EXPERIMENTAL PROBLEMS USING ELECTRONIC PARTICLE COUNTERS

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ABSTRACT

The following scheme lists the problems which have been and will continue to be encountered in grazing experiments on natural particle assemblages. In some cases there are solutions, but many of the problems listed below remain intractable. To solve them will require innovative approaches, most probably combining the use of particle counters with other techniques to approach the problem to be solved from several angles at once.

Variance between samples due to
- statistical causes (especially caused by large particles) and
- differences between experimental bottles and between experimentals and controls at start of experiment.

Shifts in particle distribution during experiment due to
- increase in small particles,
- growth of bacteria and other organisms due to excretion of grazers and
- breakage during handling by grazers into fragments.

Processes, independent of grazing, leading to changes in particle size distribution due to
- primary production,
- grazing by additional components and
- bacterial growth on detrital particles and the formation of detrital flocs.

INTRODUCTION

The use of any instrument or instrumental measurement in experiments carries with it its own problems. In the case of electronic sensingzone particle counters (Elzone, Coulter counter) the advantages of using these instruments in experiments where one is interested in knowing the particle size distribution and the changes therein over time, as for example in grazing experiments, are clear: in these instruments one has a tool for a quick and painless enumeration of the number and the frequency distribution of the particles in, usually, water. The facility, with which one can determine size distributions with these instruments has led to their being used widely in limnology and oceanography (BERK et al., 1977; BARLOW & MONTEIRO, 1979; GAMBLE, 1978; RICHMANN et al., 1977). However, as has been made clear in other contributions in this issue, (KERSTING, 1985, BAKKER et al., 1985) the question as to what these instruments really measure is still not fully answered. Data, acquired from grazing experiments by particle-counters, can, but by no means have to, be corrupted by differences in the dielectric constant between living and nonliving particles. This can result in uncertainties in the results.
USE OF PARTICLE COUNTERS IN THE FIELD

Electronic sensing-zone particle counters, such as Coulter counters and Elzone counters are very attractive to use in the field in marine biology because of their ability to evaluate water samples quickly as to their particle spectrum. Using them in water at salinities higher than \( \pm 6.5\% \). S eliminates the necessity to add electrolyte. This implies that estuarine and marine water samples usually can be counted directly without in any way manipulating the composition of the samples.

As has been shown by KERSTING (1985), however, this is true only if a number of conditions are met, of which the most important is the maximum particle-concentration that should not be exceeded, because of coincidence. Some other restrictions exist that make direct counts on untreated samples at least in estuaries and coastal waters difficult. The occurrence of filamentous particles or colony-forming organisms (Phaeocystis) often leads to clogging of the counting aperture, necessitating recounting. When the frequency of occurrence of these particles is high, filtering before counting is necessary. This filtering, to be done over a mesh-size of about the size of the aperture to be used, is dangerous though, because it will alter the particle spectrum to be determined, not only by removing the filamentous and too-large particles but also by damaging and/or destroying fragile forms (SOROKIN, 1981). This is important, because these fragile organisms may be only detected by particle counters and live counts by microscope. As is shown by KLEIN BRETELER (1985) fixation of these organisms is not suitable for quantitative purposes.

The frequency of occurrence of particles in natural assemblages is usually inversely related to their size. Electronic particle counters can, due to coincidence-problems, only handle up to a certain limit of particles per volume (KERSTING, 1985). Small particles will dominate in numbers, if not always in volume and large particles will, because of their low frequency of occurrence and large volume, cause large variations in terms of their volume-contribution. The only solution here would be to sample larger volumes for the large size classes to improve the statistics, while ignoring the small size classes by raising the lower threshold of the particle counter to prevent coincidence problems. However, this will increase the chance of blockage of the orifice.

To reduce both the problems of too high particle concentrations and the occurrence of obstructing particles one could dilute the original sample with filtered water from the same station to a suitable end concentration. This, of course, implies a reduction in statistical accuracy because of the reduction in the number of particles counted.

Including a blank count of the filtrate to establish the background count is very useful because this will also turn up electrical problems in the form of spurious peaks. Electrical problems on board ship are regrettably common, because of the presence of large electrical motors, radar, radiotransmitters etc. Regular checks, especially when very well-defined peaks occur in the particle-spectrum, are necessary.

When a dilution technique is used it is advisable to use very accurate pipettes or other dispensers when taking the sample to be diluted, because any volumetric error is multiplied by the dilution factor.

Another approach is using two counting tubes with different aperture diameters to count the same sample. This procedure is practical with a Coulter counter, because it can be set up with two different tubes. With the Elzone counter, one has to change both the tube and the volumetric section, which carries the risk of spilling mercury. Moreover, the whole procedure is too time-consuming to do it in the time-frame of routine sampling.

USE OF PARTICLE COUNTERS IN GRAZING EXPERIMENTS WITH NATURAL PARTICLE ASSEMBLAGES

Experiments under field conditions need to be done because it is unlikely that one can