Functional traits, rather than taxonomic identity, determine the fitness of individuals in their environment: traits of marine organisms are therefore expected to vary across the global ocean as a function of the environment. Here, we quantify such spatial and seasonal variations based on extensive empirical data and present the first global biogeography of key traits (body size, feeding mode, relative offspring size and myelination) for pelagic copepods, the major group of marine zooplankton. We identify strong patterns with latitude, season and between ocean basins that are partially (c. 50%) explained by key environmental drivers. Body size, for example decreases with temperature, confirming the temperature-size rule, but surprisingly also with productivity, possibly driven by food-chain length and size-selective predation. Patterns unrelated to environmental predictors may originate from phylogenetic clustering. Our maps can be used as a test-bed for trait-based mechanistic models and to inspire next-generation biogeochemical models.