FIELD Cruise to the Northern EPR: Discoveries Made During Biological Investigations from 8°37' N to 12°48' N

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On October 31, 2003, the FIELD (Focused Investigations of Environment and Life at Depth) cruise, funded by NSF's Biotic Surveys and Inventories (DEB-0072695 to J. R. Voight) set sail on the R/V *Atlantis* for a series of *Alvin* dives on the East Pacific Rise. Objectives were to document and collect fauna from numerous hydrothermal vents along a 400-km section of the EPR, and to preserve the specimens acquired in museum collections for full taxonomic description and systematic study. Night operations included use of the WHOI towed digital camera system (Fornari et al., 2003) to refine dive target selection in unexplored areas, short plankton tows, and near-axis SeaBeam mapping to investigate abyssal hill topography and the mechanics of ridge-transform interactions near the Clipperton Fracture Zone. Funding from the Negaunee Foundation supported an outreach program that reported cruise results to a general audience via a Field Museum Web site, http://www.fieldmuseum.org/expeditions/janet2_expedition/about.html.

Complementary programs funded by NSF's Ocean Sciences Division (OCE-0002458 to K. Von Damm and OCE-0002729 to C. Fisher) used 6 dives at 9°50' N to continue ongoing studies of the EPR ISS bull's-eye. These dives continued the time-series investigations of hydrothermal vent fluid composition in response to the magmatic/tectonic evolution of the site and recovered experiments that were deployed in November 2002 to test the effects of physical structure and habitat on a *Riftia* community.

To ensure that vent-associated fauna were successfully collected from the classic EPR tube worm- and mussel-dominated habitats and that among-habitat diversity was well documented, we dove purposefully to make large collections at vent sites recently reported to support the targeted species assemblages and at exploratory sites to extend our knowledge of the distribution of vent-associated fauna. Fauna from vent peripheries were targeted for collections, as were species known only from areas with active hydrothermal flow. We made collections at Genesis and Parigo vents (near 12°48' N) where tube worms of the genus *Riftia* had been documented to dominate (Lallier et al., 1999). The tube worms were associated with extremely high densities of serpulids and octopuses of *Vulcanoctopus,* but relatively few mussels, consistent with trends that Lallier et al. (1999) noted.

Exploratory dives in the 13° N area targeted a near-axis shield volcano 2 km east of the ridge, referred to as Caldera (Lallier et al., 1999; Figure 1). Active vents at Caldera occur on one of the largest known seafloor massive sulfide deposits (Fouquet et al., 1996). Extensive weathering rinds on much of the outcropping sulfide and talus, and the difference between our high temperature measurement of 310°C and the peak temperature of 12°C recorded in 1992 (Fouquet et al., 1996), confirm that high temperature hydrothermal activity has been rejuvenated at this site during the last decade.

Our explicit goal for dives at Caldera was to collect *Riftia* with rust-colored tubes and any associated fauna. So-called "rusty *Riftia*" typify areas of relatively elevated Fe/H_2S fluid concentrations that can indicate waning hydrothermal activity. Tube worms of genus *Tevnia,* in contrast, are generally considered to be early colonizers of hydrothermal vents (Lutz et al., 1994). At this site, rusty tube worms of both genera were found together in several habitats, including massive sulfide talus and 6 m tall sulfide chimneys with temperatures up to 310°C. Collections

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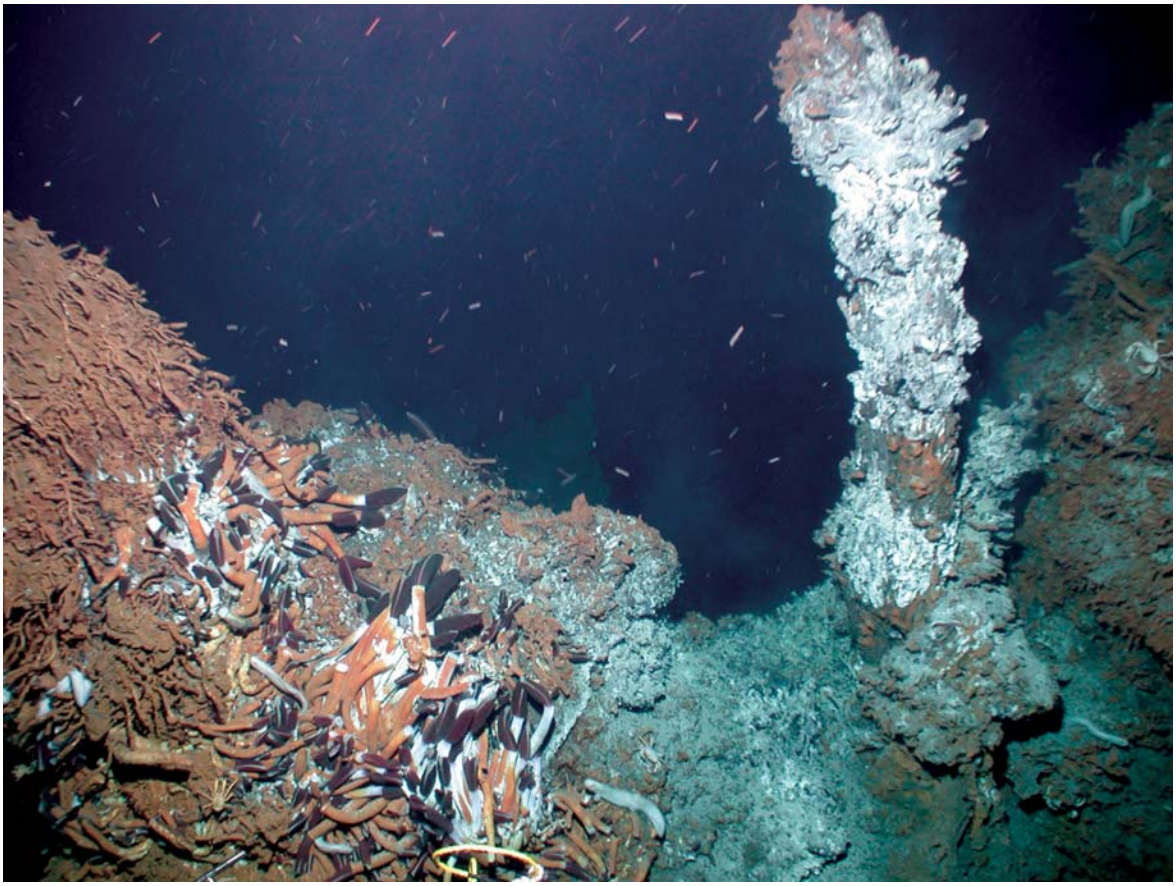

Fig. 1. View of Caldera with rusty-colored *Tevnia* and *Riftia* with adjacent chimney. Note the abundance of predatory taxa, including galatheids, vent crabs, and zoarcids. Photo from forward-looking digital camera, *Alvin* dive 3940. Courtesy of J.R. Voight.

revealed that the high-temperature chimney areas supported unusually large individuals of *Alvinella* and associated species. Detailed shore-based investigations will be required to determine if any faunal differences exist between the collections from the off-axis Caldera site and from Genesis and Parigo.

Dense communities of clams and mussels at 11°24' N in the BuckField vent field (C. L. Van Dover, pers. comm.) were thoroughly sampled, and two exploratory areas, 8°37' N and 10°44' N, were targeted. Hydrophone data indicated the occurrence of a seismic swarm with characteristics consistent with a volcanic eruption in March 2001 near 8°37' N. A follow-up CTD survey in December 2002 detected a weak plume, identified primarily by decreased optical transmissivity and slightly elevated manganese concentrations (Bohnenstiehl et al., 2003). At 10°44' N a magma-starved ridge segment extends north from the Clipperton Transform to south of the BuckField vent site. These areas were targeted in anticipation of discovering evidence of a recent lava flow and new hydrothermal activity, respectively.

Our first dive near 8°37' N found very cloudy diffuse flow that appeared to sustain a macrofaunal assemblage dominated by Stauromedusae, similar to those reported from 21° N and 7° S (Lutz et al., 1998; Halanych et al., 1999). Camera tows imaged additional areas with cloudy water and abundant Stauromedusae, marginal to a lava lake collapse. One site also supported tube worms of *Tevnia jerichonana* and limpets of *Eulepetopsis vitrea.* The venting areas are located in fissured terrain of partly sediment-dusted lavas, south and west of Bohnenstiehl et al.'s (2003) primary seismic swarm. In the southernmost area of the seismic swarm, we found no indication of recent volcanic activity or hydrothermal venting, either in the axial valley or on the andesite-capped ridge east of the spreading center.

Providing a surprising contrast, the first dive at 10°44' N landed amid clear evidence of a recent volcanic eruption. This previously unexplored region occupies a local, along-axis topographic high where towed camera operations documented vent fauna in the 1980s (ARGO-RISE GROUP, 1988). Our three dives in this area encountered a very young basalt flow that extends at least 4 km along the axis. Wherever glassy flow was observed, it was associated with diffuse hydrothermal flow, bacterial mats, and snow-blower vents (3°-9.5°C; Figure 2) issuing from collapsed areas of the lava flow. Bythograeid and galatheid crabs and zoarcid fishes *(Thermarces cerberus)* were abundant, but no other vent macrofauna were observed from *Alvin.* Nematocarcinid shrimps, a background taxon, were also abundant. The only evidence seen of the previously photographed hydrothermal system was the top of an extinct sulfide chimney rising from the glassy lava flow. The absence of macrofaunal communities and the preponderance of filamentous bacteria and formless, gelatinous material, considered to be a microbial by-product, are all strikingly reminiscent of observations made at Axial Volcano six months after its eruption. The vagile macrofauna we saw are the same as those reported post-eruption at 9° N (Shank et al., 1998). We also found a previously unknown species of polynoid polychaete associated with the bacterial mats. *Continued on page 24*

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Fig. 2. The *Alvin* low-temp probe being inserted into a snow-blower located in a collapse structure at 10°44' N on the East Pacific Rise. Maximum temperatures reached only 9.5°C. Photo from forward-looking digital camera, Alvin *dive 3937.* Courtesy of J.R. Voight.

The results of this cruise, outlined here, offer a new perspective on the 8° to 11° N Ridge 2000 Integrated Studies Site and adjacent ridge segments. Our preliminary shipboard observations indicate that our collections are rich in species new to science. Although many determinations await shore-based research, we conservatively estimate that our collections contain representatives of 15 to 20 new species, including up to 4 new genera. Cnidaria provided 7 of the new species, several of which were collected from or near vents. Among crustaceans, 5 of the 19 species documented on board are either new or show greater morphological variation than previously reported. Conservatively, representatives of 3 new species of polychaetes were collected. Of the 3 octopod taxa collected, only one has been previously collected in the Pacific from within 30° in any direction of our dive sites; a leech that appeared to have been associated with *Vulcanoctopus* is likely new. Bryozoan colonies collected were a surprise addition to the vent fauna.

Clearly, one of the more successful aspects of this cruise was the complete inclusion of taxon specialists in the cruise. The presence of taxonomic experts in *Alvin* had a favorable impact on sampling priorities and allowed us to fully exploit unanticipated sampling opportunities. The biological collections will be deposited at The Field Museum, loaned to experts for determination, and become the basis for an on-line taxonomic key that will be made available in CD-ROM format to UNOLS ships. These specimens will provide an invaluable resource for systematic studies of hydrothermal vent fauna.

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