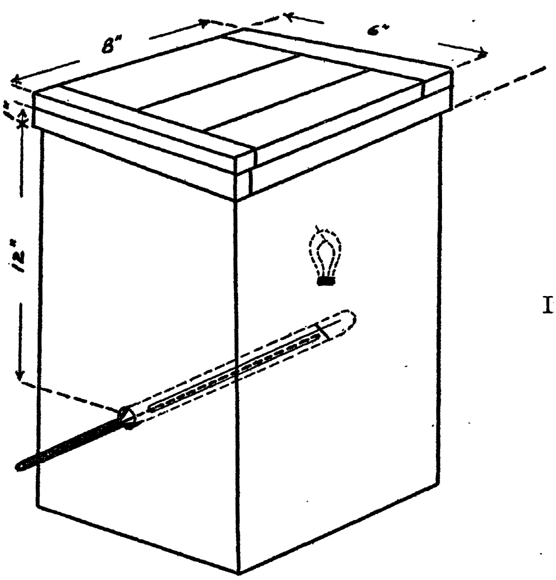
TABLE I

	Mean (Degrees Fahr.)	Standard deviation (Degrees Fahr.)
Standard thermometer	67.77 ± .57	11.00 ± .40
Six's thermometer	67.27 ± .56	10.90 ± .40
(D) Difference	.50	.13
(PED) Probable error of difference	.79	.56
D/PED	.6+	.2+

In use this thermometer is placed horizontally in a boxed pit so that the bulb extends into the soil six inches from the side of the pit. The two ends of the scale rest on the sides of the box within the pit (Fig. 1). When readings are made the cover of the pit is



BOX PIT WITH SIX'S THERMOMETER IN POSITION

removed, the temperatures recorded, the indices drawn back to the mercury by means of a magnet and the pit is again covered. In application the thermometer can be placed at any desired distance from the surface of the ground, within the reach of the observer. Its most practical uses are at six-inch and one-foot depths. Greater depths will require a flashlight for reading and a considerable enlargement of the pit to facilitate resetting.

The principal advantage of the Six's maximum and minimum thermometer in obtaining soil temperatures are: (1) The bulb remains at all times in contact with the soil. (2) Readings can be taken with the least possible exposure of the instrument to the atmosphere. (3) The instrument is relatively inexpensive, costing no more than a single standard instrument. (4) The instrument can be used with satisfactory results under forest conditions even in heavy brush where it is often difficult to reset standard maximum thermometers.

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A QUANTITATIVE CLOSING NET FOR CATCHING PLANKTON ORGANISMS

FOR many years investigators of quantitative distribution of plankton, both of marine and fresh-water types, have recognized the need for a device capable of capturing the organisms in a certain quantity of water. For most of the fresh-water plankton, and for particular kinds of marine plankton, closing bottles have been found to give satisfactory results. But none of these bottles are large enough for many of the important forms of marine zooplankton.

It seems to be generally understood that a net of cylindrical shape is most likely to be practicable for accurate operation in taking a sample of designated size, but it has been found difficult to plan construction which would result in an instrument which could be operated easily and rapidly. After several years of more or less frequent consideration of the problem I have finally developed a design which is simple, fairly easy to operate, and which can be manufactured at moderate cost. Inasmuch as the Scripps Institution is not doing quantitative work with zooplankton at present it may be a considerable time before a model is constructed and I offer this brief note so that others can make use of the idea if they have need for such equipment.

In outer view when closed the net is a cylinder with metal ends connected by side walls of cloth (*e.g.*, No. 12 silk or No. 000 linen). A median sectional view in approximately half-open position is roughly indicated in Fig. 1. The sliding wheel (S) to which the lower edge of the cloth is attached has been raised from the bottom plate (B) to which it was tightly fastened when closed. The cloth (F) is thrown into folds between the margins of S and the top plate (A). The central support and guide rod (C) is left exposed to view by lifting of the fabric.

The bottom plate (B) is offset upward in the center to form a dome into which the central rod (C) can be fixed, and through the open sides of which water can drain from the plate into the detachable cup (R) indicated by the dotted line beneath. Plate B must be heavy and rigid to prevent distortion and consequent ill fit when the wheel (S) joins it to close the net and prevent escape of enclosed organisms. Its margin must be recessed or otherwise provided with accurate means for holding the hook or pin fasteners on the sliding wheel (S) at closing.

The central supporting rod (C) should be square or otherwise shaped to prevent twisting of the net in opening and closing.

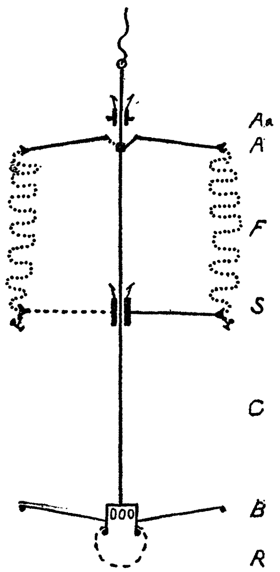

FIG. 1. Allen closing net. About half open to show main features of design. For explanation see text.

The sliding wheel (S) must be heavy and rigid to insure rapid and accurate closing after release by messenger at the desired depth. Its rim must be flanged in order to hold securely the lower end of the hollow cylinder of filtration cloth (F) which can be tied to it. The flanged rim should be connected to the central hub by enough spokes to prevent warping of the wheel. The hub must have enough length to avoid binding and it must fit the rod (C) loosely enough to allow free sliding. On the upper end of the hub must be set catches to hold the wheel near the top plate (A) until released by messenger.

The filtration walls (F) should be made of cloth appropriate in size of mesh to the organisms to be caught. If made up as a hollow cylinder just large enough to slip over the end plates and sliding wheel one kind of cloth can be quickly detached and another kind tied in its place on the flanges of S and A.

The top plate (A) must be flanged at the margin for attachment of the filtration cloth as on the sliding wheel (S). In order to prevent too great accumulation of organisms on the folded cloth while descending to the desired level the plate must have an opening at its center. Therefore, it must be supported on arms (or braces) rigidly attached to the supporting rod (C).

The top plate valve (Aa) must have considerable weight because when released by the cable messenger it must in closing the top plate opening act in turn as a messenger to release the sliding wheel (S) to close the net. On its top it must have catches to hold it up until released by the cable messenger.

In operating (at least at sea with a rolling and pitching boat or ship) it will be necessary to attach a pendulum stabilizer, perhaps a window weight at the end of fifty feet of line. For suspension of this stabilizer it will probably be best to attach a stirrup to the bottom plate (B) astride the drain cup.

It seems fairly certain that this net (which is to be operated in the vertical position) can not avoid a slight error through entangling some organisms at higher levels while descending to a selected level. But, with the central opening in the top plate, this error should be negligible quantitatively.

It is obvious, also, that the weak point in the design is the possibility of leakage between the sliding wheel (S) and the bottom plate (B) when the net is closed around a catch. If the joint is tight enough to prevent passage of the organisms being sought leakage is not important, but its possibility must be considered at all times. Since most fabrics used for zooplankton will allow quick drainage through filtration orifices as the net leaves the surface of the water when being hauled in, it seems improbable that much pressure will be exerted against the joint. Therefore, if its faces are ground to fit loss should not occur even if no fasteners be used.

I have in mind a modification of this design whereby the net could be closed by upward instead of downward slide of the sliding wheel, but its structure and operation would be so unwieldy that it can hardly be as practicable as the basic design.

Judging from my three years of experience with fresh-water plankton of the San Joaquin River a closing net to handle one hundred liters of water would be satisfactory for fresh-water organisms. A cylinder 42 centimeters in diameter and 74 centimeters long would enclose 102.4 liters.

Experience and information available from many years of plankton work in the ocean waters of southern California indicate that a net filtering one hundred liters will also be satisfactory for much of the marine zooplankton. However, there is much work for which larger closing nets are desirable. A cylinder 60 centimeters in diameter and 90 centimeters long would enclose 254 liters, and 505 liters could be taken with one 76.2 centimeters in diameter and 110 centimeters long. It seems doubtful that the design would be practicable for a net of greater capacity than one half of a cubic meter.

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