Northwest Atlantic Fisheries Organization

Serial No. N514

NAFO SCR Doc. 82/VI/26

SCIENTIFIC COUNCIL MEETING - JUNE 1982

Rhynchoteuthion larvae from the Northwest Atlantic and aspects of the distribution of larval *Illex*

by

E.G. Dawe and P.C. Beck
Department of Fisheries and Oceans
Research and Resource Services
Northwest Atlantic Fisheries Center
P. O. Box 5667
St. John's, Newfoundland A1C 5X1

INTRODUCTION

Spawning adults and egg masses of *Illex illecebrosus* have not yet been encountered in nature and so the site of spawning remains unknown. Consideration of the spawning site based on the distribution of larvae and juveniles has thus far been largely speculative. Information concerning the distribution of much younger stages is necessary to gain more insight into the time and location of spawning.

Three types of ommastrephid rhynchoteuthion larvae have been described within the Northwest Atlantic (Roper and Lu MS 1978). Rhynchoteuthion Type A is believed to be the larval form of a species of *Ommastrephes* whereas Type B may be that of *Ornithoteuthis antillarum* (Roper and Lu MS 1978). Rhynchoteuthion Type C is the larval form of *Illex* (Roper and Lu MS 1978, Vecchione MS 1978). Two species of *Illex* occur in the Northwest Atlantic. *Illex illecebrosus* ranges from central Florida to Newfoundland and southern Labrador, whereas the sympatric species, *Illex oxygonius*, occurs from Florida to New Jersey and in the Gulf of Mexico (Roper and Lu MS 1978). Rhynchoteuthion larvae previously collected between Virginia and George's Bank were believed to be *Illex illecebrosus* (Roper and Lu MS 1979, Vecchione MS 1978, Lu and Roper 1979). Some insight as to the distribution and development of egg masses and larvae of *Illex illecebrosus* has been gained from laboratory experiments (Durward et al. 1980, O'Dor et al. MS 1980, O'Dor et al. MS 1981).

Based on times of the year when larvae were captured as well as size composition and maturity of juveniles and adults, it is believed that spawning occurs, at least to some extent, over most of the year (Roper and Lu MS 1978, Lu and Roper 1979, Froerman et al. MS 1981, Dawe and Drew 1981, Lange MS 1981). Several theories have been proposed regarding the possible location of spawning sites including spawning on the Continental Shelf and slope (Roper and Lu MS 1978, Froerman et al. MS 1981). It has also been suggested that spawning may occur in deep offshore water at less than 15°C (Lu and Roper 1979), or in warmer water seaward of the Gulf Stream (Dawe MS 1981).

This paper presents location of capture and sizes of rhynchoteuthion larvae collected in the Northwest Atlantic during surveys conducted between 1967 and 1981. Two relatively large samples of larval *Illex* are described from extreme regions of the area of distribution of *Illex illecebrosus*. Distribution of catches and sizes of larval *Illex* are considered in relation to previous studies toward providing new insight regarding spawning site and mechanisms of transport.

MATERIALS AND METHODS

During cruises of the Canadian research vessel A.T. CAMERON in 1967, 1968, and 1969 plankton was sampled using both a 10' Isaacs Kidd Midwater Trawl (IKMT) and a 1 m plankton net. All these cruises were along the Continental Shelf and slope. Hydrography consisted of surface temperature and a bathythermograph cast to 270 m at each station. Temperature and salinity were sampled using reversing bottles at 270 m, a depth intermediate between 270 m and bottom, and 4 m above bottom. Surface salinity was also determined during 1969. Bottom trawling was also carried out using a Yankee 41.5 otter-trawl with a small mesh liner. Details of methodology and results of bottom trawling have been described elsewhere (Mercer MS 1969a, MS 1969b, MS 1970).

During 1967 plankton sampling during March 21-April 6 extended from La Have Bank to Cape Hatteras. Eight tows of the 1 m plankton net included 3 tows to near bottom of 4-40 min duration and 5 surface tows of 5-125 min duration. There were 3 IKMT tows of 40-60 min duration at depths of 99 and 150 m. Plankton sampling in 1968 was carried out between Atlantis Canyon and Raleigh Bay during August 16-September 1. Sampling included 28 tows of 3-26 min duration of the 1 m plankton net to near bottom and 5 IKMT tows of 60-120 min duration at depths of 46-458 m. During February 12-22, 1969 plankton sampling extended between Raleigh Bay, North Carolina and Fort Pierce, Florida. There were 103 tows of the 1 m plankton net which included 52 30 min surface tows and 51 tows to near bottom of 2 min 33 sec to 10 min 50 sec duration.

In 1980 plankton sampling employed 333 mm mesh bongo nets along pre-established transects between the slope of the Grand Bank and 39°59'N. Transects extending true south were located at 55°W, 54°W, and 53°W. At 15 stations plankton sampling consisted of an oblique tow to 200 m using standard MARMAP technique. Hydrography included a bathythermograph cast to 265 m, surface temperature and salinity as well as collection of temperature and salinity data at 200 m and 400 m using reversing bottles.

In 1981 during a cruise of the GADUS ATLANTICA, plankton was sampled from February 22-March 7 along four equally spaced transects between 56°W and 47°W. At each station a standard oblique tow to 200 m was executed using 505 μm mesh bongo nets. Occasionally, a tow to 50 m was also conducted. Thus, for the entire cruise there were 22 tows to 200 m and 6 tows to 50 m. Hydrography included XBT casts to 750 m, surface temperature, and sampling of temperature and salinity at 50 m, 100 m, 300 m, and 500 m using reversing bottles. At some stations temperature and salinity were sampled at standard depths to 200 m. Since temperature and salinity data at 200 m were not available for some sets larval catches from bongo tows to 200 m were plotted in relation to temperature and salinity at a depth of either 100 m or 200 m. It was felt that although temperature and salinity data were not always available for maximum depth of tow this comparison would serve to identify water masses in which larvae were captured. Details of midwater trawling operations have been described elsewhere (Dawe et al. MS 1981). The location of stations and number of sets at stations for the various cruises are presented in Figures 1-4.

Cephalopods encountered in plankton collections for all cruises were identified at Huntsman Marine Laboratory. For rhynchoteuthion larvae and juvenile *Illex*, the dorsal mantle length was measured to the nearest 0.1 mm. Measurements were performed on preserved specimens.

RESULTS

During February 1969, 30 *Illex* larvae and four juveniles were captured on the Continental Shelf between Cape Kennedy, Florida and Charleston (Fig. 1). Two Rhynchoteuthion Type A larvae with mantle lengths of 1.8 mm and 2.4 mm were also collected. Most *Illex* larvae were captured in two sets of the IKMT and none were collected at stations along the continental slope from Long Bay north to Delaware Bay. Table 1 shows that *Illex* larvae were captured in areas where surface temperature and salinity were high, ranging 19.4-22.3°C and 36.31-36.33°/₀₀, respectively, for sets where hydrographic data are available.

Illex larvae were not captured during March-April 1967 between Cape Hatteras and Chesapeake Bay on the continental slope and further offshore (Fig. 2), but three Rhynchoteuthion Type A larvae with mantle lengths 1.1 mm, 1.4 mm, and 1.8 mm were collected. During August-September 1968 there were also no larval *Illex* collected at stations on the Continental Shelf and slope between Raleigh Bay and central New Jersey (Fig. 3). However, three Rhynchoteuthion Type A larvae were collected along the slope at the southern extreme, between 34°28'30"N and 36°03'30"N. These were of similar size to those collected in the same area during March-April 1967, with mantle lengths 1.1 mm, 1.4 mm, and 2.9 mm.

During February-March 1981 a Rhynchoteuthion Type A larva was collected in the Gulf Stream at 56°00'W. A second Type A larva, with mantle length 1.8 mm was captured south of the southern tip of the Grand Bank at 39°16'30"N, 49°59'40"W. Four Rhynchoteuthion Type B larvae (2.9-3.8 mm) were collected in Slope Water near the northern boundary of the Gulf Stream at 56°W. A large collection of 38 rhynchoteuthion Type C (*Illex*) larvae came from 0-50 and 0-200 m bongo tows along a transect at 56°W, including two large catches of 10 and 12 larvae (Fig. 4). A Temperature-Salinity diagram (Fig. 5) indicates that four of these larvae from two sets were found within the Gulf Stream, where temperature was 18°C or greater and salinity was approximately 36.5°/₀₀ in the upper 200 m. However, most frequent and greatest catches occurred in Slope Water near the northern boundary of the Gulf Stream where temperature and salinity at 100 m or 200 m were less than 15°C and 36.10°/₀₀, respectively. There were no catches of larval *Illex* at stations east of 56°W (Fig. 4). Similarly, during a cruise in early March 1980, only a single larval *Illex* of 6.6 mm mantle length was captured at 55°00'W. No larval *Illex* were captured at stations to the east (Fig. 4).

Size compositions are described for Illex larvae and juveniles collected using IKMT south of Cape Hatteras during February 1969, as well as for Illex larvae collected using bongo nets during February-March 1981 at 56°00'W (Fig. 6). The greater range of lengths for the 1969 sample probably reflects differences in size selectivity of the sampling gear. During 1969 Illex ranged 1.1-10.5 mm with 22% of specimens less than 2.0 mm. However, at the northeastern extreme during 1981 mantle lengths ranged 2.4-5.4 mm. Modal length interval was 4.1-4.5 mm and larvae less than 2.4 mm were completely absent.

DISCUSSION

Samples of rhynchoteuthion Types A and B were small and so no conclusions can be drawn regarding patterns of distribution. It is noted however that ten Type A larvae were collected during all years along the slope of the Continental Shelf throughout the survey area of all cruises, as well as seaward of the Shelf at the most eastern extreme. These larvae were small with minimum sizes ranging 1.1-1.8 mm throughout the area during February-April and August-September. Type B larvae were larger and fewer, and were only caught seaward of the Shelf within Slope Water at 56°W during 1981.

Distributions of Rhynchotheuthion Type C larvae presented here represent the most southwestern and northeastern records of larval Illex documented to date. Vecchione (MS 1978) reported larval Illex as far south as Virginia. Data presented by Amaratunga et al. (MS 1980) indicated that during a joint Canadian/Soviet survey in 1979 larval captures extended almost as far east as 56°W.

The species identity of larval Illex captured in 1969 is unknown since these catches occurred within the range of distribution of both Illex illecebrosus and Illex oxygonius. During this cruise larger specimens of both species were caught using bottom trawl (Mercer MS 1970). It has been suggested that since previous catches of Rhynchoteuthion Type C larvae have occurred north of and within the range of Illex oxygonius and since Illex illecebrosus is the more abundant species, then those larvae to the south may also be Illex illecebrosus (Roper and Lu MS 1978, Vecchione MS 1978). Other observations which suggest that larvae collected in 1969 may be Illex illecebrosus include the fact that most previous catches further north occurred during the same time of year (Vecchione MS 1978) and that during 1969 Illex larvae were not caught at the most southern stations, south of central Florida. Further, catches in 1969 occurred within or in close proximity to the Florida Current which flows northeast doubling in volume transport at Cape Hatteras where it merges with the Gulf Stream (Worthington 1976). Rhynchoteuthion larvae captured at 56°W during February-March 1981 are undoubtedly Illex illecebrosus.

The capture of many Illex larvae as small as 1.1 mm mantle length between Cape Kennedy and Long Bay suggests that spawning occurs in this area, within or in close proximity to the Florida Current, the precursor of the Gulf Stream. Durward et al. (1980) noted that newly hatched Illex illecebrosus larvae are 1.1 mm mantle length. It is also believed that from Cape Hatteras to the northeast spawning occurs in the Gulf Stream. This is consistent with the fact that for cruises described here no larvae were captured near Cape Hatteras and to the northeast over the Continental Shelf and slope. Further, on the slope of the Continental Shelf only three fully mature females were captured between Chesapeake Bay and New Jersey during August-September 1968 (Dawe and Drew 1981). At Cape Hatteras, which is the southern limit of the Labrador Current and Slope Water, the Gulf Stream turns to flow away from the Continental Shelf (Worthington 1976). From an earlier study over the continental slope and rise, the smallest larval Illex captured between 38°N and 41°N was 1.5 mm mantle length. This specimen was not likely newly hatched since in captivity a larva was only 1.25 mm eight days after hatching (Durward et al. 1980). During another cruise on the outer Continental Shelf off New Jersey and Virginia the smallest Illex larva captured was 2.4 mm (Vecchione MS 1978). These earlier surveys did not extend into the Gulf Stream.

It has been suggested that Illex illecebrosus spawns over a broad area which extends north of New England (Roper and Lu MS 1978) but may be southwest of the Nova Scotian Shelf (Froerman et al. MS 1981). The likelihood of spawning to the northeast is supported by the finding of larvae as small as 2.4 mm at 56°W in 1981. However, the absence of minimum-size larvae at 56°W indicates that spawning does not occur in this general area. During a survey in 1979 only four of 32 larvae captured were to the east of 62°W (Amaratunga et al. MS 1980). If spawning does occur to the northeast of Cape Hatteras, then suitable conditions for both spawning and embryological development would likely only exist in the pelagic zone of the Gulf Stream and its northern boundary where temperature exceeds 13°C. O'Dor et al. (MS 1981) showed that fertilization rate is very low at 7°C and that embryological development requires temperatures in excess of 10°C. Thus egg masses would be neutrally buoyant within a favourable environment at a certain depth within the Gulf Stream. This depth would be regulated by density, as determined by temperature and salinity. This is in keeping with the findings of O'Dor et al. (MS 1980) that in the Aquatron Laboratory egg masses became neutrally buoyant when water density increased. They also noted that there is high mortality of eggs within masses which rest on bottom. Temperatures suitable for fertilization and embryonic development also exist within the Sargasso Sea but transport of young stages could likely only occur within its northern boundary, the Gulf Stream.

Since the Gulf Stream decreases greatly in strength and volume transport to the east of a line between Nova Scotia and Bermuda (Worthington 1976), the existance of small larvae at 56°W may in part be due to passive transport of egg masses. Egg masses could be transported from the spawning site for a period of approximately 8-11 days, after which they hatch (O'Dor et al. MS 1981). Young stages could become concentrated near the northern boundary of the Gulf Stream through passive mechanisms. Illex larvae were not found east of 55°W, which may reflect either a decline in the rate of passive transport or an eastern limit of passive transport due to changes in the dynamics of the water masses in this region. It has been reported that a small anticyclonic gyre exists in the eastern Slope Water region, formed by the opposing Slope Water Current and Slope Water Countercurrent (Worthington 1976).

ACKNOWLEDGEMENTS

The authors acknowledge M.C. Mercer under whose supervision these earlier cruises were carried out during 1967-1969. Thanks go to J. Drew who participated in 1980 and 1981 surveys and to the many other technicians who participated in the various cruises. Thanks also to S.J. Stephen who identified cephalopods from plankton collections and to H. Mullett who prepared the illustrations.

REFERENCES

Amarantunga, T., T. Rowell, and M. Roberge. MS 1980. Summary of joint Canada/USSR research program on short-finned squid (Illex illecebrosus), 16 February to 4 June 1979: spawning stock and larval survey. NAFO SCR Doc. 80/II/38, Ser. N069, 36 p.

Dawe, E.G. MS 1981. Further notes on distribution of young short-finned squid (Illex illecebrosus) in relation to water masses, February-March 1981. NAFO SCR Doc. 81/IX/104, Ser. N406, 6 p.

Dawe, E.G., P.C. Beck, and H.J. Drew. MS 1981. Distribution and biological characteristics of young short-finned squid (Illex illecebrosus) in the Northwest Atlantic, February 20-March 11, 1981. NAFO SCR Doc. 81/VI/23, Ser. N302, 20 p.

Dawe, E.G. and H.J. Drew. 1981. Record of a mature female short-finned squid, Illex illecebrosus, captured inshore at Newfoundland and previous cpatures of mature females in the Northwest Atlantic. J. Northw. Atl. Fish. Sci., 2: 61-65.

Durward, R.D., E. Vessey, R.K. O'Dor, and T. Amaratunga. 1980. Reproduction in the squid, Illex illecebrosus: first observations in captivity and implications for the life cycle. ICNAF Sel. Papers, No. 6: 7-13.

Froerman, Yu. M., P.P. Fedulov, V.V. Khalyukov, E.N. Shevchenko, and T. Amaratunga. MS 1980. Preliminary results of the R/V ATLANT research of short-finned squid, Illex illecebrosus, in NAFO Subarea 4 between 3 March and 4 May 1981. NAFO SCR Doc. 81/VI/41, Ser. N323, 13 p.

Lange, A.M.T. MS 1981. Evidence of summer spawning of Illex illecebrosus (LeSueur), off the Northeastern USA. NAFO SCR Doc. 81/VI/33, Ser. N315, 15 p.

Lu, C.C. and C.F.E. Roper. 1979. Cephalopods from deepwater dumpsite 106 (Western Atlantic). Vertical distribution and seasonal abundance. Smithsonian contributions to zoology, 288: 36 p.

Mercer, M.C. MS 1969a. A.T. CAMERON Cruise 130, otter-trawl survey from southern Nova Scotia to Cape Hatteras, March-April 1967. Fish. Res. Bd. Canada Tech. Rep. No. 103: 24 p.

Mercer, M.C. MS 1969b. A.T. CAMERON Cruise 150, otter trawl survey of the mid-Atlantic Bight, August-September 1968. Fish. Res. Bd. Canada Tech. Rep. No. 122: 47 p.

Mercer, M.C. MS 1970. A.T. CAMERON Cruise 157, otter-trawl survey of the southwestern North Atlantic, February 1969. Fish. Res. Bd. Canada Tech. Rep. No. 199: 66 p.

O'Dor, R.K., N. Balch, and T. Amaratunga. MS 1981. The embryonic development of the squid, Illex illecebrosus, in the laboratory. NAFO SCR Doc. 81/VI/29, Ser. N308, 11 p.

O'Dor, R.K., E. Vessey, and T. Amaratunga. MS 1980. Factors affecting fecundity and larval distribution in the squid, Illex illecebrosus. NAFO SCR Doc. 80/II/39, Ser. N070, 9 p.

Roper, C.F.E. and C.C. Lu. MS 1978. Rhynchoteuthion larvae of ommastrephid squids of the Western North Atlantic with the first description of larvae and juveniles of Illex illecebrosus. p. 14.1-14.26 In N. Balch, T. Amaratunga and R.K. O'Dor [ed.]. Proceedings of the workshop on the squid, Illex illecebrosus. Dalhousie University, Halifax, Nova Scotia, May 1978, and a bibliography on the genus Illex. Fish. Mar. Serv. Tech. Rep. 833.

Vecchione, M. MS 1978. Larval Illex (Cephalopoda, Oegopsida) from the Middle Atlantic Bight. p. 15.1-15.16 In N. Balch, T. Amaratunga, and R.K. O'Dor [ed.]. Proceedings of the workshop on the squid, Illex illecebrosus. Dalhousie University, Halifax, Nova Scotia, May 1978, and a bibliography of the genus Illex. Fish. Mar. Serv. Tech. Rep. 833.

Worthington, L.V. 1976. On the North Atlantic circulation: Johns Hopkins Oceanogr. Stud. 6, 110 p.

Table 1. Temperature and salinity at surface and bottom in relation to Illex catch for sets of 1 m plankton net during A.T. CAMERON Cruise #157, February, 1969.

Set No.	Depth of Tow	Surface Temp. (°C)	Surface Salinity %	Bottom Temp. (°C)	Bottom Salinity %	Catch Illex Larvae	Catch Illex Juvenile
2	40.26-0 m	3.8	33.44	4.09	33.49	0	0
4	surface	9.5	33.30	10.10	33.21	0	0
5	87.84-0 m	9.5	33.30	10.10	33.21	0	0
7	surface	10.1	35.02	10.15	35.05	0	0
8	128.10-0 m	10.1	35.02	10.15	35.05	0	0
10	surface	10.1	35.07	10.57	35.34	0	0
11	228.75-0 m	10.1	35.07	10.57	35.34	0	0
13	surface	10.2	35.01	6.74	35.03	0	0
14	428.22-0 m	10.2	35.01	6.74	35.03	0	0
16	surface	11.6	35.50	10.93	-	0	0
17	87.84-0 m	11.6	35.50	10.93	-	0	0
19	surface	11.5	35.39	11.65	35.41	0	0
20	151.89-0 m	11.5	35.39	11.65	35.41	0	0
22	surface	11.6	35.41	11.47	35.44	0	0
23	219.60-0 m	11.6	35.41	11.47	35.44	0	0
25	surface	18.1	35.34	18.10	-	0	0
26	42.09-0 m	18.1	35.34	18.10	-	0	0
28	surface	19.2	36.47	17.34	36.17	0	0
29	87.84-0 m	19.2	36.47	17.34	36.17	0	0
31	surface	19.5	36.36	17.04	36.18	0	0
32	133.59-0 m	19.5	36.36	17.05	36.18	0	0
34	surface	19.4	36.38	14.14	35.90	0	0
35	179.34-0 m	19.4	36.38	14.14	35.90	0	0
37	surface	19.1	36.38	14.10	36.00	0	0
38	228.75-0 m	19.1	36.38	14.10	36.00	0	0
40	surface	19 6	36.38	14.05	36.13	0	0

Set No.	Depth of Tow	Surface Temp. (°C)	Surface Salinity %	Bottom Temp. (°C)	Bottom Salinity %	Catch Illex Larvae	Catch Illex Juvenile
41	278.16-0 m	19.6	36.38	14.05	36.13	0	0
43	surface	19.0	36.36	-	35.19	0	0
44	362.34-0 m	19.0	36.36	-	35.19	0	0
47	42.09-0 m	19.4	36.44	19.38	36.33	0	0
49	surface	19.5	36.44	17.78	36.26	0	0
50	91.50-0 m	19.5	36.44	17.78	36.26	0	0
52	surface	19.0	36.38	15.90	36.08	0	0
53	146.40-0 m	19.0	36.38	15.90	36.08	0	0
55	surface	21.4	36.33	15.26	36.02	0	0
56	201.30-0 m	21.4	36.33	15.26	36.02	0	0
58	surface	21.5	36.26	14.60	35.90	0	0
59	241.56-0 m	21.5	36.26	14.60	35.90	0	0
61	surface	19.5	36.31	19.50	36.80	1	0
62	45.75-0 m	19.5	36.31	19.50	36.80	0	0
64	surface	19.5	36.27	17.55	36.36	0	0
65	135.42-0 m	19.5	36.27	17.55	36.36	0	0
67	surface	20.8	36.31	14.00	35.75	0	0
68	247.05-0 m	20.8	36.31	14.00	35.75	1	0
70	surface	19.6	36.33	17.34	36.29	0	0
71	87.84-0 m	19.6	36.33	17.34	36.29	0	0
73	surface	19.1	36.31	15.59	36.20	0	0
74	142.74-0 m	19.1	36.31	15.59	36.20	0	0
76	surface	19.5	36.31	15.72	36.00	0	0
77	188.49-0 m	19.5	36.31	15.72	36.00	0	0
79	surface	19.4	36.29	15.28	35.93	0	0

Tabel 1. (Continued)

Set No.	Depth of Tow	Surface Temp. (°C)	Surface Salinity %	Bottom Temp. (°C)	Bottom Salinity %	Catch *Illex* Larvae	Catch *Illex* Juvenile
80	225.09-0 m	19.4	36.29	15.28	35.93	0	0
82	surface	19.9	36.33	14.60	35.84	0	1
83	279.99-0 m	19.9	36.33	14.60	35.84	0	0
85	surface	19.8	36.31	7.53	36.71	0	0
87	surface	19.8	36.27	7.48	34.88	0	0
91	surface	19.8	36.33	17.09	36.24	0	0
92	87.84-0 m	19.8	36.33	17.09	36.24	0	0
94	surface	19.7	36.29	17.03	36.29	0	0
95	133.59-0 m	19.7	36.29	17.03	36.29	0	0
97	surface	19.8	36.29	15.87	36.11	0	0
98	179.34-0 m	19.8	36.29	15.87	36.11	0	0
100	surface	19.8	36.31	14.15	35.86	0	0
101	237.90-0 m	19.8	36.31	14.15	35.86	1	0
103	surface	19.4	36.31	10.77	35.37	0	0
104	270.84-0 m	19.4	36.31	10.77	35.37	1	0
106	surface	19.8	36.29	8.04	34.99	0	0
107	356.85-0 m	19.8	36.29	8.04	34.99	0	0
109	surface	22.1	36.09	7.09	35.16	0	0
110	439.20-0 m	22.1	36.09	7.09	35.16	0	0
113	surface	20.2	36.26	16.58	36.04	0	0
114	87.84-0 m	20.2	36.26	16.58	36.04	0	0
116	surface	20.6	36.29	16.13	36.02	0	0
117	133.59-0 m	20.6	36.29	16.13	36.02	0	0
119	surface	20.6	36.26	15.51	35.95	0	0
120	179.34-0 m	20.6	36.26	15.51	35.95	0	0

Set No.	Depth of Tow	Surface Temp. (°C)	Surface Salinity %	Bottom Temp. (°C)	Bottom Salinity %	Catch *Illex* Larvae	Catch *Illex* Juvenile
122	surface	20.5	36.22	11.50	36.00	0	0
123	225.09-0 m	20.5	36.22	11.50	36.00	0	0
125	surface	20.9	36.27	8.91	35.01	0	0
126	278.16-0 m	20.9	36.27	8.91	35.01	0	0
128	surface	20.9	36.38	8.91	34.87	0	0
129	351.36-0 m	20.9	36.38	8.91	34.87	0	0
133	surface	22.3	-	18.78	-	0	0
134	89.67-0 m	22.3	-	18.78	-	1	0
136	surface	23.1	-	14.00	-	0	0
137	179.34-0 m	23.1	-	14.00	-	0	0
139	surface	22.9	-	12.50	-	0	0
140	225.09-0 m	22.9	-	12.50	-	0	0
142	surface	23.7	-	9.56	-	0	0
143	270.84-0 m	23.7	-	9.56	-	0	0
145	surface	23.9	-	8.20	-	0	0
146	356.85-0 m	23.9	-	8.20	-	0	0
149	surface	22.2	-	19.30	-	0	0
150	87.84-0 m	22.2	-	19.30	-	0	0
152	surface	22.3	-	15.93	-	0	0
153	133.59-0 m	22.3	-	15.93	-	0	0
155	surface	22.5	-	11.16	-	0	0
156	179.34-0 m	22.5	-	11.16	-	0	0
158	surface	23.6	-	9.40	-	0	0
159	225.09-0 m	23.6	-	9.40	-	0	0
161	surface	24.2	-	8.94	-	0	0
162	301.95-0 m	24.2	-	8.94	-	0	0

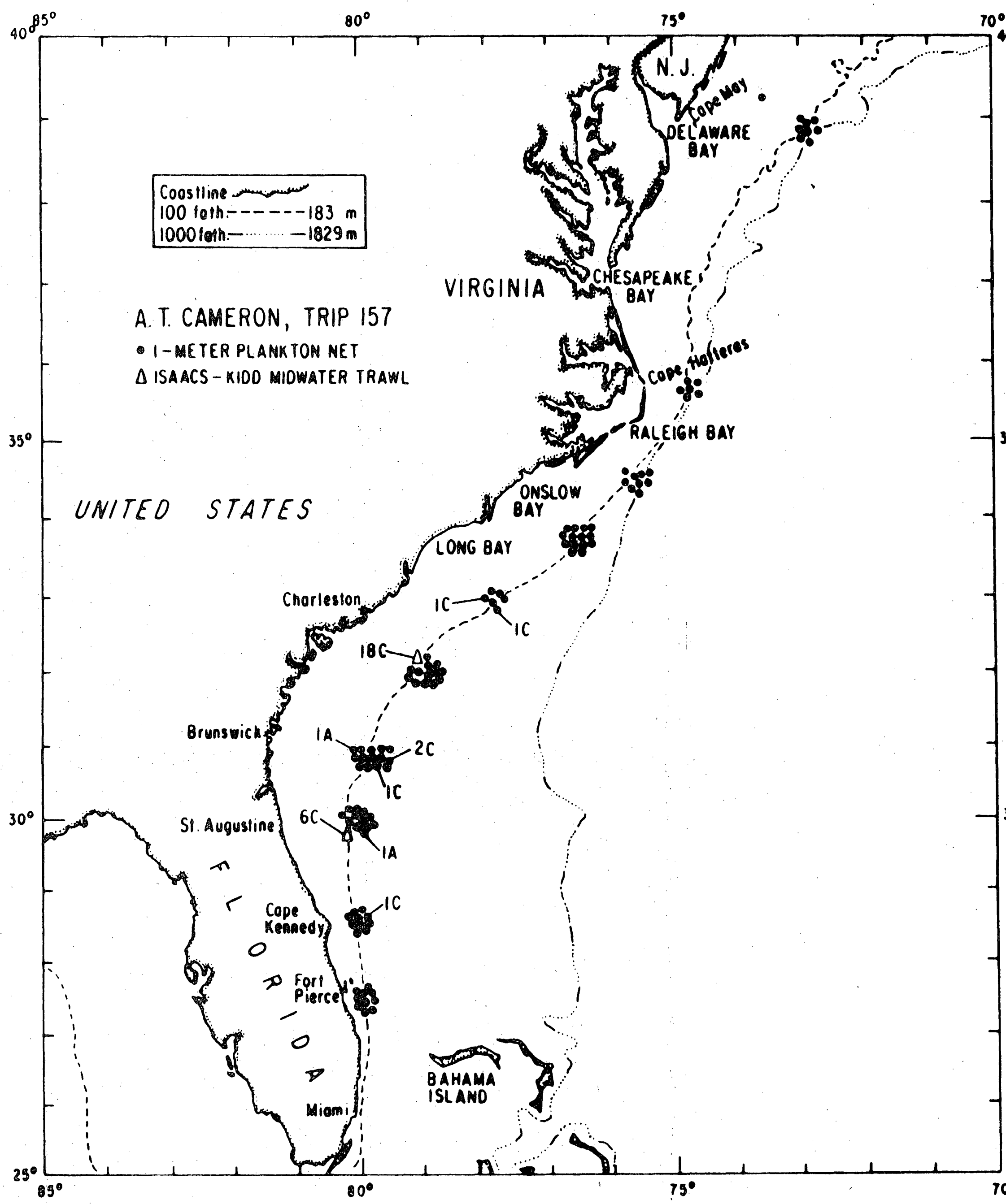

Fig. 1. Location of plankton tows and catch by type of rhynchoteuthion larva during A.T. CAMERON Cruise 157, February 1969.

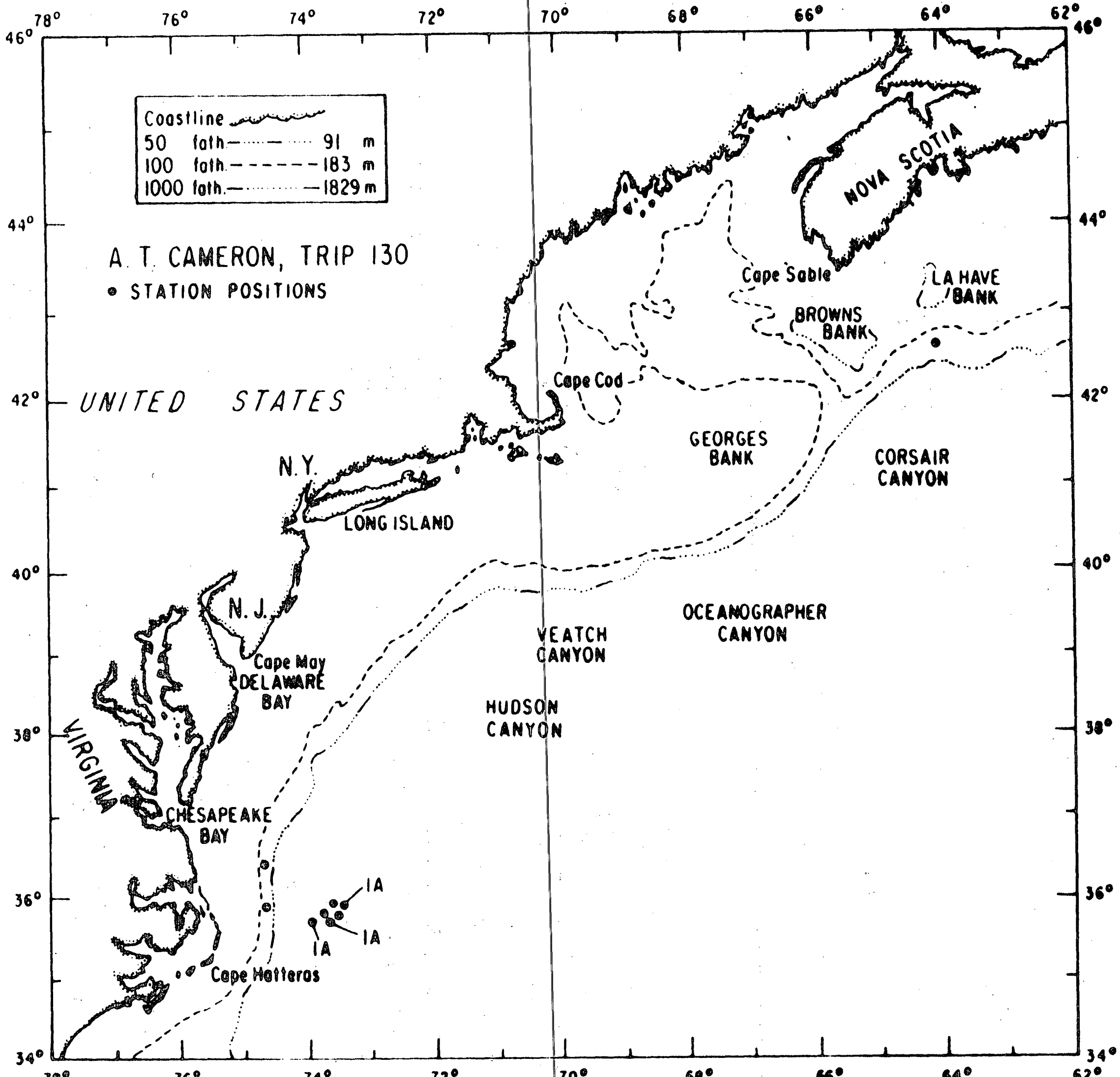

Fig. 2. Location of plankton tows and catch by type of rhynchoteuthion larva during A.T. CAMERON Cruise 130, March-April 1967.

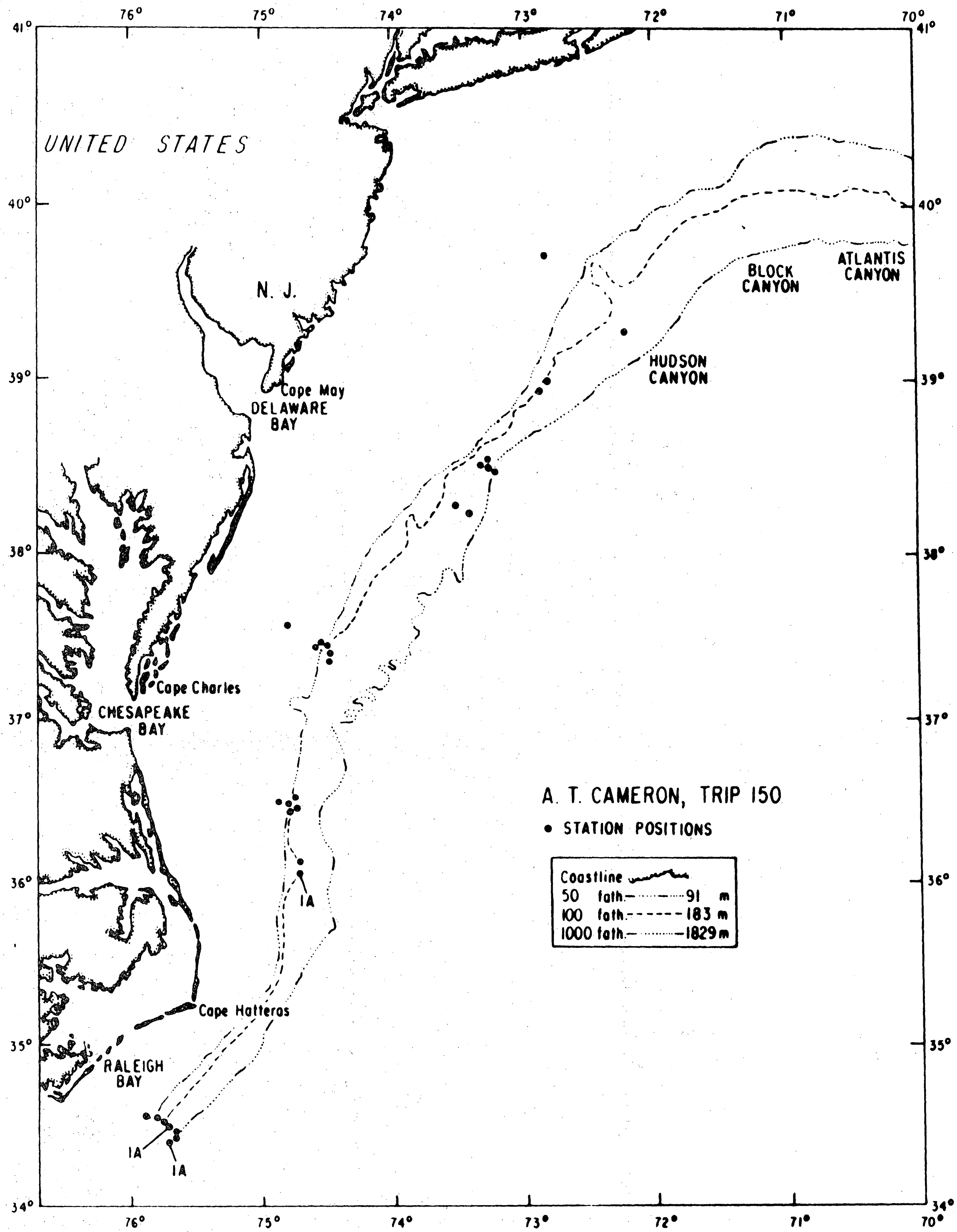

Fig. 3. Location of plankton tows to the southwest of the Grand Bank and catch by type of rhynchotheuthion larva during A.T. CAMERON Cruise 150, August-September 1968.

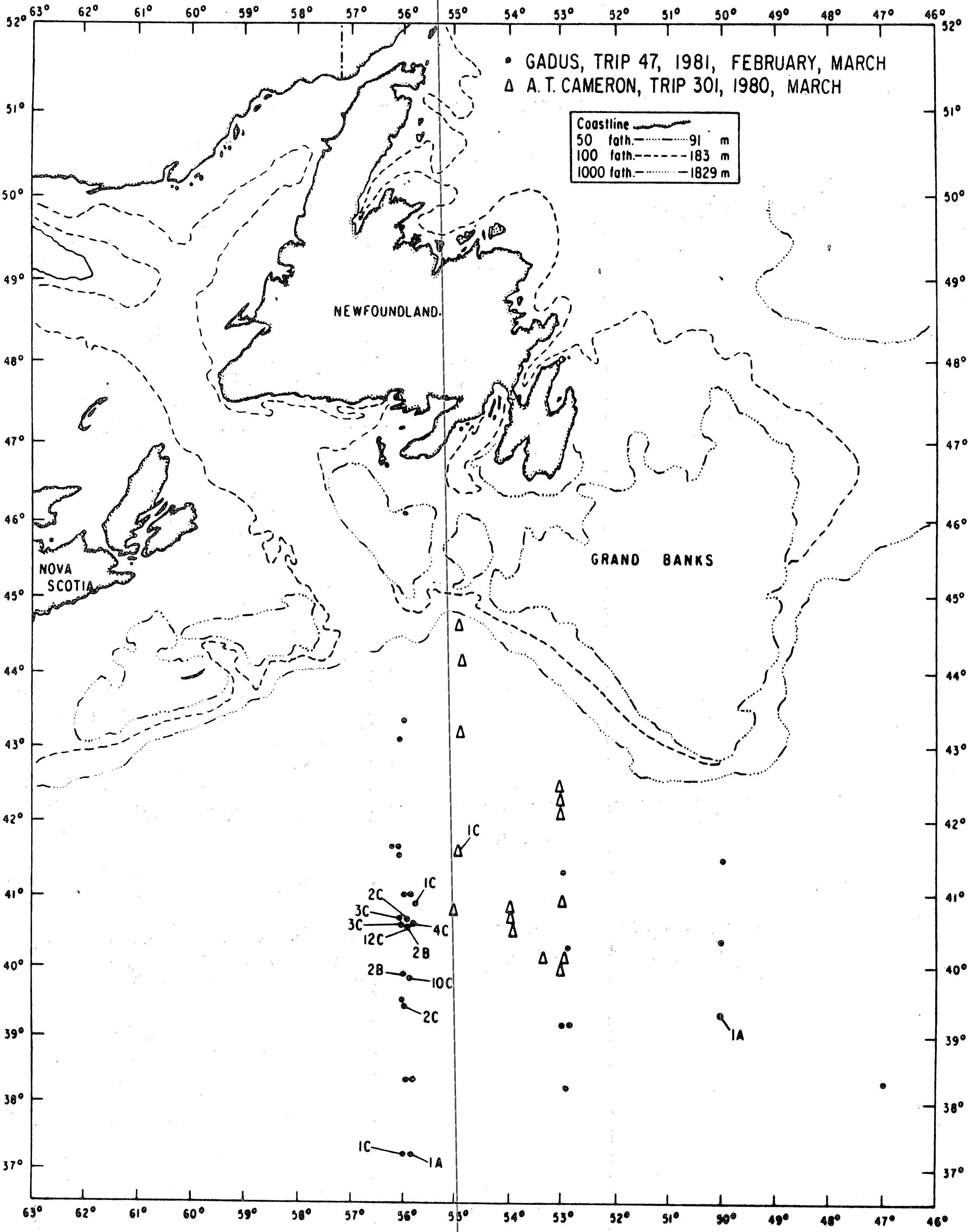

Fig. 4. Location of plankton tows and catch by type of rhynchoteuthion larva during A.T. CAMERON Cruise 301, March 1980 and GADUS ATLANTICA Cruise 47, February-March 1981.

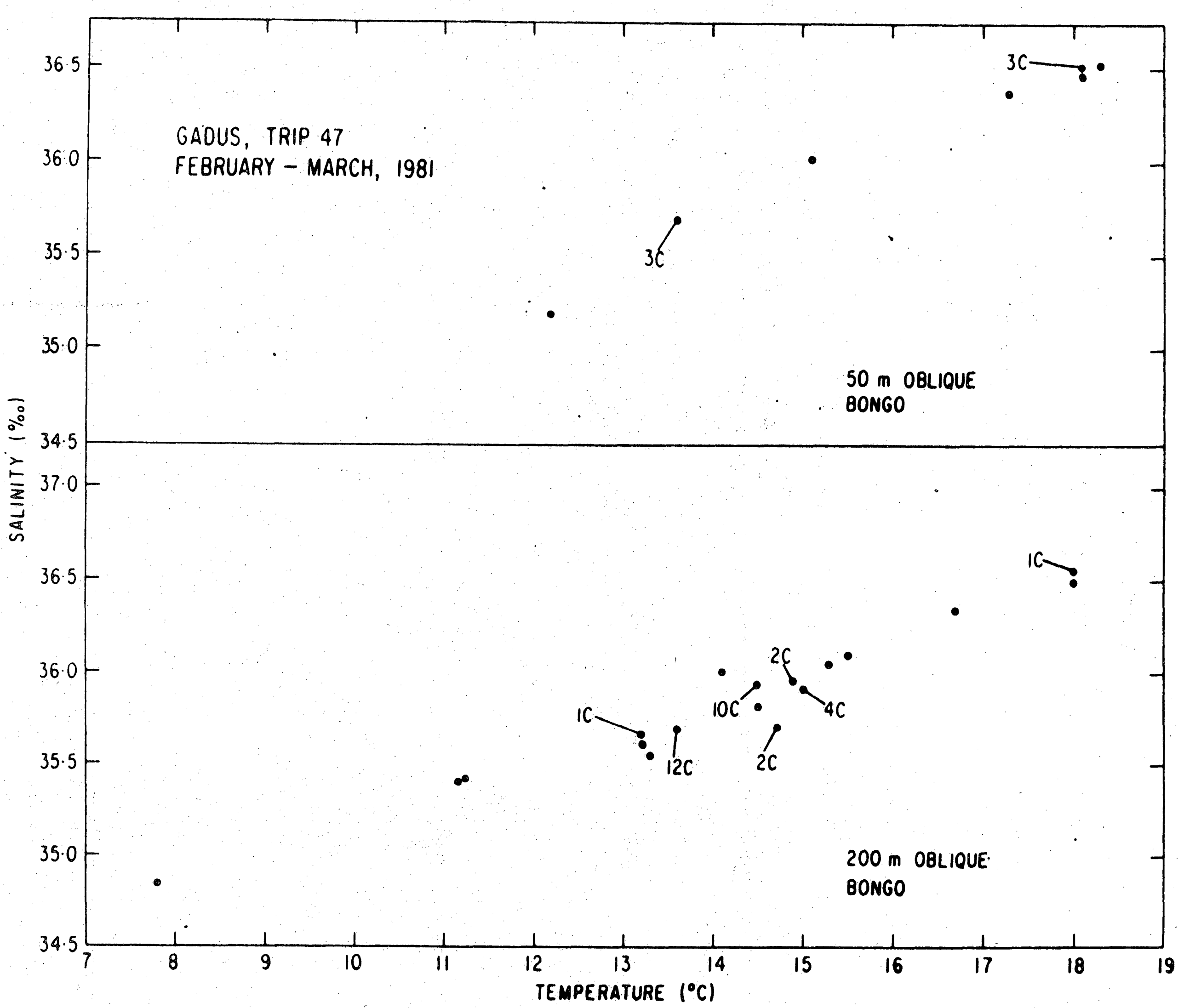

Fig. 5. Catch of rhynchoteuthion Type C larvae in relation to temperature and salinity during GADUS ATLANTICA Cruise 47, February-March 1981.

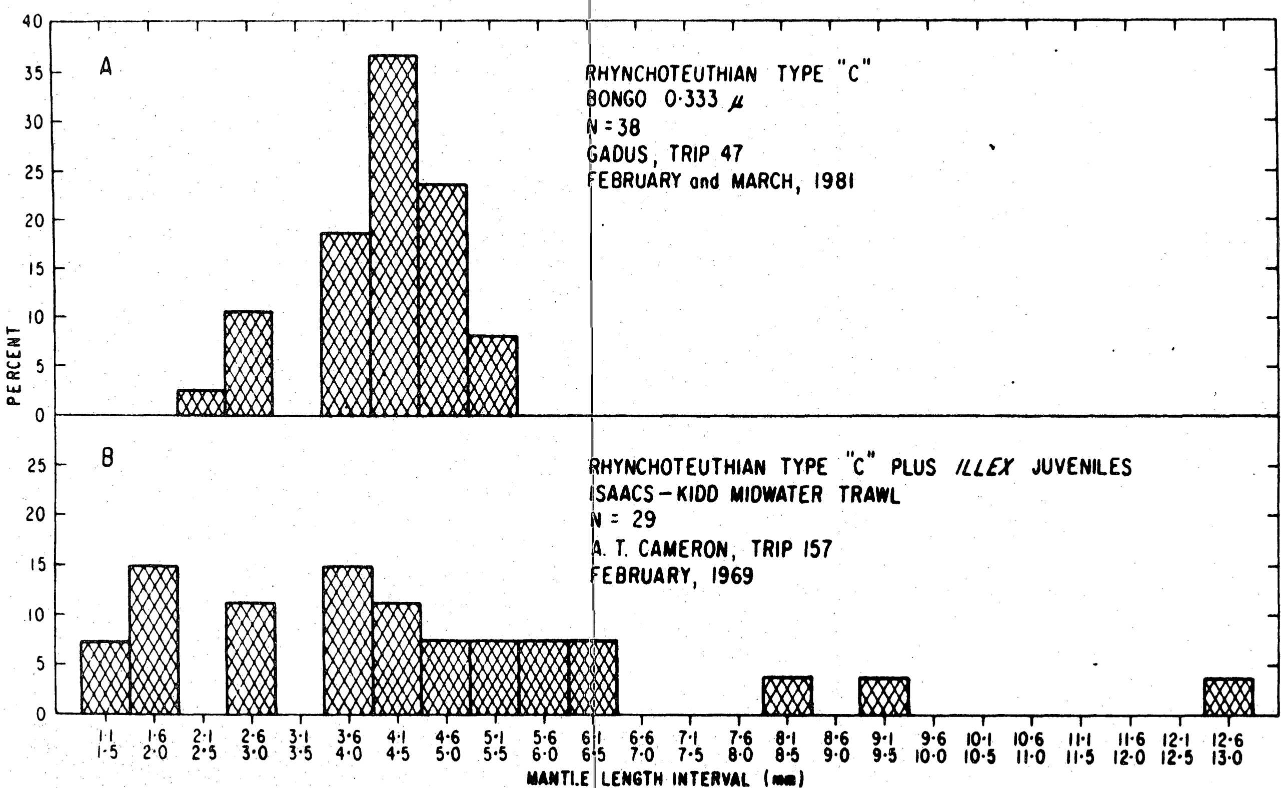

Fig. 6. Length frequency distributions of rhynchoteuthion Type C larvae during February-March 1981 (A) and rhynchoteuthion Type C larvae plus <u>Illex</u> juveniles from IKMT sets during February 1969 (B).