

Biogeographical patterns of the hydrothermal vent fauna: a comparison with “non-vent biogeography”

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The hydrothermal vent fauna has a high ratio of taxa specific for vent biotopes, i.e. obligate vent taxa (> 90% at the species level). This observation, together with the dramatic difference between the vent and regular non-vent deep-sea communities, has resulted in vent fauna being treated as a separate evolutionary and biogeographic unit (e.g. DOVE Workshop Report).

Most pronounced differences between the hydrothermal vent fauna assemblages were reported for the East Pacific, Northeast Pacific, West Pacific and the Mid-Atlantic Ridge (MAR) regions, which are recognized by some authors as biogeographical hydrothermal provinces (e.g. Tunnicliffe & Fowler, 1996). These four regions, however, also have different non-vent faunas. The shallow-water biogeographical units (of the continental shelf and oceanic islands, 0-200 m depth), corresponding to these regions are known as the Tropical Western Pacific, the Tropical Eastern Pacific, the Warm-Temperate Pacific (Fig. 1) and the Atlantic regions (e.g. Briggs, 1995). Similar biogeographic divisions are found in the upper bathyal - on the continental and island slopes and on seamounts (200-1500 m depth) (Fig.2). When the biogeographic units of the abyssal ocean floor are considered (3000-6000 m), the four regions are defined as the East Pacific Province, the North Pacific Province, the West Pacific Province of the Pacific Deep-Sea Subregion and the Atlantic Deep-Sea Subregion. Documented differences along the depth gradient, e.g. between the Lucky Strike vent fauna and vent faunas of deep-water MAR sites, correspond well to the differences between the bathyal (200-3000 m) and abyssal (3000-6000 m) faunas. The hydrothermal vent fauna also shows some other biogeographic features in common with the regular deep-sea fauna, e.g. “the edge effect” (Mironov, 1994), (as along the MAR; Fig. 2) and the circumcontinental zonation (Mironov, 1994) (e.g. the Guaymas basin; Fig. 2). Additionally, there is increasing evidence for links between vent and seep faunas (see Tunnicliffe et al., 1996; Gebruk et al., 1997).

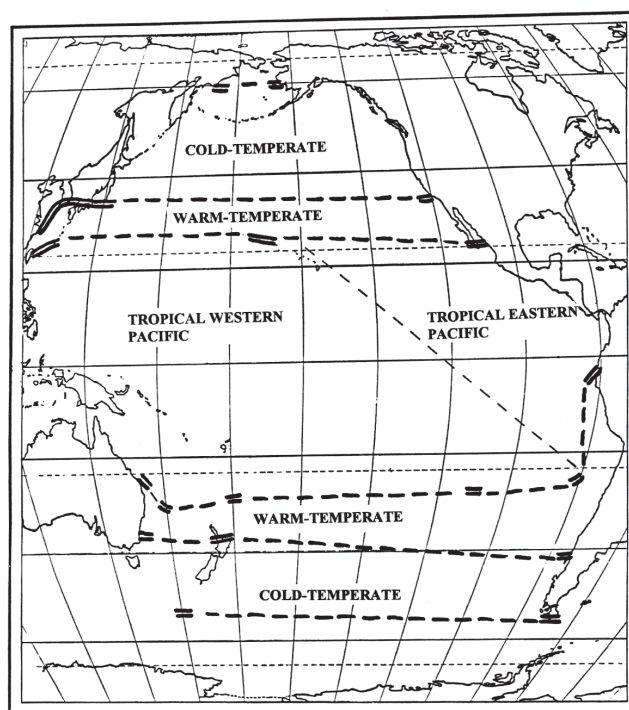


Figure 1. Western Pacific, Eastern Pacific and North-East Pacific hydrothermal vent regions and latitudinal arrangement of shelf biogeographic regions (based on coordinates given by Briggs, (1995)).

In general, the large-scale biogeographical patterns of the hydrothermal vent fauna agree well with those of the non-vent fauna. There is a strong reason to believe that the distribution of both faunas on a global scale is controlled by the same factors. The effect of the “non-vent ocean environment” on the distribution of vent organisms occurs most likely through dispersal stages of vent organisms.

Plate tectonics, geomorphology, spreading rates and specific habitat parameters (e.g. chemistry of vent fluids and chemoautotrophic bacterial production) are usually considered important factors in controlling the global vent

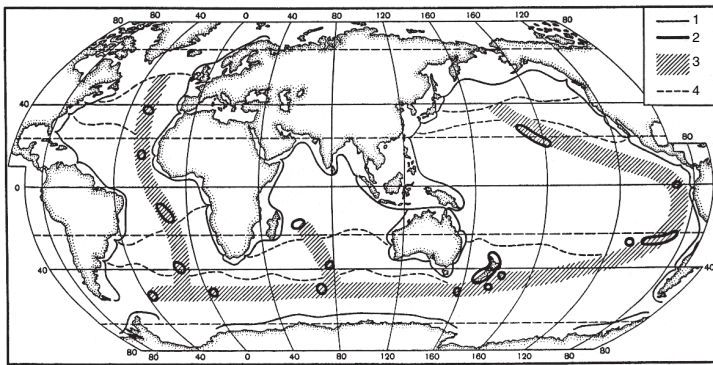


Figure 2. Assumed faunistic division of the sublittoral and the upper bathyal of the ocean (after Mironov, (1994)). 1 - faunistic boundaries between subcontinental and open-oceanic subordinate provinces; 2- boundaries of open-oceanic exotical provinces; 3 - zone of location of oceanic exotical provinces also showing the limits of distribution of some western, eastern and antarctic panthallasic taxa; 4 – winter (February and August) 10 and 20°C surface isotherms, supposed to be correlating with faunistic boundaries between oceanic subordinate regions.

biogeographic patterns. The major role of the geometry of plate boundaries (mid-ocean ridges) in the distribution patterns of vent fauna has been discussed by Tunnicliffe & Fowler (1996) and Tunnicliffe et al. (1996). In general, it is often suggested that if a mid-ocean ridge thread had no breaks throughout the world ocean with continuously spread hydrothermal fields, then the vent fauna would be similar throughout the world. However, if the animal distribution among hydrothermal vents on a large scale is primarily controlled by the non-vent environment as we hypothesize, then the set of factors controlling the global vent and non-vent fauna distribution would be universal. Zonal distribution (latitudinal, circumcontinental and vertical) of physico-chemical factors, major current systems and large geomorphological barriers, such as East Pacific Barrier, the New World Land Barrier, and the Old World Land Barrier, are expected to have a principal role. The “non-hydrothermal” fauna is characterized by pronounced differences over the geomorphologically uniform sections of continental shelf, slope and ocean floor and by a strong tendency for biotically and abiotically defined latitudinal zones to coincide. The tropical, subtropical, boreal, notal, arctic and antarctic faunistic zones are based upon biogeographical (non-vent) provinces (on the shelf) and correspond to the latitudinal zonation in the distribution of physico-chemical environmental factors. Latitudinal zonation is also seen in the distribution of abyssal animals. Patterns of bathymetric (sublittoral, bathyal and abyssal faunistic zones) and circumcontinental (subcontinental and open-oceanic faunistic zones) distribution are also controlled by the interplay of numerous factors operating in today’s oceans and characterized by a zonal distribution.

Similar global-scale patterns of distribution of vent and non-vent” faunas allow us to predict faunal features of the

newly described hydrothermal areas. Thus, it may be suggested that a closer relationship exists between the south East-Pacific Rise hydrothermal vent fauna and that of the West Pacific than to the east Pacific fauna - a feature known as “meridional asymmetry” (e.g. Mironov, 1994; Briggs, 1995). It may be also suggested that there is a strong faunistic independence of the Antarctic region and that the Indian Ocean hydrothermal vent fauna is more closely related to Pacific fauna than to Atlantic fauna: the abyssal Indian Ocean and Pacific faunas belong to the same biogeographical units: north of 40°S - the Pacific-North-Indian deep-sea region and south of 40°S - the Antarctic-Indian-Pacific subregion (Vinogradova, 1997).

Various examples show that the distribution of faunistic assemblages of different types (from different environments) is described by the same zonal regularities. Thus, similar latitudinal zonation is typical for fresh-water and terrestrial faunas; similar latitudinal and vertical zonation is found in faunas of continental slopes and seamounts. Global biogeographic patterns of abyssal and ultra-abyssal (hadal, or deep-sea trench) faunas are also in a good correspondence.

On the community level, hydrothermal vent fauna indeed clearly differs from the non-vent one. However, there is not enough reason to distinguish separate hydrothermal and non-hydrothermal biogeographical provinces. The distribution of vent and non-vent faunas on the global scale is most likely controlled by universal factors and both faunas belong to the same biogeographical provinces.

References

- Briggs J.C. 1995.** Global biogeography. Elsevier: Amsterdam. 252 pp.
- DOVE BRIDGE Workshop Report N 4. 1994.** Diversity of Vent Ecosystems (DOVE). Marine Biological Association of the U.K., Plymouth. 39 pp.
- Gebruk A.V., Galkin S.V., Vereshchaka A.L., Moskalev L.I. & Southward A.J. 1997.** Ecology and Biogeography of the Hydrothermal Vent Fauna of the Mid-Atlantic Ridge. *Advances in Marine Biology*, **32**: 93-144.
- Mironov A.N. 1994.** Bottom faunistic complexes of oceanic islands and seamounts. *Trudy Instituta Okeanologii*, **129**: 7-16. [In Russian].
- Tunnicliffe V. & Fowler M. 1996.** Influence of sea-floor spreading on the global hydrothermal vent fauna. *Nature*, **379**: 531-533.
- Tunnicliffe V., Fowler C.M.R. & McArthur A.G. 1996.** Plate tectonic history and hot vent biogeography. In: *Tectonic, Magmatic, Hydrothermal and Biological Segmentation of Mid-Ocean Ridges* (C.J. MacLeod, P.A.Tyler & C.L.Walker eds), Geological Society Special Publication **118**, pp 225-238.
- Vinogradova N. 1997.** Zoogeography of the Abyssal and Hadal Zones. *Advances in Marine Biology*, **32**: 325-387.