BENTHIC MARICULTURE AND RESEARCH RIG DEVELOPED FOR DIVER OPERATIONS

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A benthic structure has been designed and deployed in 18 meters of water in the center of Buzzards Bay for two years for the purpose of growing mussels and other molluscs. This structure can also be used for settlement and growth studies of other marine species where long-term field experiments are required. The structure is designed to be deployed on the bottom, and extends vertically 3.5 meters above the sediment surface. The food source consists of detritus suspended from the bottom by the tidal stream (Benthic Turbidity Zone). The structure is based on a design that utilizes materials that are readily available, structurally stable in sea water, and are low in cost. Deployment and recovery of the structure can be done with vessels > 7 meters in length. Installation of grow-out ropes, cages, or experiments on the rig by SCUBA divers is facilitated by hooks and snaps which permit rapid attachment or recovery of deployed materials

BACKGROUND

Suspended rope aquaculture is commonly practiced around the world and usually involves a floating surface platform or buoyed system (Davy and Graham, 1982; Huner and Brown, 1985) which maintains the cultured species within the near-surface water associated with high primary productivity. The system described here is a radical departure from existing practice as the growth structure is located on the seafloor and the food resource is nitrogen-rich detritus associated with resuspension of bottom sediment.

Deep muddy areas of estuaries and non-estuarine embayments of New England have been shown to be potential growth sites for commercially important molluscan species, particularly *Mytilus edulis* (Rhoads *et al.*, 1984). Normally filter-feeding organisms do not live on these bottom types because of high fluxes of fine sediments that are resuspended by tidal scour. The high resuspension rates exclude natural settlement of filtering organisms by burying them or otherwise inhibiting survivorship (Rhoads and Young, 1970).

This sediment flux results in a near bottom layer of turbid water called the Benthic Turbidity Zone (BTZ) (Rhoads *et al.*, 1984). This phenomenon is well known to divers who work at depth over these kinds of sediments. The initial purpose for designing the benthic platform was to suspend filter-feeding bivalves above the bottom to avoid smothering settling sediment yet locate them within the BTZ to facilitate feeding on the suspended particles that are nitrogen-rich (Rhoads, Tenore, and Browne, 1975; Tenore, 1977).

Earlier attempts at growing bivalves within the BTZ were based on very small benthic racks (Rhoads, 1973; Rhoads *et al*, 1984). The structure described here was designed to be a prototype platform (unit deployment) for a commercial scale mariculture operation.

DESCRIPTION

The general design of the rig is shown in fig. 1. The main structural member consists of a 6 meter-long air-filled schedule 80 PVC sewer pipe (A). This 12 inch (30cm) i.d. diameter pipe has a wall thickness of 3/8" (0.95cm). The ends of the pipe are water tight by means of PVC-welded hard end caps. This pipe provides a vertical lifting force of 960 pounds (432 kg) and maintains the structure in an upright orientation. Prior to deployment, the pipe was hydrostatically tested by drilling and tapping small holes in each end of the hard caps. The pipe was filled with water and one tapped hole was sealed with a plug. The other tapped hole was fitted with a low pressure gauge and a few pounds of positive pressure were applied. This static pressure was maintained for one hour to insure that the system would be water tight.

Three automobile tires are positioned around the buoyant pipe. These tires are held in their relative positions by pieces of PVC that are welded onto the pipe on either side of each tire. A pair of holes is cut into the tread surface of each tire in order to secure lines for deployment (top of each tire as shown in fig. 1) and a pair of holes are cut into the tread surface at the bottom of each tire to secure the 1 inch diameter (2.54cm) polypropylene anchor lines (B).

Each of the three anchor lines are attached at their lower ends to 500 pound (225 kg) weights. Once deployed, the total negative buoyancy is 540 (1500 - 960 = 540) pounds (243 kg). These three anchor lines pass through a lower structural member; a 6" diameter (15 cm) i.d. "Blue Brute" water service pipe (C). This lower pipe is water-filled and negatively buoyant. This pipe is not secured to the anchor lines. Rather, the lines loosely pass through the pipe through flared 1 inch (2.54cm) PVC guides. The ends of the guide pipes are flared to avoid chafing of the anchor lines when pipe (C) experiences slight lateral or vertical movement. Pipe (C) can move up or down on the anchor lines related to lateral forces by current flow (ca. 25 cm/sec at the Buzzards Bay deployment site) and negative vertical forces by increases in biomass of the cultured species. The purpose of pipe (C) is to maintain tension on the 16 vertical grow-out ropes (D) and to keep the grow-out ropes equally spaced.

The 16 grow-out lines (D) are 3/8" (0.95cm) polypropylene and are easily attached or detached from the rig by means of "S"-shaped metal hooks attached to pipe (A) by two plastic tie wraps. The lower ends of the grow-out lines are attached to eye-bolts in pipe (C) by means of stainless snap hooks. The grow-out lines were spaced approximately 12 inches (30cm) apart.

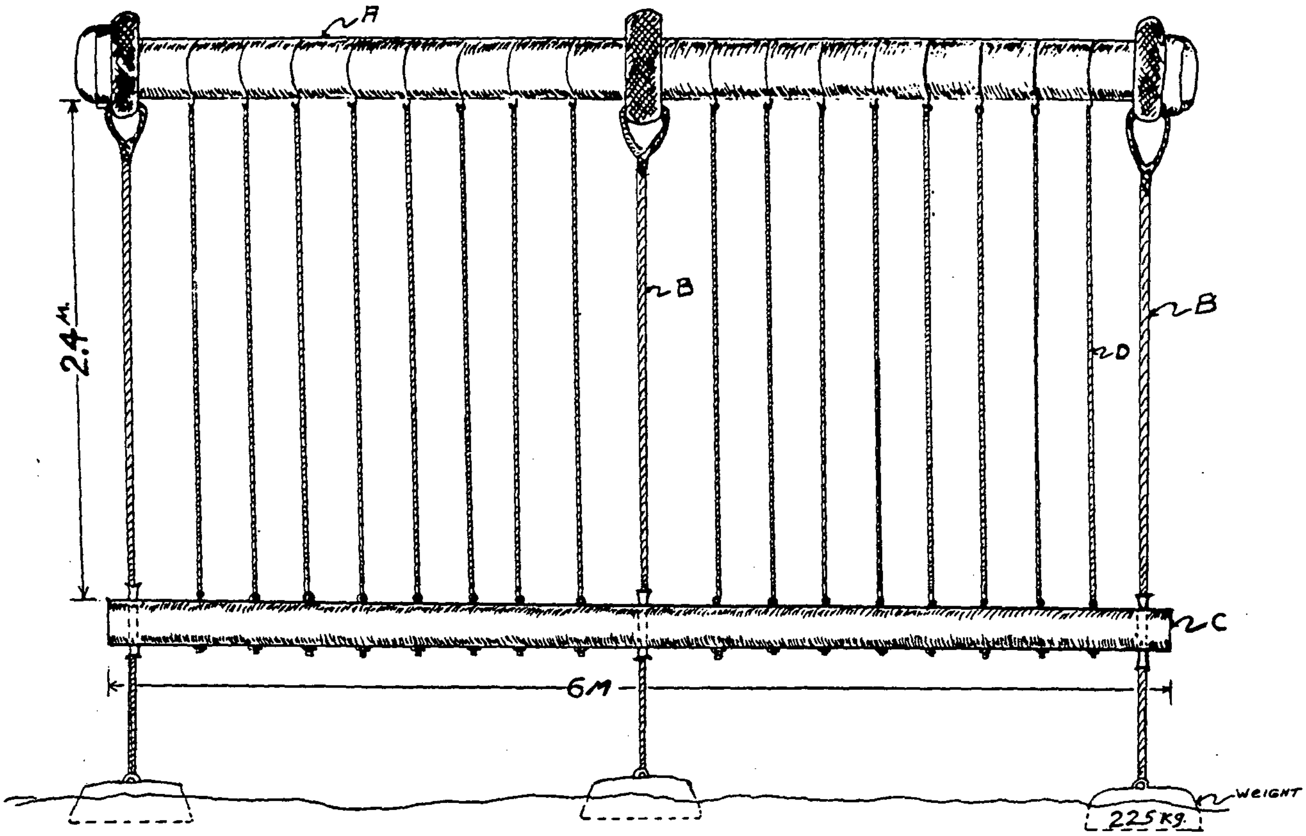

Figure 1. Near-bottom molluscan grow out rig.

We have also secured Japanese lantern nets (10 tiered) at each end of the rig for deployment of scallop, oyster, and hard clams. This was done by extending pipes beyond the ends of the upper (A) and lower (C) pipes. Other configurations can also be utilized with some modifications of the basic rig.

DEPLOYMENT

The rig was transported to the deployment site on July 9, 1987 on the deck of the John A. Edwards (20m). An alternate option would be to tow the rig to the site by utilizing the positive buoyancy of pipe (A) (without weights or anchors). Pipe (A) and pipe (C) can be tied closely together during transport.

Once on site, the entire rig was placed in the water except for the weights which were retained on deck. Each weight was individually lowered with a tag line and the rate of descent of the weights was controlled with a wrap of each tag line around a cleat.

Once deployed, divers descended to inspect the condition and orientation of the rig. Before leaving the site, the LORAN coordinates were recorded and the acoustic signature of the air- filled pipe (A) was noted on the fathometer. The site was marked with a small flotation buoy.

Subsequent dives were made to attach grow-out lines with attached mussel spat. These lines were prepared in the laboratory in advance. The spat were attached to mussel tapes that, in turn, were coiled around each grow-out line. Periodic inspection dives are made to evaluate growth, mortality, and fouling. On July 27, 1987 two ten-tiered Japanese lantern nets were also attached to the ends of the rig for growth of scallops, oysters, and hard shelled clams. All deployed species were recovered on December 1, 1987. The rig has remained at the original deployment site to this date.

DISCUSSION

The main attributes of the rig are that it is constructed of materials that are stable in seawater over extended periods of time. Therefore, maintenance of the structure is low. Also, all materials are stock items and costs can be kept to a minimum if one is able to use surplus or used components. Fabrication and assembly is relatively simple. The only special equipment needed is a PVC welding process.

The deep water deployment of the rig avoids many problems associated with surface rafts such as conflicts with surface traffic, ice, waves, and fouling by plants. Because the deployment can be sited far from shore, and in deep water, the susceptibility to pollution is dramatically reduced.

Another attribute is the ability to find the rig not only by LORAN TD's but also by acoustic sounding. The air-filled pipe (A) has high acoustic impedance and yields a striking return on the fathometer. This is important for efficiently locating the rig if the surface float is lost.

One limitation of this approach is that the location of the bottom rig may conflict with bottom trawling. In the Buzzards Bay case, this is not a problem because trawling is not allowed in the area of deployment. However, this may be a potential problem in other embayments which are trawled.

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