Inorganic Nutrients: Nitrogen, Phosphorus, and Other Nutrients

Compounds of nitrogen, and especially those of phosphorus, are major cellular components of organisms. Since the availability of these elements may be less than the biological demand, environmental sources can regulate or limit the productivity of organisms in freshwater ecosystems. Other elements such as iron and sulfur are essential cellular constituents but are required in relatively low concentrations in relation to availability in fresh waters. The major base cations, calcium, magnesium, sodium, and potassium, usually are required in very low quantities, but their concentrations in fresh water can influence the osmoregulation of organisms.

It should be remembered that chemical concentration in water is a static variable, that is, the chemical mass (weight) of an element or compound per unit volume at a particular place or time within the lake. Certain nutrients, such as magnesium and sodium, are relatively conservative in concentration in that their solubility is high, they usually are abundant in relation to metabolic demands, and their concentrations are relatively unaffected by metabolically altered reduction-oxidation conditions of the water. Concentrations of nitrogen and phosphorus compounds, on the other hand, are highly dynamic because they may be utilized, stored, transformed, and excreted rapidly and repeatedly by the various aquatic organisms.

Measurements are further complicated by the chemical form in which the element occurs. Ionic concentrations are often exceedingly low, requiring great care in collection and analysis of water samples to avoid contamination. In general, all equipment and glassware should be cleaned thoroughly with acid, such as 6N HCl, and only high-quality deionized or glass-distilled water and analytical grade reagents should be used.

Storage of water samples before analysis should be avoided. If storage is necessary, the time must be minimized if reliable results are to be obtained. Prompt freezing of water samples or the addition of certain preservatives may be satisfactory for certain analyses but not for others. Storage methods will be discussed specifically in the following procedures.

It is often meaningful to the biologist, from the standpoint of availability, to separate analyses of total nutrient concentrations into those fractions that are dissolved in inorganic and organic states from those that occur in particulate form. This separation is done generally by filtration through glass fiber filters, taking great care to make certain that contamination is not introduced from the filters and filtration apparatus. Separate chemical analyses for the inorganic and the organic components then are performed on each of these fractions.

The following discussion of chemical analyses assumes that samples were obtained with suitable sampling apparatus. By far the most commonly used device is a nonmetallic Van Dorn sampler (Fig. 7.1). This device (Van Dorn,
1956) has the important advantages of being completely nonmetallic at points of contact with the sample and of being simple and relatively foolproof to operate. Available commercially in several sizes, Van Dorn water samplers are lowered slowly to the depth to be sampled. The weighted messenger is dropped down the line to trigger closure of the end cups. Horizontally positioned Van Dorn samplers are also available for sampling in sharply stratified layers, but these tend to disturb the microstrata by their physical movement. Battery-driven nonmetallic or peristaltic pumps also are available to sample at specific depths.

Figure 7.1. The Van Dorn nonmetallic underwater sampler in the open position.