EDINBURGH

INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH — CRUISE REPORT

IMER/FCPR/1/76

VESSEL — S.V. FATHOMER II

CRUISE PERIOD — 1-4 November 1976

PERSONNEL — J. Aiken (Senior Scientist)
G.B. Wood
J. Moon

ITINERARY

30-31 October	Equipment and personnel travelled to Falmouth
1 November am	Mobilization
12.30 hrs	FCPR trials Falmouth Bay
2 November	Trials continued
3 November	Trials continued
13.30 hrs 4 November	FCPR trials completed
4 November pm	Demobilization
4 to 6 November	Equipment returned to Edinburgh

OBJECTIVES

1. To investigate the towing performance of two prototype Fast Continuous Plankton Recorders (FCPRs).

2. To compare, where possible, the sampling performance of the prototype FCPR and the Continuous Plankton Recorder.

3. Measure the envelope of depth, speed, cable length and tail plane attitude of the FCPR to assess its potential for a limited depth Undulating Oceanographic Recorder (LDUOR).

METHODS — See Cruise Programme

EQUIPMENT FAILURES — No flow measurements were obtained because of a fault in the cable to the flow sensor.

All other equipment performed reliably.

RESULTS — Forty-two tows were completed satisfactorily. A tow summary is given in Appendix 1. Objective one was investigated thoroughly (28 of the 42 tows); the remaining 14 tows were devoted to objective 3. No comparative sampling investigations were possible (objective 2) as it was not feasible to tow a CPR and a FCPR simultaneously.

Both FCPR's towed extremely stably, showing no tendency to deviate from the astern position and only surfacing when the tail plane was set to make the recorder tow shallow. When on the surface, the FCPR's towed stably astern (like a water-skier) with no violent snatching of the towing cable which characterised surfacing incidents with the CPR. The stable performance was confirmed by the measurement of the roll parameter of the FCPR "in situ". In most cases the mean roll was within 1^{o} or 2^{o} of zero with maximum fluctuations of $\pm 5^{o}$ corresponding to conditions when the vessel was rolling heavily; when heading into the sea, the rapid pitch motion of the vessel was transmitted to the FCPR and roll fluctions were less than $\pm 2^{o}$. The mean roll was greater than 5^{o} on only two occasions (Tows 29 and 30, FCPR 2, tail plane setting $+ 15^{o}$ (maximum)), increasing from zero at 6 knots to a maximum of 15^{o} port-down at 17 knots; the increasing roll displacement with speed is indicative of a simple mis-alignment of the trim.

In most respects the towing performance of the FCPR conformed to design expectations. At a fixed tail plane setting, the FCPR towed with a constant pitch angle and a near constant depth over a speed range 10-20 knots. In this condition the depth of towing could be pre-set by choosing the appropriate tail plane angle and length of towing cable.

This performance was achieved by ballasting the FCPR for zero pitch angle in water at zero speed (i.e. the centre of gravity in water was positioned below the towing eye). With this arrangement the pitch of the body when towed was extremely sensitive to the angle of the tail plane. With no diving plane, diving forces were developed solely by "negative-lift" forces on the under surface of the FCPR which increased with greater nose-down pitch angles.

Stable towing at circa 10 m depth was obtained for a variety of tail plane settings and towing cable lengths. A tail plane angle of + 7½° was found to be optimum with about 20m of cable in water, 0.4in high tail fins and towing eye position No 2 (0.32m from the nose of the FCPR at the position of the centre of gravity in water). With these settings both FCPR's towed with a constant pitch of 7° nose-down over the speed range 8-18 knots and the depth characteristics were within 0.5m decreasing from about 12.5m to 9m over the same speed range. For a tail plane angle of +10°, and only 16m of cable in water, a depth of 10m was maintained over the speed range 10-18 knots but with the FCPR pitched 12° to 15° nose-down. The pitch of the FCPR was near zero with the tail plane set at +5° but the recorder surfaced at about 12 knots unless No 3 towing eye (0.35m from the nose) or higher (0.45m) tail fins were used; in both cases the pitch was restored to circa 5° nose-down.

Appendix 2 summarises the depth performance of the FCPR for different lengths of cable, different tail fins and tail plane angles at three speeds; 10 knots (typical research ship cruising speed), 14 knots (top research ship speed/average merchant ship speed) and 18 knots. With 25m cable in water, 15° of movement of tail plane angle caused a change of depth of 15 to 20m at speeds from 10 to 18 knots; with 50m of cable in water, 20 to 30m of depth variation was achieved and with 80m of cable in water, 25 to 30m of depth variation. It seemed that the longer lengths of cable did not produce proportionally greater depth capabilities; this is as anticipated, since the diving forces which can be generated by the body alone without diving planes are limited and unable to overcome the increasing drag forces from the longer lengths of cable. Without modification the body in its present form would have a maximum undulation amplitude of 30m if used as a Limited Depth Undulating Oceanographic Recorder (LDUOR). With wholly or partially faired towing cable, this amplitude would be significantly improved (perhaps to 50 to 60m for the longer cable lengths).

The plankton sampler transport system worked satisfactorily throughout the cruise with transport rates close to 1 division/5 miles.

CONCLUSION/

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1. The performance of the FCPR was completely satisfactory at speeds up to 18/20 knots and should be a suitable replacement for the standard CPR at any speed.

2. Further tests are necessary to compare sampling performance between the CPR and FCPR.

3. Operational tests from merchant ships are recommended to test sampling performance and gain operational experience.

4. As an LDUOR, the undulation amplitude would be limtied to 30m with 80m unfaired cable in water.

Prepared by: J. Aiken

Approved by: R.S. Glover

Date: 16.12.76

APPENDIX I. TOW SUMMARY

Tow No.	FCPR No.	Tail Fin	Plane Angle	Towing Eye	Cable Length (m)	Speed Range knots	Depth Range (m)
1	1	1	0°	2	20	6-8	8.7-0
2	1	1	+5°	2	20	6-12	12.3-0
3	1	1	+5°	2	25	6-12	14.8-0
4	1	1	+10°	2	20	6-17	13.5-9
5	1	1	+7⅓°	2	20	6-18	13.6-8.1
6	1	1	+7⅓°	2	25	6-17	14.2-9.2
7	1	1	+7⅓°	2	30	6-18	19.2-10
8	1	1	+7⅓°	2	35	6-17	18 -11.7
9	1	1	+15°	2	20	6-17	13 -10.5
10	1	1	+15°	2	30	6-16	20 -16.5
11	1	1	+5°	2	30	4-19	14.8-4.3
12	1	1	+5°	2	60	10-18	9.5-4.3
13	1	1	+5°	3	20	6-19	13.1-4.8
14	1	1	+5°	3	25	8-18	8.6-6.0
15	1	1	+5°	3	60	8-18	16.2-13.6
16	1	1	+5°	3	30	8-17	12.2-7.9
17	1	1	0°	3	20	6-10	12.6-0
18	1	1	0°	3	30	8-10	5.0-0
19	1	1	0°	3	60	8-12	7.9-0
20	1	1	+10°	3	20	6-16	13.5-10.5
21	2	1	0	2	30	6-10	14.1-0
22	2	1	+5°	2	30	6-13	16.8-0
23	2	1	+7⅓°	2	20	6-18	12.4-6.6
24	2	1	+7⅓°	2	25	10-18	11.0-7.6
25	2	1	+7⅓°	2	60	10-18	18.8-13.7
26	2	1	+7⅓°	2	30	10-18	12.1-9.3
27	2	1	+10°	2	30	6-18	18.9-12.1
28	2	1	+10°	2	60	10-18	22.3-18.9
29	2	1	+15°	2	30	6-17	20.9-14.4
30	2	1	+15°	2	60	10-17	24.7-20.7
31	1	2	0°	2	30	6-12	18.4-0
32	1	2	0°	2	60	6-12	14.3-0
33	1	2	+5°	2	30	6-18	20.2-8.1
34	1	2	+5°	2	60	10-18	15.9-10.5
35	1	2	+10°	2	30	6-18	22.2-16
36	1	2	+10°	2	60	10-18	23.2-21.6
37	1	2	0	2	80	10-12	12.7-0
38	1	2	0	2	100	10-13	7.6-0
39	1	2	5	2	40	10-18	12.2-6.4
40	1	2	5	2	80	10-18	14.3-9.5
41	1	2	5	2	100	10-18	17.2-9.5
42	1	2	10	2	100	10-16	29.0-24.3

NOTES

a. Tail fins No 1, 0.4m high, Tail fins No 2, 0.45m high
b. Positive tail plane angles correspond to leading edge above trailing edge.
c. Towing Eye No 1, 0.28m from nose; No 2, 0.32m from the nose; No 3, 0.35m from nose.
(See Appendix 3)

APPENDIX 2. SUMMARY OF DEPTH PERFORMANCE OF THE FCPR

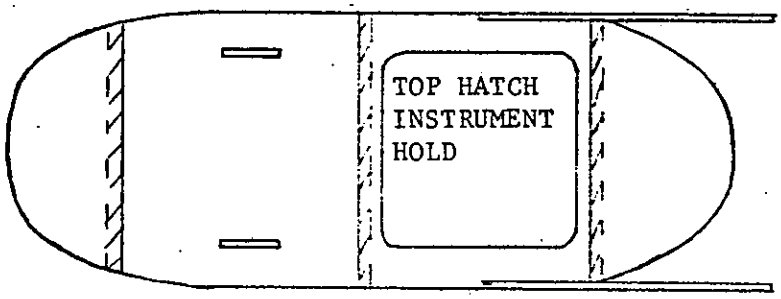
Cable length in air/water	Tail Plane	10 knots 0.40/0.45m Fins		14 knots 0.40/0.45m Fins		18 knots 0.40/0.45m Fins	
20/16m	0°	0		0		0	
	+5°	7.5		0		0	
	+10°	10.9		9.0		10.9	
	+15°	10.2		10.1		10.5	
30/25m	0°	3.6	8.9	0	0	0	0
	+5°	10.2	13.9	7.2	9.9	4.8	8.6
	+10°	14.8	16.2	12.7	15.5	12.1	16.0
	+15°	16.5	18 *	16.3	17.5 *	14.4	18 *
60/50m	0°	4.1	5.1	0	0	0	0
	+5°	9.5	15.9	7.0	13.1	4.3	11.4
	+10°	22.3	23.2	20.1	22.2	18.9	21.6
	+15°	24.7	25 *	22.7	24 *	20.7	23 *
100/80m	0°		7.6		0		0
	+5°		17.2		16.5		11.4
	+10°		29.2		25.3		24 *
	+15°		31 *		27.5 *		26 *

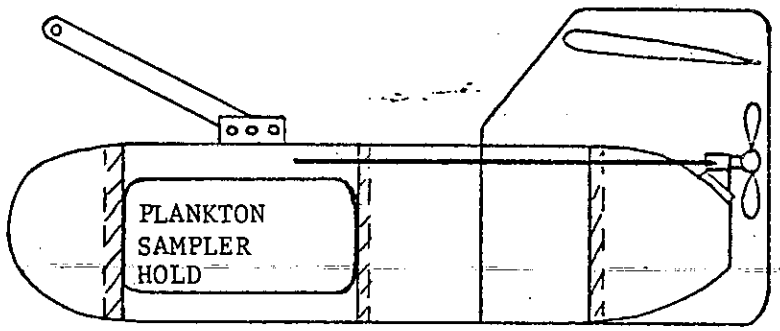
* estimated depths from other measurements

APPENDIX 3

EDINBURGH SAMPLER (FCPR)

Schematic diagram	Scale	1:10
Overall length		0.99m
Overall width		0.36m
Height at towing eye		0.26m
Height at tail fin		0.40m or 0.45m
Towing Eye	No 1	0.29m from nose
	No 2	0.32m from nose
	No 3	0.35m from nose





REGULAR CIRCULATION
OWS AND UOR CRUISES

Internal

Glover
Longhurst
Robinson (2)
Heath
Plymouth file (2)

External

NERC
Foxton
STS

RVB
Stobie

IOS
Tucker

IGS
Moore

IOS
Cartwright

MBA
Denton

SMBA
Currie

MAFF
Lee, Lowestoft
Cushing, Lowestoft
Wood, Burnham-on-Crouch

DAFS
Parrish, Aberdeen
Holden, Pitlochry

IOS
Charnock
Mrs. P. Edwards (BODS)

DOE
Garnett, London
Wise, London.