaymas Basin (Gulf of California) where the clam *Vesicomya gigas* (previously identified as *Calyptogena pacifica* and reclassified by R.D. Turner on the basis of additional material) is abundant (Grassle et al. 1985). Guaymas sediments are infused with petroleum hydrocarbons formed from high-temperature cracking of recent organic material (Simoneit and Lonsdale 1982); an odor of petroleum was detected in Gorda vent sediment, but it was neither as strong nor as pervasive as that of Guaymas material. The single, qualitative sample of Gorda vent sediment shares no common infaunal taxa with the samples of vent sediment from Guaymas Basin and the extensive bacterial mats associated with the sediment surface at Guaymas are absent at the Gorda soft-sediment vent site.

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