Observations and Comparisons of California Seamount Communities

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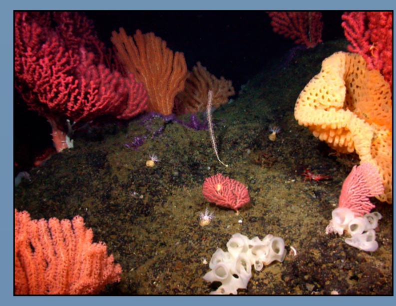


Introduction

Seamounts provide hard substratum, complex habitat, and other conditions which favor faunal assemblages that differ from those found on the flat, sediment-covered benthos more typical of the deep-sea (Gage and Tyler 1991). Due to these physical characteristics, biological communities found on seamounts may be very diverse, have high abundance, and contain many endemic organisms (Richer de Forges 2000) including unique corals, sponges, and other sessile invertebrates. Other factors contributing to observed levels of abundance and diversity include enhanced productivity in the water column surrounding some seamounts due to the formation of Taylor columns and increased concentrations of prey items which have been attributed to entrapment of migrating zooplankters (Rogers 1991).

In this investigation we used video recordings from remotely operated vehicle (ROV) dives to look for patterns of biological diversity and although these dives were originally conducted for geological studies, they provide valuable information about the biological composition of these deep-sea habitats. In many regions of the world seamount communities have suffered at the expense of deep-water fisheries such as those found near Tasmania, where trawling for orange roughy has decimated fragile seamount ecosystems (Koslow, et al. 2001). Baseline observations like those presented here provide a valuable first step in documenting and, eventually, preserving these unique habitats.

The seamounts surveyed in this study, Davidson, Guide, Pioneer, and Rodriguez, all have similar intraplate volcanic origins and each is located atop older oceanic crust which formed 19-20 million years before present (MYBP). These four seamounts have a similar northeast-to-southwest orientation, indicating that they may have formed astride an abandoned mid-ocean ridge system (Davis et al. in press). Though formed under similar conditions, the topography, size, and depth of the seamounts examined here vary (Fig. 1, Table 1). Rodriguez Seamount is unique among this group in that it was subaerially exposed approximately 10 MYBP and is flat-topped (guyot) with rugged flanks and extensive flat regions encrusted with pavements and a thin sediment veneer.

Methods

Geological features and biological communities were observed using the Monterey Bay Aquarium Research Institute's (MBARI) ROV *Tiburon* (Fig. 2). Twelve dives (120 hours of video) on Davidson, Guide, Pioneer, and Rodriguez Seamounts off the coast of California, USA (Fig. 1), were annotated using MBARI's Video Annotation and Reference System (VARS, Fig. 3) to determine seamount community composition. The VARS components reference a knowledge database of over 3,300 biological, geological, and technical terms. The hierarchical structure of VARS allows for consistent and rapid classification, description, and complex querying of video observations. VARS software is available at http://www.mbari.org/VARS/ or contact lonny@mbari.org.

Several hundred species were collected, using a variety of ROV sampling devices, and subsequently sent to taxonomists for identification. Using VARS, we identified benthic and demersal megafauna to the lowest possible taxon. Each video observation was merged with ancillary data (geographic position, CTD, and camera information) within VARS. Video observations were imported into ArcGIS® 9.1 and mapped along with high-resolution bathymetric data. Thirty-meter bathymetric grids were analyzed using ArcGIS's Spatial Analyst extension to calculate aspect and NOAA's ArcGIS extension, the Benthic Terrain Modeler (BTM), to calculate Bathymetric Position Index (BPI) for each observation. We conducted Chi-square tests to compare the distribution of observed organisms with the expected distribution (our tracklines). Due to their close proximity, Guide and Pioneer data were combined.

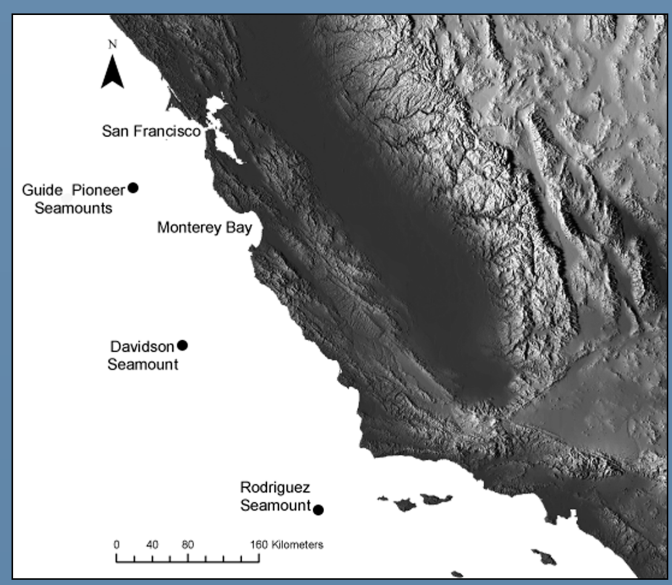


Figure 1. Location of study sites; Guide, Pioneer, Davidson, and Rodriguez Seamounts

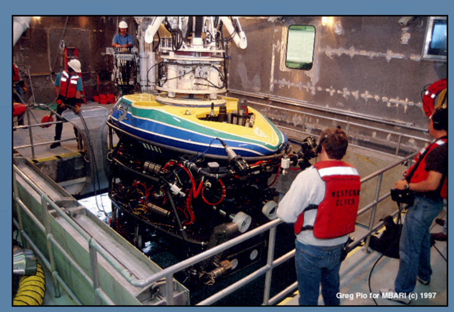


Figure 2. MBARI'S ROV *Tiburon*

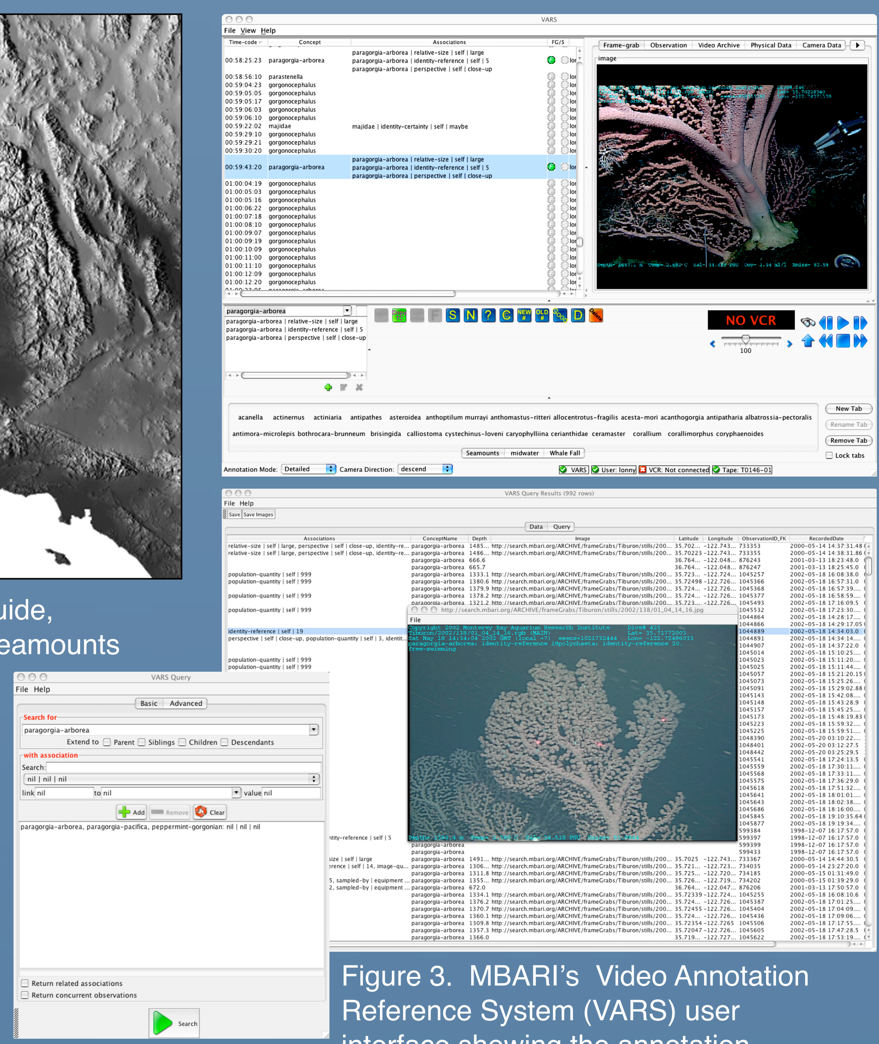


Figure 3. MBARI's Video Annotation Reference System (VARS) user interface showing the annotation interface, the query interface, and results table.

Table 1. Physical characteristics of each seamount

Seamount	Distance from shore (km)	Depth at Foot (m)	Depth at Summit (m)
Davidson	150	3,656	1256
Rodriguez	150	2,325	650
Pioneer	120	2,750	820
Guide	120	3,122	1682

Table 2. Hours of video annotated, distance traversed and number of organisms observed.

Location	Observation Time (hrs of video)	Distance Traversed (km)	Organisms Observed	Organisms per km Traversed
Davidson	47	11.8	23,916	2,027
Rodriguez	47	16.3	39,189	2,404
Pioneer/ Guide	26	8.3	27,224	3,280

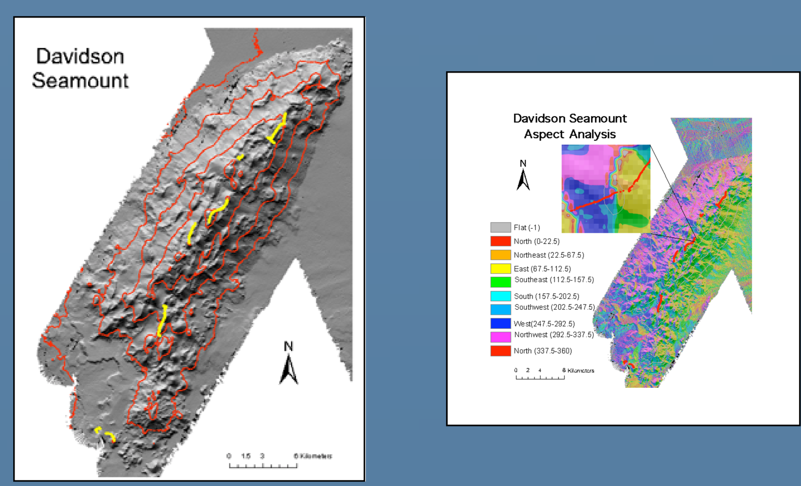


Figure 8. Davidson shown with dive tracks (yellow) and 500m contours (red). Davidson aspect analysis (right).

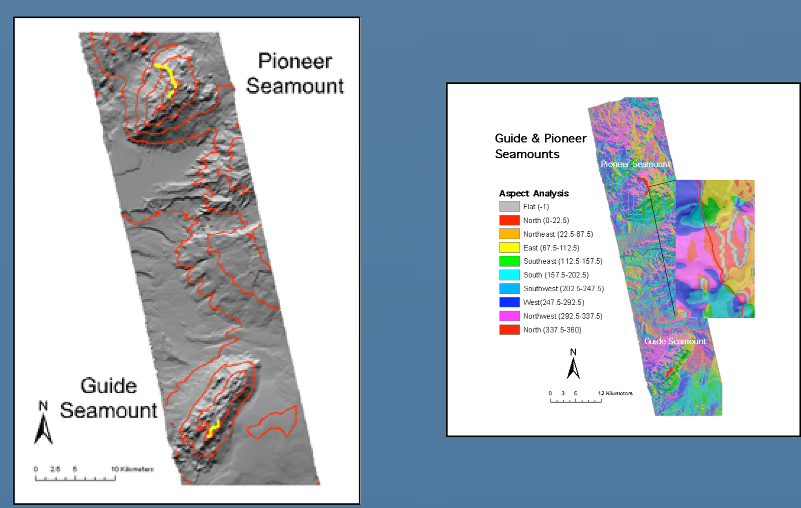


Figure 9. Guide & Pioneer shown with dive tracks (yellow) and 500m contours (red). Guide & Pioneer aspect analysis (right).

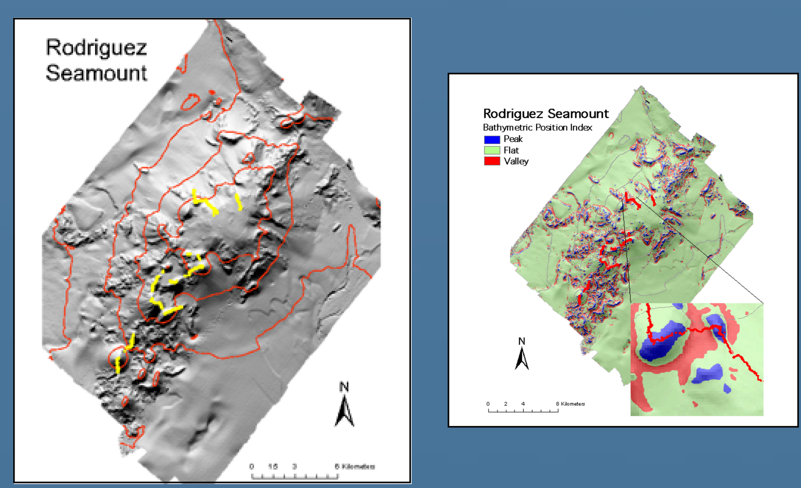


Figure 10. Rodriguez shown with dive tracks (yellow) and 500m contours (red). Rodriguez BPI analysis (right).

Figure 4. Feeding styles and motility of observed organisms.

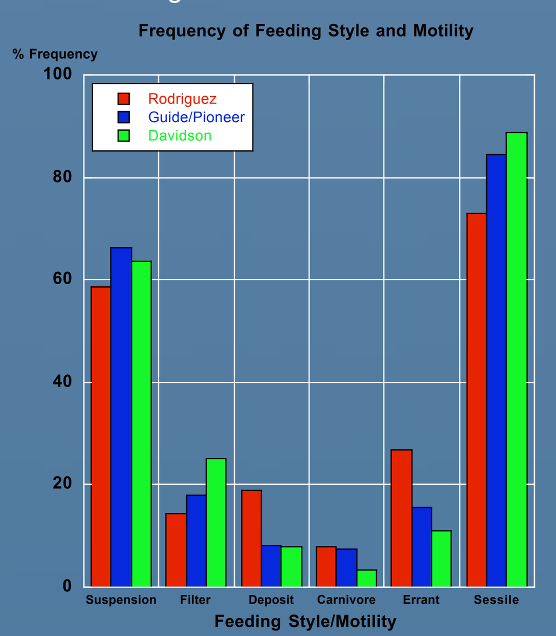


Figure 5. Number of distinct species at each seamount.

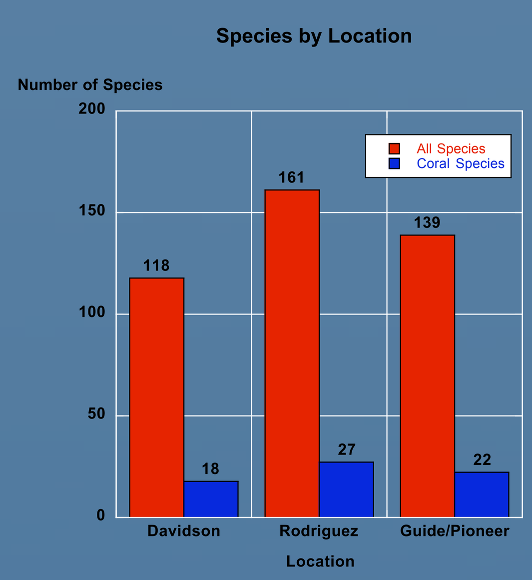


Figure 6. Number and percentage of species in common at each seamount

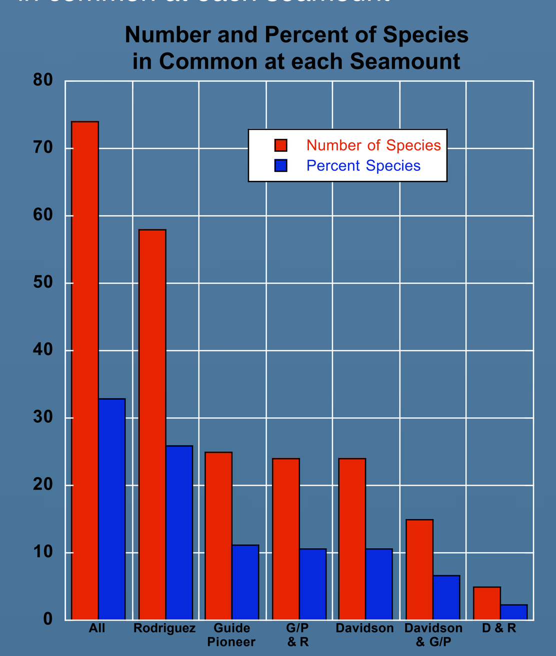
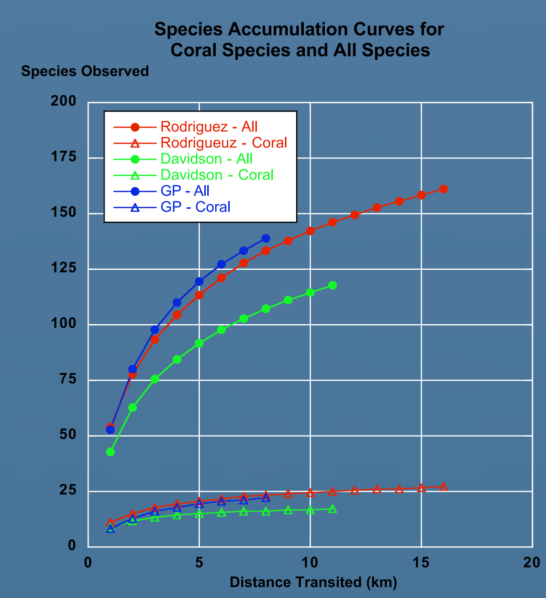


Figure 7. Cumulative species curve showing both total and coral species per distance traversed.



Coral Associates

Corals were often found associated with other organisms. The asteroids *Hippasteria spinosa* and *H. californica* were frequently seen grazing on the isidid corals *Keratoisis sp.* and *Isidella sp.* Brittle stars, basket stars, crinoids, and galatheid, lithodid, and majiid crabs were seen clinging to the branches of *Paragorgia arborea*, *Paragorgia sp.*, and *Acanthogorgia sp.* Other organisms found on sampled corals included polychaete worms and ophiuroids, which were typically too small to be identified from video.

Results & Discussion

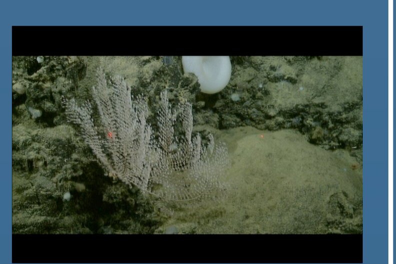
We traversed more than 36 km and analyzed 120 hours of video (Table 2). A total of 90,329 individuals were annotated; 28,338 were corals. The highest number of organisms per km was at Guide/Pioneer (Table 2). Note that because these investigations were not conducted specifically for biological study these results are not strictly quantitative. The majority of animals were sessile suspension and filter feeders (Fig. 4). Rodriguez Seamount had a relatively high percentage of deposit feeders (19%) compared to the other seamounts (~8%). The presence of abundant deposit feeders - *Pannychia moseleyi* (a holothurian) and a new species of echinoid - account for this difference. Their numbers are likely due to the flat, relatively sediment-covered habitat of this seamount.

New Species

Several new species which are currently being described by taxonomists have been discovered through this research.

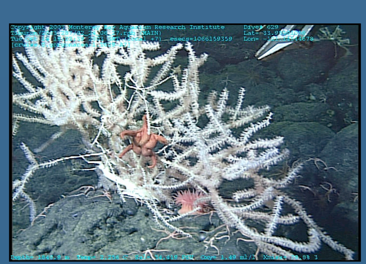
Cladorhiza pteron sp. nov.

Isidella sp. nov.

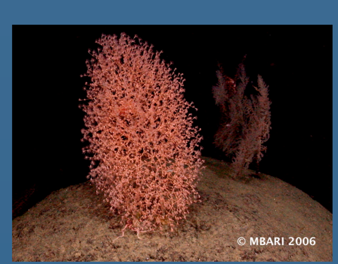


Chrysogorgiidae

Sperosoma



Evoplosoma



Chrysogorgia

We found a total of 225 distinct species, 33 of which were corals representing no fewer than 17 families (Fig. 5). Rodriguez Seamount was the most diverse in both total number of species and number of coral species (Fig. 5). Fewer than 33% of the total species were found at all of the studied seamounts. More than 25% of the total species were found on Rodriquez alone (Fig. 6). It appears that even more species would be found at these sites with continued sampling (Fig. 7). Corals may have been well-sampled as the number of species increased only slightly with additional sampling (Fig. 7).

BPI Analysis: A significantly higher than expected percentage of deep-sea corals were found on peaks at Davidson (65.9%, $p = 0.01$) and Guide/Pioneer (82.6%, $p < 0.001$) Seamounts . Lower than expected numbers were found in valleys and on flat terrain. These results are similar to a previous study of Davidson Seamount which showed that habitat-forming corals were strongly associated with peaks (DeVogelaere et al. 2005).

Aspect Analysis: Significantly higher than expected percentages of five large complexly branched habitat-forming corals were found on northwest- and west-facing slopes of Davidson (NW = 30%, W = 16.9%, $p = < 0.001$) and Guide/Pioneer (W = 43.9%, NW = 17.8%, $p = 0.003$) Seamounts (Fig. 8 & 9). Davidson also had a higher than expected number of corals on east-facing slopes (20.5%). Prevailing currents are likely the cause of these observed distribution patterns.

Neither of these analyses showed significant patterns at Rodriquez Seamount which is flat-topped and sediment veneered (Fig. 10).

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