The study of the Ediacaran biota has commonly been based upon analogy rather than homology, due to the paucity of morphological data. Here, we present a new methodology for the analysis of the geometry and biological relationships of such extinct groups. As such, the concept of the theoretical morphospace is developed to provide an insight into enigmatic fossil taxa. Using this technique, we reject direct affinity of Ediacarans with the Pennatulacea and all affinity to the Xenophyophorea, which have also been examined. We suggest that the latter group are better considered as derived Foraminiferida. The occupation of morphospace is examined with respect to the evolutionary constraints of internal communication, structural support and surface area elements, which can be linked through graph theory.