A characterization of the megafauna at Davidson Seamount

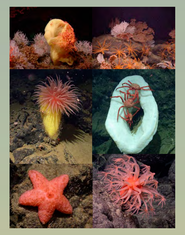
V13A-0650

Lundsten, L.,*[1,2] DeVogelaere, A.P.,[3] Barry, J.P.,[1] Clague, D.A.[1] [1]Monterey Bay Aquarium Research Institute, [2]Moss Landing Marine Laboratories, [3]Monterey Bay National Marine Sanctuary, *Corresponding author: MBARI 7700 Sandholdt Road, Moss Landing, CA 95039, lonny@mbari.org

Abstract Seamounts offer hard substrate, complex habitat, elevated current velocities, and other features that allow for the existence of unique assemblages of organisms, often dominated by long-lived and fragile corals and sponges. Seamount faunas may have high rates of endemism with biogeographic patterns analogous to land-based island faunas. Seamount organisms, particularly long-lived deep-sea corals, are vulnerable to bottom trawling and other resource extraction techniques. Davidson Seamount, located 120 km southwest of Monterey, CA, USA, is an example of a relatively undisturbed and pristine seamount habitat. Volcanic in origin, Davidson Seamount was formed 12-16 million years ago atop a fossil spreading center, which produced a unique pattern of northeast trending ridges on the seamount. Remotely Operated Vehicle (ROV) dives at Davidson Seamount were conducted in 2000 and 2006 by a collaboration of scientists, resource managers and educators. Sixteen dives were annotated in detail using MBARI's Video Annotation Reference System (VARS), yielding more than 60,000 biological observations. Over 170 organisms were identified to the lowest possible taxon. The distribution of organisms in relation to the bathymetric complexity of the seamount were analyzed using ArcGIS 9.1 and NOAA's Benthic Terrain Modeler (BTM) to relate faunal distributions to slope, aspect, and bathymetric position. Video transects completed in 2006 were analyzed to quantify species' density and richness. Several new species were observed and collected, and are currently being described by taxonomists. Results of this study indicate that corals and sponges may have species-specific depth distributions with little overlap of large habitat forming phyla. Moreover, substratum type, slope, and aspect are important in determining the distribution of some coral species. This baseline survey is valuable in describing the fauna of Davidson Seamount, has been used in developing essential fish habitat zones where trawling is regulated by the National Marine Fisheries Service, and will be critical in the final determination for the potential inclusion of the seamount as part of the Monterey Bay National Marine Sanctuary.

Davidson Seamount
Quick Look

Distance from shore (km)	120
Depth at summit (m)	1256
Depth at foot (m)	3,656
Total height (m)	2,400
Length (km)	42
Calculated volume (km³)	320
Observation time (hrs of video)	110
Organisms observed	60,374
Organisms/m transected	2.5



Introduction The hard substrate, complex habitat, and modified hydrographic conditions found at many seamounts favor faunal assemblages that differ from those found on the flat, sediment-covered seafloor more typical of the deep-sea (4, 10). Additional factors contributing to the increased levels of abundance and diversity observed at some seamounts include elevated current velocities, entrapment of migrating zooplankton, enhanced productivity due to the formation of Taylor columns (3, 4, 6, 9, 10). Due to these physical characteristics, biological communities found on seamounts are often very abundant, show high levels of diversity, and contain many endemic organisms (9). These unique communities are composed of corals, sponges, a variety of other invertebrates, as well as commercially important precious corals and seamount aggregating fish stocks. Vulnerable to trawling and other extractive techniques, many regions of the world have seen collapses in seamount aggregating fisheries and subsequent decimation of benthic invertebrate communities where deep-water trawls have been used (6).

Davidson Seamount is a enigmatic volcanic feature of intraplate origins estimated to have formed 12-16 million years ago atop older, oceanic crust estimated to be 19-20 million years old. Similar in formation to other central California seamounts, Davidson Seamount has a distinctive northeast-to-southwest orientation (**Fig. 2**), indicating that it - like Rodriguez, Pioneer, and Guide Seamounts - may have formed astride an abandoned mid-ocean ridge system (2).

Methods Geological features and biological communities were observed using the Monterey Bay Aquarium Research Institute's (MBARI) ROV *Tiburon* (**Fig. 1**). Sixteen dives representing 110 hours of video from Davidson Seamount off the coast of California, USA (**Fig. 2**), were annotated using MBARI's Video Annotation and Reference System* (VARS, **Fig. 3**) to determine seamount community composition. Several hundred individual organisms were collected 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. In 2006 we recorded 35 haphazardly selected video transect's which were used to help describe the community. Video observations were imported into ArcGIS® 9.1 and mapped along with high-resolution bathymetric data. A thirty-meter bathymetric grid of Davidson Seamount was analyzed using ArcGIS's Spatial Analyst extension to calculate aspect and slope. NOAA's ArcGIS extension, the Benthic Terrain Modeler (BTM), was used to calculate Bathymetric Position Index (BPI).

* 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 is open-source software. More information is available at http://www.mbari.org/VARS/ or contact lonny@mbari.org.

Fig. 1 ROV *Tiburon*

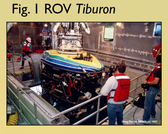


Fig. 2 Location of Davidson Seamount

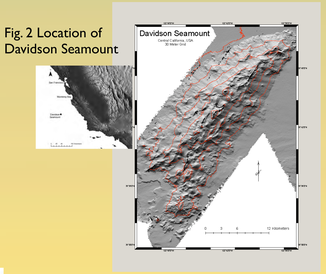
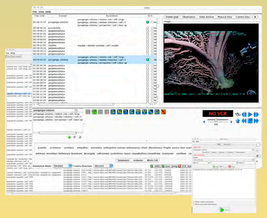


Fig. 3 MBARI's Video Annotation and Reference System (VARS)



Results Qualitative observations reveal that nearly 70% of the megafauna identified at Davidson Seamount are sessile (88% when functionally sessile organisms are included), 58% are suspension feeders, and ~30% are filter feeders. Dominant phyla include the cnidaria (many of which are corals), echinodermata, and porifera (**Fig. 4**). Similar patterns were found using quantitative transect data.

We identified 60,374 benthic invertebrates and demersal fishes in this analysis, which represented 190 species. We observed approximately 2.5 organisms per meter transected (range of .57 - 5.17 per meter transected). Transects varied in depth (-1280 m - ~3300 m) and length (35 m - 445 m). **Fig. 5A**

Twenty-five coral species were identified. *Paragorgia arborea* is the largest of the habitat-forming corals and it appears to have a narrowly defined depth range. Dense stands of *P. arborea* were found on the peaks of shallow cones, often overhanging sheer cliff faces. Other large habitat-forming corals, like the isidid *Keratoisis sp.*, appear to have a more broad depth distribution and were often found in saddles and on slopes. Interestingly, the average depth range of all but one coral is below the average depth of *P. arborea*. Corals in the family primnoidae were numerous, although there were several species in this group and they were difficult to distinguish in video and are being reviewed now. Two new species of corals in the genus *Chrysogorgia* were collected and are currently being described. These two corals have similar depth distributions, though the flabellate form is more abundant in slightly deeper water. The precious coral, *Corallium sp.*, was also abundant below the *P. arborea* stands. **Fig. 5B**

Fig. 4 Motility, feeding style, and dominant phyla represented by video observations.

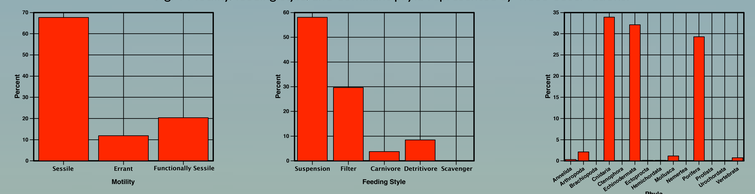


Fig. 5A (Left) Transect length, avg. depth, and organisms/meter transected. Fig. 5B (Right) Depth distribution of coral species.

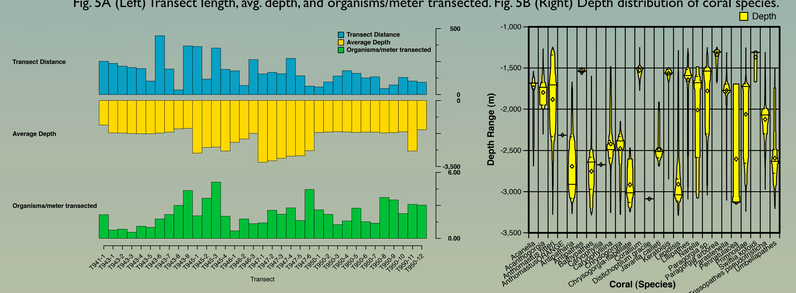
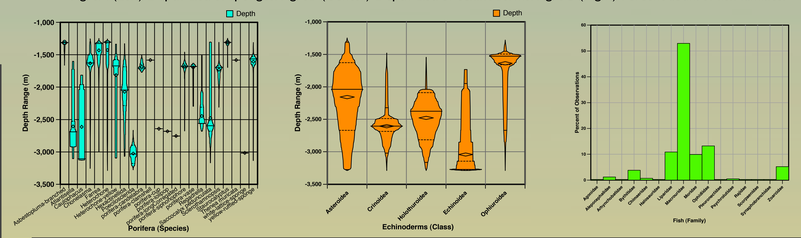


Fig. 6A (Left) Depth dist. of sponges. Fig. 6B (Center) Depth dist. of echinoderms. Fig. 6C (Right) Percent abun. of fish families.



Results continued Shallow "sponge reefs" were composed of *Farrea, Staurocalyptus,* and a new species of sponge in the genus *Asbestopluma.* This new species of asbestopluma was sampled in 2006 and has a depth distribution which is similar to that of *P. arborea.* It may be endemic to Davidson Seamount, as it has not been observed elsewhere. *Heterchone* and *Chonelasma* were also abundant at shallower depths. *Sclerothamnopsis* is another common sponge that has a broad depth distribution. **Fig. 6A**

Among the echinodermata the ophiuroid *Gorgonocephalus* was extremely abundant at shallower depths, the crinoid *Florometra seratissima* and several stalked crinoids in the families hyocrinidae and bathycrinidae were abundant in the middle depth ranges. A holothurian in the family laetmogonidae was abundant, as were two other unidentified species of holothuroidea. The echinoids *Tromikosoma panamense* and *T. hispidium* were common upon the sediment at deeper depths. Asteroids were fairly abundant at all depths. *Hippasteria spp.* were often observed feeding upon the abundant corals. **Fig. 6B**

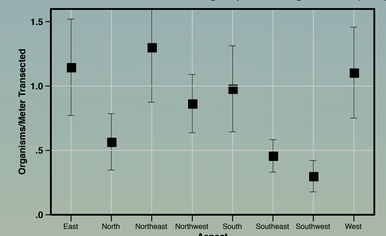
Demersal fish were low in abundance when compared with invertebrates. Only 423 fish were identified in video of the 60,374 biological observations. Dominant fish families included the macrouridae (~52%), ophidiidae (~14%), bythitidae (11%), moridae (10%), and zoarcidae (~5%). These finding are consistent with other studies of deep-sea fish fauna off central California (1). **Fig. 6C**

Higher densities of organisms were found on northeast, east, and west facing slopes, **Fig. 7A**, with moderate (11° - 30°) and steep (>30°) declination, **Fig. 7B**. BPI values indicated that denser communities were found in areas of elevated relief. The BPI analysis gave results similar to those found in previous studies (3), **Fig. 7C**.

Conclusions

- **The biological communities found at Davidson Seamount are composed mainly of sessile suspension and filter feeders.**
- **A community of large corals and several species of sponge compose a "peak" community, which is found between 1250 and 1500 meters. The occurrence of this community is most likely due to a combination of factors including reproductive strategies, substrate type, and elevated current velocities (6, 7, 9).**
- **Organisms found below the "peak" seem to have broader depths of occurrence, patchy distribution, and increased diversity.**
- **Fish abundance is low when compared to the other organisms observed, but these results are consistent with other reports for this region (1).**
- **Data from this research is being used to draft a management plan for incorporating Davidson Seamount into the Monterey Bay National Marine Sanctuary.**
- **VARS is a powerful tool for recording video observations and can be used to characterize unique habitats.**

Fig. 7A Aspect analysis indicated higher densities of organisms were found on Northeast, East, West and South facing slopes. Nonsignificant, F(7,84)=1.31, p=0.25.



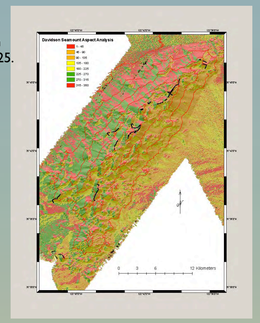
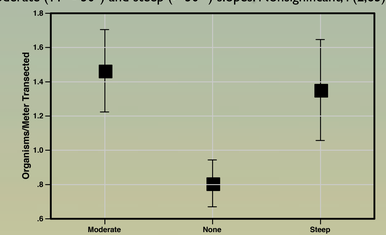


Fig. 7B Slope analysis indicated that higher densities of organisms were found on moderate (11° - 30°) and steep (> 30°) slopes. Nonsignificant, F(2,63)=2.61, p=0.08.



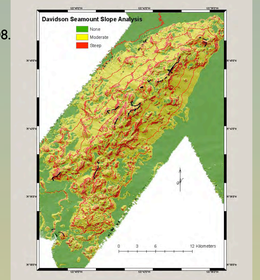
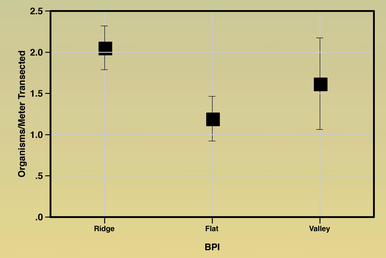
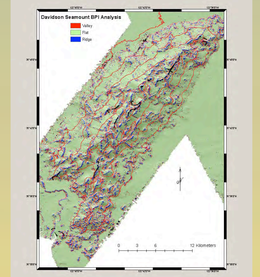


Fig. 7C BPI analysis indicated that higher densities of organisms were found in ridge habitat. Nonsignificant, F(2,48)=1.99, p=0.15.





References

1. Caillet, G.M., Andrews, A.H., Wakefield, W.W., Moreno, G., Rhodes, K.L. 1999. Fish faunal and habitat analyses using trawls, camera sleds and submersibles in benthic deep-sea habitats off central California. Oceano. Acta. 22:579-592.
2. Davis, A.S., D.A. Clague, W.A. Bohrson, G.B. Dalrymple, H.G. Greene. 2002. Seamounts at the Continental Margin of California: A Different Kind of Oceanic Intra-Plate Volcanism. Geological Society of America Bulletin: Vol. 114, No. 3, pp. 316–333..
3. DeVogelaere, A.P., E. J. Burton, T. Trejo, C. E. King, D.A. Clague, M. N. Tamburri, G. M. Caillet, R. E. Kochevar, W. J. Douros, 2005. Deep-sea corals and resource protection at the Davidson Seamount, California, USA. In: Freiwald A, Roberts JM (eds), 2005, Cold-water Corals and Ecosystems. Springer-Verlag Berlin Heidelberg, pp 1189-1198.
4. Gage, J.D., P.A. Tyler, 1991. Deep-Sea Biology: A Natural History of Organisms at the Deep-Sea Floor. Cambridge University Press, Cambridge, CB2 1RP, UK, 504 pp.
5. Genin, A., L. R. Haury, and P. Greenblatt. 1988). Interactions of migrating zooplankton with shallow topography: predation by rockfish and intensification of patchiness. Deep-Sea Research, 35:151-175.
6. Koslow, J.A., K Gowlett-Holmes, J.K. Lowry, T. O'Hara, G.C.B Poore, 2001. Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. Marine Ecology Progress Series 213, 111-125.
7. Mullineaux, L.S. and S.W. Mills. 1997. A test of the larval retention hypothesis in seamount-generated flows. Deep-Sea Research 44: 745-770.
8. Parker, T. and V. Tunnicliffe. 1994. Dispersal strategies of the biota on an oceanic seamount: implications for ecology and biogeography. Biological Bulletin, 187: 336-346.
9. Richer de Forges, B., J. Anthony Koslow, G.C.B. Poore, 2000. Diversity and endemism of the benthic seamount fauna in the southwest Pacific. Nature 405, 944-947.
10. Rogers, A.D., 1994. The Biology of Seamounts. Advances in Marine Biology 30, 305-350.
11. White, M. and C. Mohn. 2004. Seamounts: a review of physical processes and their influence on seamount ecosystems. OASIS report, University Hamburg, 40 pp

Acknowledgements: Primary support for the Monterey Bay Aquarium Research Institute comes from the David and Lucile Packard Foundation. Special thanks to the crew of the R/V Western Flyer and the pilots of ROV Tiburon. The authors also wish to thank taxonomists Gary Williams, Steve Cairns, Chris Mah, Charles Messing, Henry Reiswig, and Welton Lee. Assistance and support was also graciously provided by Erica Burton, Jenny Paduan, Linda Kuhnz, Nancy Jacobsen-Stout, Brian Schlining, Kyra Schlining, and Susan von Thun.