How Many Specimens Should one Count to Obtain a Reliable Measurement of Species Diversity? Case Studies of Coccoliths Using Rarefaction Analyses

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ABSTRACT

In biodiversity study, species richness is a function of how many individuals were identified and counted. It has been a long-lasted issue on how many specimens should one count and how to set a protocol with which to compare species diversities among samples of different sample sizes.

This study developed an empirical method that permits one to compare species diversities among coccolith assemblages of different sample sizes. This technique provides also an independent evaluation whether an adequate sample size was approached for measuring the species diversity of a sample. We compared also this empirical technique with the conventional rarefaction method of Hurlbert (1971).

Individual coccoliths produces by unicellular haptophyte coccolithophores and coccoliths were filtered from 1 liter seawater at different water depths at three stations from the South China Sea and one Station in the East China Sea.

At the East China Sea station, both methods showed that species richness can be adequately measured if all the coccoliths from 320 view fields were counted at the magnification of 2000 X under a Scanning Electron Microscope (SEM). Trajectories of species diversities from the two methods are almost identical. We suggest that applying either empirical or rarefaction technique, one can evaluate whether a census has reached the saturation number of species diversity, and meanwhile, one can also choose a standard specimen abundance level at which to compare species diversities among samples. The result suggests that counting of 500 specimens can approach the true species diversities of 20 – 25 at different water levels at this station..

Due to the low abundance of coccolithophoirdes, counting of 320 views' of coccoliths could not get enough specimens to reach the saturation number of species diversity. Nevertheless, although only 9-15 species were encountered in different samples while 100 specimens were counted, the rarefraction curves are stable enough to compare the relative species diversities at different water levels and stations.

要計數多少個體數才能獲取可靠的物種多樣性測量？

——以稀薄化法分析鈣板片為例

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摘 要

在生物多樣性的研究中，每一標本中所鑑得的物種數往往與被鑑定與計數的個體數量有關。到底要計算多少個體？以及如何建立一套準則以比較不同的樣本量中的物種多樣性？一直是長久以來學者們廣為討論的課題。

本研究發展出一套經驗法可用於比較不同樣本的鈣板片集群中的物種數。這個方法也針對測量物種數時對一個標本中的個體計數量是否足夠提供了一個獨立的評估方式。我們將此經驗方法與傳統的 Hurlbert（1971）稀薄化(rarefaction)法相互比較。

我們選擇了三個南海以及一個東海站位，分別過濾了在不同水深所採取的一公升海水，濾得其中所含之單細胞鈣板藻球(coccolithophores)與脫落之鈣版片(coccoliths)標本。

對東海站位標本，我們利用掃瞄式電子顯微鏡，以 2000 倍率檢視了 320 個視野中的鈣板片，，所得到的物種數軌跡線和利用稀薄化法所推得的理論值曲線幾乎是一樣的，因此，這兩種方法皆可適宜地測得物種數。我們認為無論是經驗法或稀薄化法，皆可用來評估計數的個體數是否有達到標本中物種數的飽和值；同時，也可用來決定比較不同樣本中的物種數時所適用之標準個體計數水平。結果顯示在這個站位的各個水深中，計數 500 個鈣板藻可辨識出 20-25 個鈣板片種，得以進行不同水深的物種多樣性比較。

南海樣本中鈣板藻的豐度較低，經計數 320 個視野的個體後仍無法獲得足夠的個體以趨近物種數的飽和值。不過，雖然在不同標本中計數 100 個鈣板片而只辨識出 9-15 個種，各站位及水深標本利用稀釋法所測得的曲線仍具有相當穩定性，足以用來比較各標本的相對物種多樣性。