A NET-CHANGING MECHANISM FOR THE LOWESTOFT MULTIPURPOSE SAMPLER

By

D. HARDING, E. SHREEVE, D. S. TUNGATE
and D. MUMMERY

Fisheries Laboratory, Lowestoft, Suffolk, England

A net-changing device for use with the Lowestoft multipurpose sampler is described. The unit consists of four nets mounted on stainless steel rods which are spring loaded and slide between stainless steel runners. The nets are held by metal "fingers" when not fishing, and by operating an electric motor they can be released instantaneously to the fishing position. Water enters the net through a standard nose cone via a trumpet-insert of fibreglass. The amount of water filtered is registered by an electric flowmeter mounted in the nose cone, and the depth at which the sample is taken is recorded by a pressure transducer. Nets can be selected by depressing a switch on the control unit, and the flow, depth and number of the net fishing register on meters mounted in the same unit. The underwater electronic equipment is connected to the console in the deck laboratory by a stainless steel multi-core electric cable via the slip rings of the winch. Results are given from a typical haul.

INTRODUCTION

The Lowestoft multipurpose high-speed plankton sampler (BEVERTON and TUNGATE, 1967) has been used for routine surveys in the shallow seas around the British Isles since sea trials showed that a high-speed sampler was more efficient than a standard plankton net for catching the larger and more mobile plankters, particularly fish larvae (BRIDGER, 1958).

The multipurpose sampler is normally fished to within 1 fathom of the sea bottom from a vessel steaming at 5 knots. It is shot and hauled at a constant warp speed, and the depth to which it fishes is controlled by adjusting the length of the towing cable. This type of haul samples each interval of depth equivalently, but the samples obtained give no information about the depth at which the organisms are most abundant. For this reason an opening and closing net, which can be fished in the same manner and which is capable of collecting uncontaminated samples from selected depths, is needed. This paper describes a net-changing mechanism which has been fitted in the Lowestoft sampler and which has proved effective for studying the depth distribution of pelagic fish larvae.

DESCRIPTION OF THE SAMPLER

The mechanism is based on the principle already used in the Bé multiple bathymetric plankton sampler, where nets are changed in sequence as the sampler is hauled from one depth interval to the next (BÉ, 1962).

The net-changing mechanism fitted to the Lowestoft multipurpose sampler has five sliding stainless steel bars to which nylon plankton nets of 24·6 meshes

J. Cons. int. Explor. Mer | 33 | No. 3 | 483–491 | Copenhague, Mai 1971

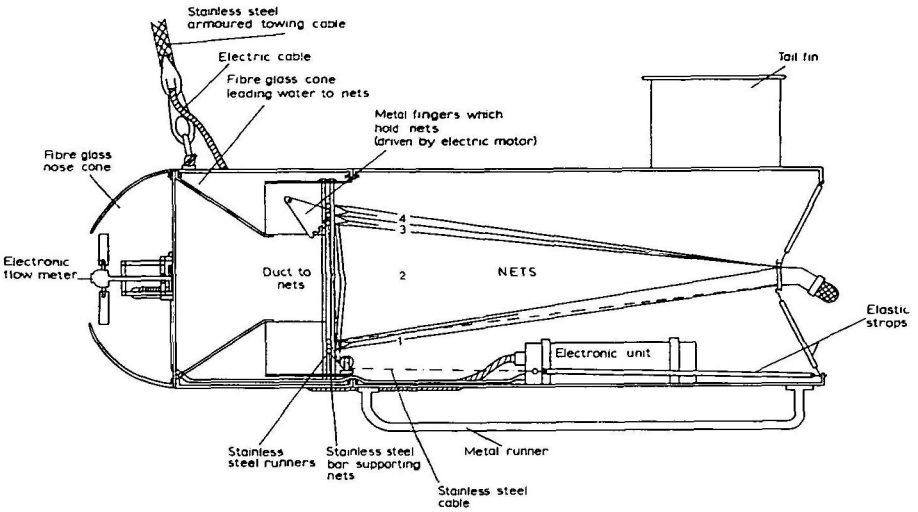

Figure 1. Diagram of the changing-net unit mounted on a standard 76·2 cm (30 inch) multipurpose sampler.

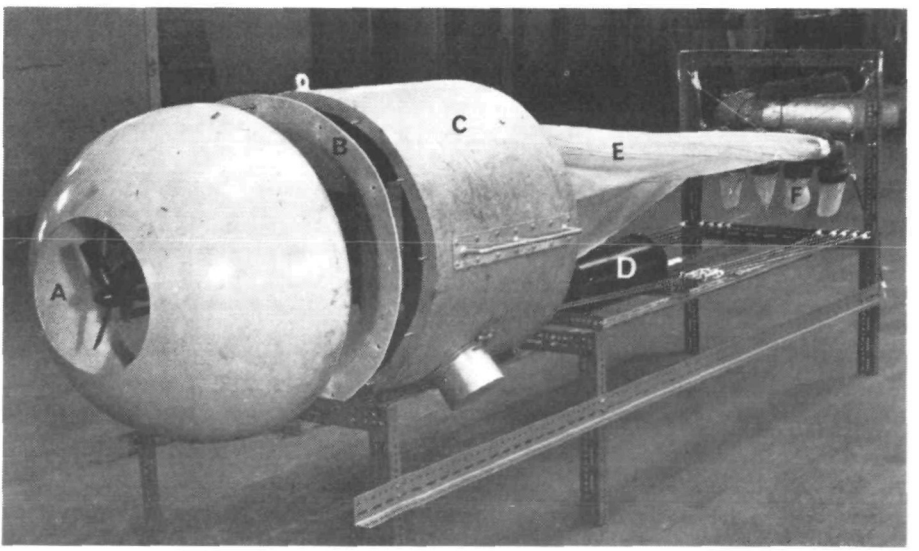

Figure 2. The changing-net plankton sampler as set up for testing in the laboratory, showing the positions of: (A) the electric flowmeter mounted in a standard nose cone; (B) the trumpet; (C) the 76·2 cm (30 inch) metal cylinder containing the changing mechanism; (D) the encased electronic control unit, and the four nets (E), fitted with buckets (F) and retaining springs (G).

per cm (62 meshes per inch) are attached by canvas sleeves. These bars are held in the loaded position by metal "fingers" which can be rotated through an arc of 180° by a geared electric motor, thus releasing the nets into the fishing position. The bars on which the nets are mounted are tensioned against the motor by 0·64 cm ($\frac{1}{4}$ inch) diameter elastic strops, which spring the nets into the fishing position as each is released. An electric sensor indicates the release of each net, and an electric flowmeter mounted in the nose cone records the flow rate of water entering each net through a trumpet-shaped fibreglass duct. The depth at which the sampler is fishing is also registered by an electrically recording pressure transducer. The underwater electrical components are contained in a waterproof case within the main body of the sampler, and are linked by 1·03 cm (0·405 inch) diameter stainless steel armoured 6-core electric cable via the slip rings of the winch to a console on board ship. The console is fitted with recording dials for the flowmeter, depth gauge and net sensor,

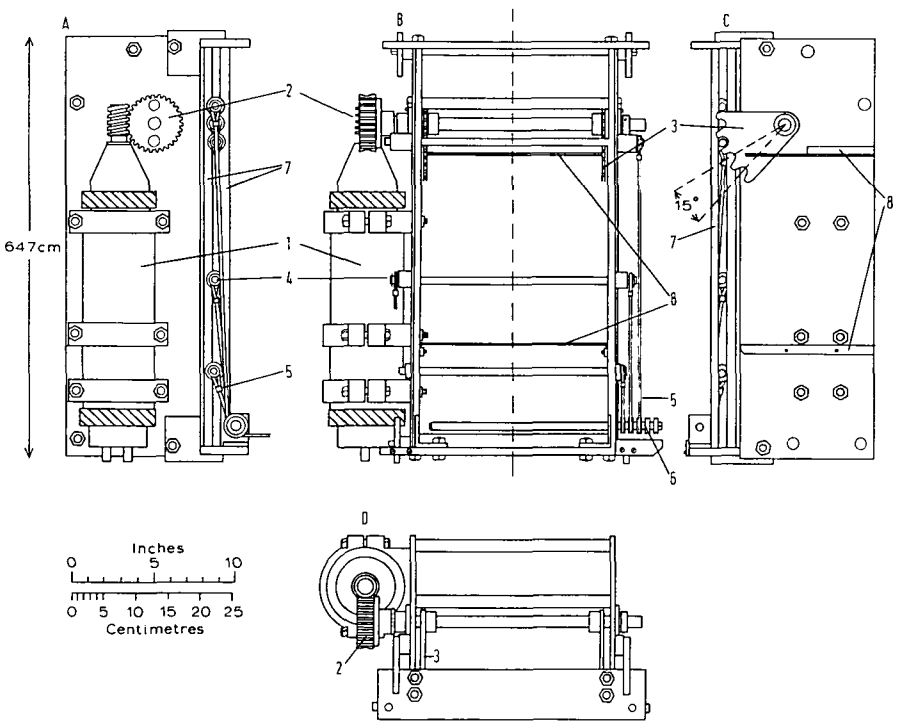

Figure 3. Scale drawing of the net-changing mechanism showing: (A) the left side view of electric motor mounted on frame, positions of sliding bars and attachments of elastic strops; (B) the rear view of the mechanism; (C) the inside view of the left side of the frame with metal fingers; (D) the top view of the motor and drive to release mechanism. (1) Electric motor; (2) geared drive to net supports (metal fingers); (3) net supports; (4) stainless steeel sliding bars which carry the nets; (5) stainless steel cable which is linked to the elastic strops; (6) pulleys for stainless steel cables; (7) stainless steel round bars in which net supports slide; (8) ducting to net.

and switches which control the motor for the net-release mechanism. The schematic layout of the sampler is shown in the diagram (Fig. 1) and an exploded photograph of the unit without the main case in the photograph (Fig. 2).

THE NET-CHANGING MECHANISM

The mechanical part of the sampler is contained in a 1·5 mm (1/16 inch) gauge galvanized iron tube 76·2 cm (30 inches) in diameter and 60·96 cm (2 feet) in length. It is constructed of galvanized mild steel plate to which are bolted two pairs of 1·27 cm (½ inch) diameter parallel stainless steel rods. Between them are five vertically sliding stainless steel rods of the same diameter to which the nets are attached. Short lengths of 2 mm diameter stainless steel rigging cable are attached to both ends of each sliding bar. These cables pass over brass pulley wheels and a nylon roller guide mounted at the base of the vertical bars, and are linked with the elastic strops attached to the main body of the sampler. Two sets of metal fingers are mounted on a stainless steel shaft supported on brass bearings and coupled to the electric motor by a worm gear (Fig. 3). The whole unit in its casing is bolted to the front end of a standard 76·2 cm (30 inch) multiple sampler.

The nets are attached to the sliding rods by canvas sleeves; the bottom margin of the first net is attached to the first sliding rod, its top margin and the bottom margin of the next net are both attached to the next rod, and so on to the last net which has its top margin attached to the last sliding rod (Fig. 4). A trumpet-shaped fibreglass insert is placed between the nose cone and the changing mechanism and serves to duct all the water into the channel leading to the fishing position. This duct also prevents water flowing around

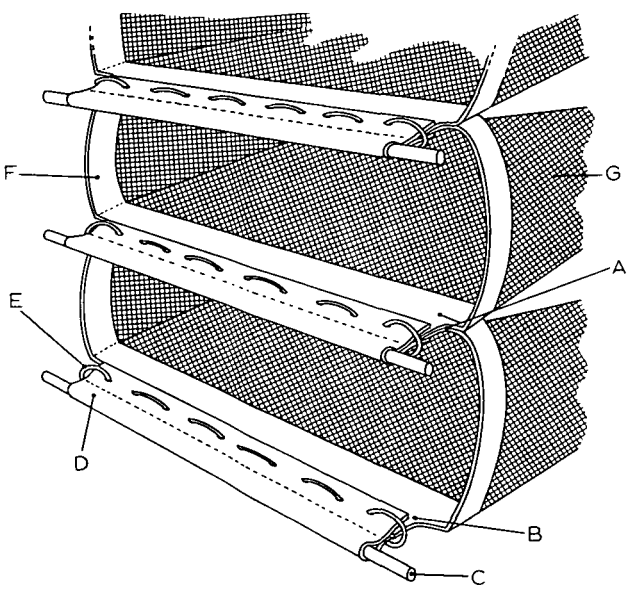

Figure 4. Diagram of method by which the nets are attached to the sliding bars.

the changing mechanism and entering the nets which are not in the fishing position. Before fishing the nets are folded in the top of the sampler and held in position on their sliding bars by the metal fingers and the rubber elastics stretched to tension the bars against the geared motor. In this position water entering the nose cone passes beneath the nets and no sample is taken.

THE ELECTRONIC CONTROL UNITS

The electronic components include underwater and deck units connected by a 1·03 cm (0·405 inch) diameter multi-core electric cable which has an outer armouring of stainless steel strands. The underwater units consist of (i) a flowmeter; (ii) a net indicator; (iii) a waterproofed 24 volt 4 amp electric motor and (iv) a water-tight case containing the transformer, rectifiers, underwater circuits and pressure transducer. Item (i) is mounted in the nose cone; items (ii) and (iii) are mounted on the frame of the changing-net mechanism; and item (iv) is normally mounted inside the main body of the sampler. Connections between these underwater electrical components and the cable are made with "Mᶜmurdo" underwater plugs (Fig. 5).

The deck unit or console displays meters which record the flow rate and depth, an electromechanical revolution counter, a net indicator and switches to control the motor. There are also outputs to a data logging system and a chart recorder.

THE FLOW-RATE UNIT

An alloy disc 7·62 cm (3 inches) in diameter with 50 mild steel inserts set at equal distance around its periphery is mounted on the propeller shaft of a standard flowmeter (TUNGATE and MUMMERY, 1965). Changes in the flux density occur as this disc rotates and are detected by a permanent magnet transducer. The sine wave output from the transducer is amplified and shaped in the underwater flow circuit (Fig. 5). The resultant square waves are fed through the multi-core towing cable and slip rings to the console, where the rate of flow is displayed on a moving coil meter calibrated to read from 0 to 4 rev/sec. Total revolutions of the flowmeter are recorded on an electromechanical counter. It is arranged that one revolution of the propeller will produce 50 pulses, and so by dividing the total pulses by 5 and again by 10 the electronic switch will operate the electromechanical counter once for each propeller revolution.

THE DEPTH INDICATOR

The depth of the sampler is also displayed on a moving coil meter and a permanent record may be obtained by using a paper recorder. A Bourdon tube type pressure transducer forms part of a Wheatstone bridge circuit (Fig. 5). Meter M1 and the paper recorder register fluctuations of circuit current caused by changes in resistance due to pressure changes within the transducer. The transducer and associated circuits are calibrated against a standard pressure gauge to read from 0 to 30 fathoms on the meter or paper recorder.

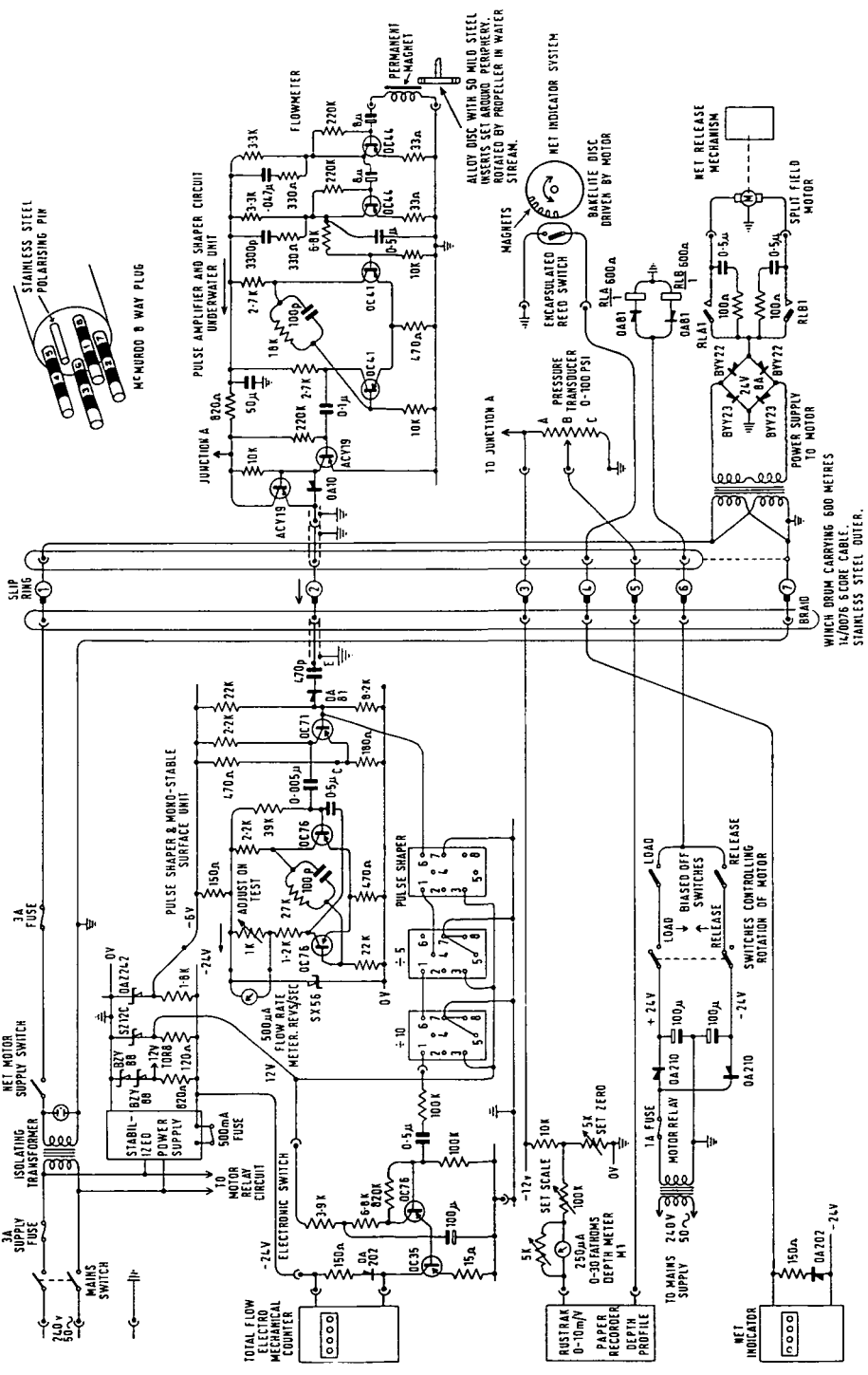

Figure 5. Electronic circuits for the vertical layer sampler.

THE NET-RELEASE AND INDICATOR SYSTEM

A split field motor is used for releasing and loading the nets. Direction and rotation are controlled from the surface display unit by switches SB and SD (Fig. 5). The power required to drive the motor is supplied by the transformer and rectifiers mentioned in (iv) above from a 240 volt A.C. generator aboard the ship. An encapsulated reed switch and a bakelite disc with five magnets accurately set around its periphery form the net indicator unit. The bakelite disc is driven by the net-release motor shaft. As a magnet approaches, the reed switch closes and energizes an electromechanical counter on the surface display unit. When the net is released to the fishing position the reed switch opens and the counter registers one whole unit.

METHOD OF OPERATION AT SEA

The 76·2 cm (30 inch) multipurpose sampler, complete with a net-changing unit, can be handled on board ship in exactly the same manner as a standard sampler (BEVERTON and TUNGATE, 1967). In practice, however, the modified

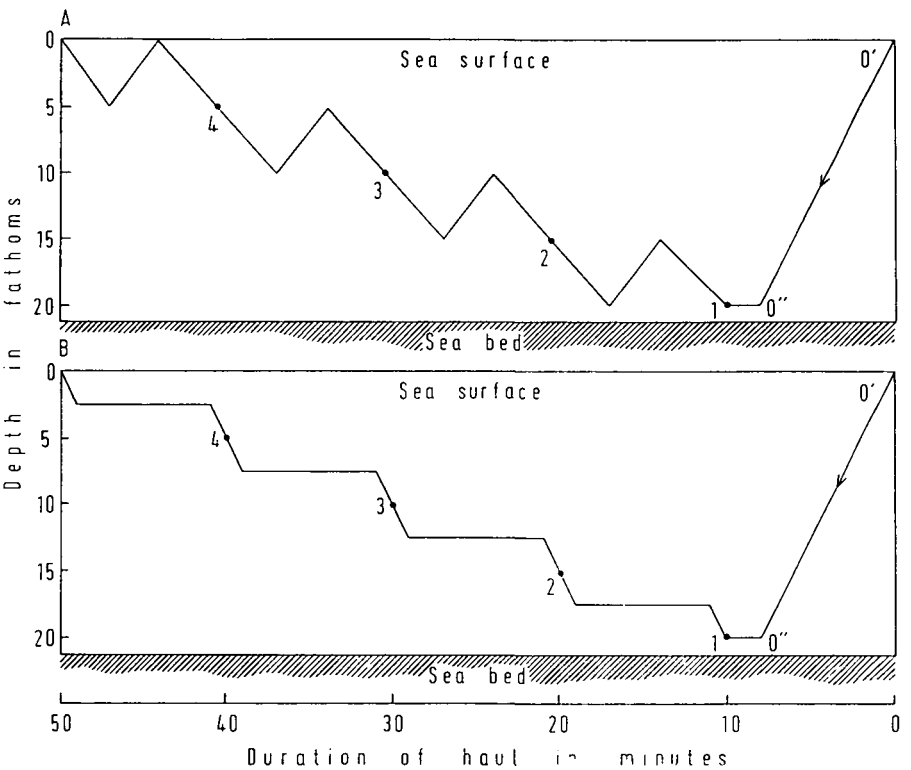

Figure 6. Diagram of diving profiles. Initial dive 0′–0″; 0″–1 calibration haul without nets; numbers 1 to 4 indicate positions at which nets are changed. A vertical oblique hauls within selected levels. B Horizontal hauls atselected levels;

sampler has normally been fished from the deepest level to the surface, changing the nets at selected levels and sampling four layers of water in succession.

The unit is loaded on deck with all four nets folded away at the top of the sampler and held in position on their supporting bars by the metal fingers. It is then lowered to the deepest level to be fished. Since no nets are fishing during this dive, the amount of water passing through the nose cone and unobstructed by the net can be measured. For this the sampler is held at a constant level, while the numbers of revolutions of the electric flowmeter are timed and the flow rate recorded.

At the deepest point to be fished the first net is released into position by allowing the motor to drive the metal fingers down by 15°. The net is sprung into place by the elastic strops, the number of the net fishing is registered on the electromechanical counter on deck and the motor is switched off. This net can now be fished for any desired period within the depth interval required. The amount of water filtered by the net and the rate of flow are registered continuously by the flowmeter. On moving up to the next level, the net-changing procedure is repeated and the next net is fished. This sequence is repeated until each of the four nets has been fished and the sampler recovered on board. Diagrammatic representations of the paper traces for typical hauls are shown in Figure 6. Reloading is carried out by reversing the motor and driving up the metal fingers against each of the net-supporting bars in turn, after first releasing the tensioning spring. This procedure is generally carried out on deck as the nets are being washed down, and once completed the bars are retensioned with the elastic strops, the trumpet and nose cone are replaced and the net is then ready to be fished again.

The time taken to sample each level depends on the operator and can be varied according to the plankton conditions, either to avoid clogging the nets or to collect a large enough sample of material. Hauls lasting 10 minutes at each level sampled have been found to give adequate material. Thus the time taken to collect a series of samples from 25 fathoms to the surface is normally

TABLE 1. Numbers of fish larvae per 100 cubic metres in the Great Orme spawning area of the Irish Sea; 0200 hours GMT, 7 June 1966

Species of fish larvae	Net 1 0–1 fm	Net 2 5–10 fm	Net 3 10–15 fm	Net 4 15–20 fm
Solea vulgaris	969	599	564	526
Limanda limanda	969	1 334	1 260	1 870
Platichthys flesus	105	34	0	22
Merlangius merlangus	288	428	188	246
Gadus morhua	52	0	0	0
Trisopterus luscus	0	51	19	67
Trisopterus minutus	0	0	19	0
Clupea sprattus	681	496	432	314
Callionymus lyra	1 520	1 146	620	1 154
Onos sp.	26	0	38	123
Pholis gunnellus	26	34	38	0
Ammodytes sp.	26	34	56	0
Ammodytes post-larvae	0	17	0	45
Raniceps raninus	0	34	0	0
Gobius sp.	105	0	56	101
Others	0	34	0	0
Totals	4 767	4 241	3 290	4 468

less than 1 hour, and the whole procedure of fishing, washing down the nets and reloading takes a maximum of $1\frac{1}{2}$ hours.

The apparatus described has been successfully used to investigate vertical distributions of marine fish larvae around the British coasts. One typical series of results is shown in Table 1.

FUTURE DEVELOPMENTS

Certain additions to the net-changing device are envisaged to improve its value in studying vertical plankton distributions. It is proposed to include instruments to measure temperature, salinity and light at the same time as the sample is taken. A mechanism is also being considered for opening and closing larger nets such as the 1 metre Boothbay Harbour net, and for a sledge-mounted net, which would extend the working range much closer to the sea bed.

REFERENCES

Bé, A. W. H., 1962. "Quantitative multiple opening and closing plankton samplers". Deep Sea Res., **9**: 144–52.

Beverton, R. J. H. & Tungate, D. S., 1967. "A multipurpose plankton sampler". J. Cons. perm. int. Explor. Mer, **31**: 145–57.

Bridger, J. P., 1958. "On efficiency tests made with a modified high-speed townet". J. Cons. perm. int. Explor. Mer, **23**: 357–65.

Tungate, D. S. & Mummery, D., 1965. "An inexpensive mechanical digital flowmeter". J. Cons. perm. int. Explor. Mer, **30**: 86.