***“β-diversity as defined by Whittaker (1960, 1972) is a measure of variation in species composition from place to place and is comprised of two processes (Baselga, 2012): the replacement of species independently of the difference in species richness (called “turnover,” βsim) and a term that considers this difference in species richness called (“nestedness-resultant,” βsne). The relative contribution of these two processes is not immediately evident from species dissimilarities, and yet such considerations should be implicit in macroecological studies.” Please discuss what Smit et al. (2017) meant when they wrote that paragraph, and explain why this matters.*** (10 marks)

*β*-diversity is a concept that describes how species assemblages (communities) measured within the ecosystem of interest varies from place to place, *e.g.* between the various transects or quadrats used to sample the ecosystem. *β*-diversity results from habitat heterogeneity (along gradients, or randomly).

There are two way in which *β*-diversity might be affected:

**Process 1.** If a region is comprised of the species A, B, C, …, M (*i.e.* *γ*-diversity is 13), a subset of the regional flora as captured by one quadrat might be species **A**, **D**, E, whereas in another quadrat it might be species **A**, **D**, F. In this instance, the *α*-diversity is 3 in both instances, and heterogeneity (and hence *β*-diversity) results from the fact that the first quadrat has species E but the other has species F. In other words, here we have the same number of species in both quadrats, but only two of the species are the same.

**Process 2.** Consider again species A, B, C, …, M. Now, we have the first quadrat with species **A**, **B**, C, D, **G**, H (*α*-diversity is 6) and the second quadrat has a subset of this, *e.g.* only species **A**, **B**, **G** (*α*-diversity 3). Here, *β*-diversity comes from the fact that even if the two places share the same species, the number of species can still differ amongst the quadrats (*i.e.* from place to place) due to one quadrat capturing only a subset of species present in the other.

The above two examples show that *β*-diversity is coupled not only with the identity of the species in the quadrats, but also *α*-diversity.

We express *β*-diversity as ‘nestedness-resultant’ (*βsne*) and ‘turnover’ (*βsim*) components so as to be able to distinguish between these two processes. It allows us to make inferences about the two possible drivers of *β*-diversity. Turnover refers to processes that cause communities to differ due to species being lost and/or gained from section to section, *i.e.* the species composition changes between sections without corresponding changes in *α*-diversity. The nestedness-resultant component implies processes that cause species to be gained or lost, and the community with the lowest *α*-diversity is a subset of the richer community.