Census of Antarctic Marine Life (CAML)

Methodologies for sampling benthos of deep-sea basins and abyssal plains

Prepared by CeDAMar February 2006

Benthic sampling in great depths presents the challenge of a great time demand, usually beginning with a long journey away from port. Efficiency is therefore of prime importance, as is the careful handling of samples at all times from the moment on they are collected through the transport back to the ship until placement in an aquarium for live observations or fixation for further processing.

Quantitative sampling- samples of a defined surface area

In principle, two size classes can be sampled quantitatively, meiofauna (up to 250 µm body size) and macrofauna (more than 250-300 µm body size). The gear used for meiofauna is the multicorer, a rosette of tubes which collects very undisturbed samples of sediment and overlying water and is most suitable for meiofauna because of the small surface area.

If the sediment permits the employment of a Sandia box corer, which is divided into 10×10-cm subcores, it should be used for macrofauna because it allows for subsampling with a defined area and gentle handling of the sample when extracting the top sediment layer. An undivided box corer is preferable in sediments with stones (e.g., dropstones from icebergs in polar waters or manganese nodules), sand or overconsolidated clay (see also acoustics).

In case of subsampling, different sedimentary parameters can be determined from the same sample as the infauna, including grain size, trace metal contents and concentrations of organics.

For both sampling devices, a pinger should be attached to the wire just above the shackle to determine accurately the distance of the gear to the bottom and bottom contact. The

latter is difficult to deduct from the wire tension only because at great depths the weight of the wire is considerably higher than that of the gear itself, and large open ocean waves obscure the signal further.

Qualitative sampling- samples of greater size but from an undefined area

In great depths trawled gear provides extremely useful information about the species that are present because densities are very low but species richness is nonetheless high. As trawled nets of any kind cover a much larger area than a coring device, it is most advisable to use both types.

Epibenthic sledge
The epibenthic sledge collects macrofauna from the upper layer of sediment, the sediment water interface and the overlying water column to 1m above bottom. It is towed over a distance defined by standardised time limits. Samples are collected in the cod end which consists of a plastic cup with a 300-µm mesh screen on the bottom. If a large amount of sediment was collected, the sample is sieved like those collected with coring devices. Usually the sample can be fixed immediately without sieving and sorted after 48 hours.

Trawl
Large and highly motile animals (megafauna) are caught with a trawl, occasionally also large amounts of sediment which then have to be sieved either entirely or as a subsample of a standardised size (e.g., 5 liters).

Images and video

SPI system

If sampling in a very poorly known area, a sediment profiling image (SPI) system has proven to be a very helpful tool to get a first impression of a large area of the seafloor in a relatively short time. The frame of this system can be outfitted with a surface still photo camera and a video camera aside from the profiling camera which takes a picture of the upper 15-20 cm of sediment against a quartz glass window about 15×20 cm. The camera works like an inverted periscope. The system is battery powered in its current state, but real-time observation via a cable is in principle possible.

Several sedimentary parameters, such as grain size, degree of oxygenation, layering, and biogenic structures (burrows etc.), presence and thickness of an organic fluff layer on the surface, and general flow regime (depositional versus erosional) can be determined from profile images with image analyzer software.

Other instrumentation

CTD

CTD casts are generally the first item at every deep-sea station. The instrument measures conductivity (which is a measure of salinity), temperature and depth continuously through the water column. Temperature can be used for more accurate bathymetry with echosounder because the output of the latter can be corrected for temperature. In poorly sampled areas such as most abyssal plains, existing charts are often insufficient for a safe deployment of sampling gear. Typically, the CTD is equipped with a rosette of water bottles so that water can be sampled at defined depths at the same time the measurements are taken.

Acoustics

Wherever possible and not prohibited by law (e.g., in the Southern Ocean) depth and nature of the sediment are determined by echosounder, usually of the type that points straight down with a narrow beam. A first rough impression of the substrate type helps to avoid empoyment of unsuitable sampling gear. If the sediment is too sandy or consists of hard clay, a box corer may not penetrate the sediment sufficiently or not seal the sample so that it is washed out on the way up. An unsuccessful launch of sampling gear means the loss of several hours of ship time, while a short exploration with the echosounder is performed quickly and time well invested.

Sample processing

Processing for morphology

Samples collected with corers are usually sieved through screens of 300 µm (macrofauna) or 30 µm (meiofauna) mesh size and fixed in buffered 4% formalin in seawater. Macrofauna should be transferred into 70% ethanol after 48 hours (6 months at the latest) to avoid decalcification which will take place even if the formalin is buffered. For the box corer, the most gentle method is extrusion from the subcores because the top layer of sediment is not touched (e.g., by a shovel). Sieving of the upper 10 cm is sufficient to capture amcrofauna quantitatively. However, the lower part of the sediment column should be spot-checked for large animals such as nemertines and echiurids that may live very deep in the sediment. If there is a semifluid upper layer, it should be poured directly into a formalin solution without any sieving to avoid damage wherever possible.

Fixation in alcohol is also possible for morphological investigations but not ideal. Small individuals are apparently penetrated fast enough by ethanol to conserve all features, but formalin is the fixation agent of choice.

Megafauna from trawl catches is photographed as soon as the cod end was emptied onto the deck, prior to any subsampling. The catch is then treated like macrofaunal samples, except that large organisms may be injected with fixation fluid to ensure proper conservation.

Processing for molecular genetics

Organisms to be used for molecular studies must be fixed immediately in cold 96% ethanol and stored cold for at least 48 hours. Ideally, epibenthic sledge or trawl samples should be used because the time consuming sieving can be avoided. In the case of large animals, small pieces of tissue are sufficient so that the specimen can be used for museum collections.