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Distribution of cephalopod paralarvae across the Florida Current front in the Florida Keys: preliminary results

David A. Goldman
Division of Marine Biology and Fisheries, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149, USA.

Resumen: Se relaciona cuantitativamente las comunidades de paralarvas de cefalópodos con las condiciones oceanográficas en el frente de la corriente de Florida hasta las afueras de los Cayos de la Florida, E.U.A. Las paralarvas de calamares (Enoploteuthidae y Ommastrephidae) fueron las más abundantes en cuatro cruceros trimestrales. *Abralia* sp. (Enoploteuthidae) fue la especie más abundante con un valor máximo de 12.6/10 m^2 en mayo de 1990. Las paralarvas de Enoploteuthidae tuvieron una distribución variable con respecto al frente. *Illex* spp. (Ommastrephidae) fueron el grupo más abundante con un valor máximo de 19.4/10 m^2 en febrero de 1990 y su distribución estuvo relacionada con el frente de la corriente. Las especies no pudieron ser determinadas y son *I. illecebrosus* o *I. coindetii*. El pico de abundancia de paralarvas de *Illex* spp. durante el invierno y su distribución en el frente coincide con la de *I. illecebrosus* reportado para el Atlantico noroccidental.

Key words: Cephalopod paralarvae, Ommastrephidae, *Illex*, Enoploteuthidae, Florida Current front.

Little information exists on the distribution of paralarval cephalopods across the Florida Current (FC) front off the southeastern U.S. Voss (i.e. 1956), Cairns (1976), and Lea (1984) investigated paralarval and adult cephalopods from the FC. Some studies have specifically concentrated on distribution of paralarvae within the FC front: Rowell and Trites (1985) and other authors have studied *Illex* spp. paralarvae and juveniles between Florida and Cape Hatteras; and Goldman and McGowan (1991) examined ommastrephid paralarvae in the Straits of Florida off the Florida Keys. No comprehensive study of the paralarval cephalopod assemblages across the FC front exists.

In this communication I present the preliminary results of a study which will quantitatively describe the paralarval cephalopod assemblages across the FC front off the Florida Keys utilizing multivariate data. Results of this work will help determine the ecological significance of the Florida Current front to paralarval cephalopods.

Paralarvae were collected on quarterly research cruises in 1989-1990 by project SEFCAR (Southeast Florida and Caribbean Recruitment), a multidisciplinary project examining recruitment dynamics off the Florida Keys. We employed a MOCNESS-1 (Multiple Opening and Closing Net and Environmental Sensing System with fishing mouth of 1 m^2) equipped with CTD instrumentation. The MOCNESS used nine opening and closing nets with 0.333 mm mesh and fished at a constant rate of ascent from a maximum tow depth of 200 m to the surface. We fished individual nets for approximately 5 min in 25 m increments and filtered about 250 m^3 water/net. I identified cephalopods, measured mantle length (ML) to the nearest 0.1 mm, and standardized catches to numbers/1000m^3 water for each net and to numbers under 10 m^2 for each station. Information on the study area, station locations, and sampling method is found in Lee *et al.* (1992) and Goldman and McGowan (1991).

I identified a total of 4124 cephalopods from four cruises over a one year period (Table 1). Paralarvae of the family Enoploteuthidae were

TABLE 1

Frequency of occurrence of cephalopod paralarvae *from four SEFCAR cruises (August 1989 to May 1990)*

CRUISE	CA8910 Aug.	CA8914 Nov.	CA9002 Feb.	LH1 May
TOTAL CEPHALOPODS	739	869	639	1877
ORDER SEPIOIDEA				
SEPIOLIDAE				
Unidentified sepiolids	0	2	0	1
ORDER TEUTHOIDEA				
SUBORDER MYOPSIDA				
LOLIGINIDAE				
Loligo spp.	1	1	4	0
Loligo plei	8	0	0	0
L. pealei	2	1	1	0
SUBORDER OEGOPSIDA				
Unidentified oegopsids	15	6	10	44
ENOPLOTEUTHIDAE				
Unidentified enoploteuthids	23	8	15	9
Enoploteuthinae	38	58	13	107
Abralia sp.	231	296	58	693
Abraliopsis sp.	15	10	2	63
Enoploteuthis sp.?	26	27	8	9
Enoploteuthis sp.	3	11	1	8
Enoploteuthid Type A	7	6	6	11
Pyroteuthinae	88	42	86	608
Pterygioteuthis spp.	0	0	1	12
Pterygioteuthis gemmata	0	2	0	2
OMMASTREPHIDAE				
Unidentified ommastrephids	8	4	3	2
Type A': *O. antillarum* ?	135	75	18	97
Type B': *S. pteropus*	54	41	15	16
Type C': *Illex* spp.	3	60	152	3
Type C'?: *Illex* spp.?	0	63	109	2
ONYCHOTEUTHIDAE				
Onychoteuthis banksii	8	32	21	38
Onkyia carriboea	0	3	0	0
CRANCHIIDAE				
Unidentified cranchiids	2	1	0	5
Leachia sp.	0	38	0	0
Megalocranchia sp.	0	1	0	2
Liocranchia sp.	0	3	0	0
Cranchia scabra	0	1	0	1
THYSANOTEUTHIDAE				
Thysanoteuthis rhombus	0	1	0	8
PHOLIDOTEUTHIDAE				
Pholidoteuthis adami	0	0	1	0
NEOTEUTHIDAE				
Neoteuthis sp.?	1	0	0	0
ORDER OCTOPODA				
Unidentified octopods	13	4	10	29
OCTOPODIDAE				
Octopus spp.	18	10	7	4
O. defillipi	28	56	87	64
O. burryi	9	4	10	21
TREMOCTOPODIDAE				
Tremoctopus violaceous	0	2	0	13
ARGONAUTIDAE				
Argonauta spp.	3	0	1	5

the most abundant. Peak occurrence was in May 1990 when 1522 enoploteuthids (81% of total specimens) were captured. *Abralia* sp. was the most abundant taxon and had mean abundance per station of 19.4 under 10 m^2 in May. Larger pyroteuthins were identified as *Pterygioteuthis* spp. or as *P. gemmata.* Analysis of developmental series indicates that most of the smaller pyroteuthins are likely to be *P. gemmata.* Ommastrephidae were second most abundant and were identified to type according to Roper and Lu (1979). Type A' had peak abundance in August 1989. All of the larger specimens of Type A' were identified as *Ornithoteuthis antillarum,* but some small individuals could be other species. Type C' is known to be *Illex* spp. and had peak abundance in February 1990 (mean per station 12.6 under 10 m^2), which coincides with peak abundance of *I. illecebrosus* paralarvae in winter off the northeast U.S.

Enoploteuthids had a variable distribution off the Keys. In August, Pyroteuthinae had an offshore distribution near the front and in the FC (Fig. 1a). In February, the pyroteuthins had a more inshore distribution in coastal water (Fig. 1b). *Abralia* sp. was found throughout the study area on several cruises in both coastal and oceanic habitats. *Illex* spp. paralarvae off the Keys had a distribution near the FC front which was most apparent in February when the front bisected most transects (Fig. 1c). Abundance of *I. illecebrosus* paralarvae downstream of the Keys is highest in and near frontal habitat (Rowell and Trites 1985). Goldman and McGowan (1991) also found that ommastrephid Type A' has a frontal distribution off the Keys.

Illex paralarvae off the Florida Keys cannot be identified to species, and may be *I. illecebrosus,* which supports a valuable fishery, or advective losses of the tropical species *I . coindetii.* Although *Illex* paralarvae have been

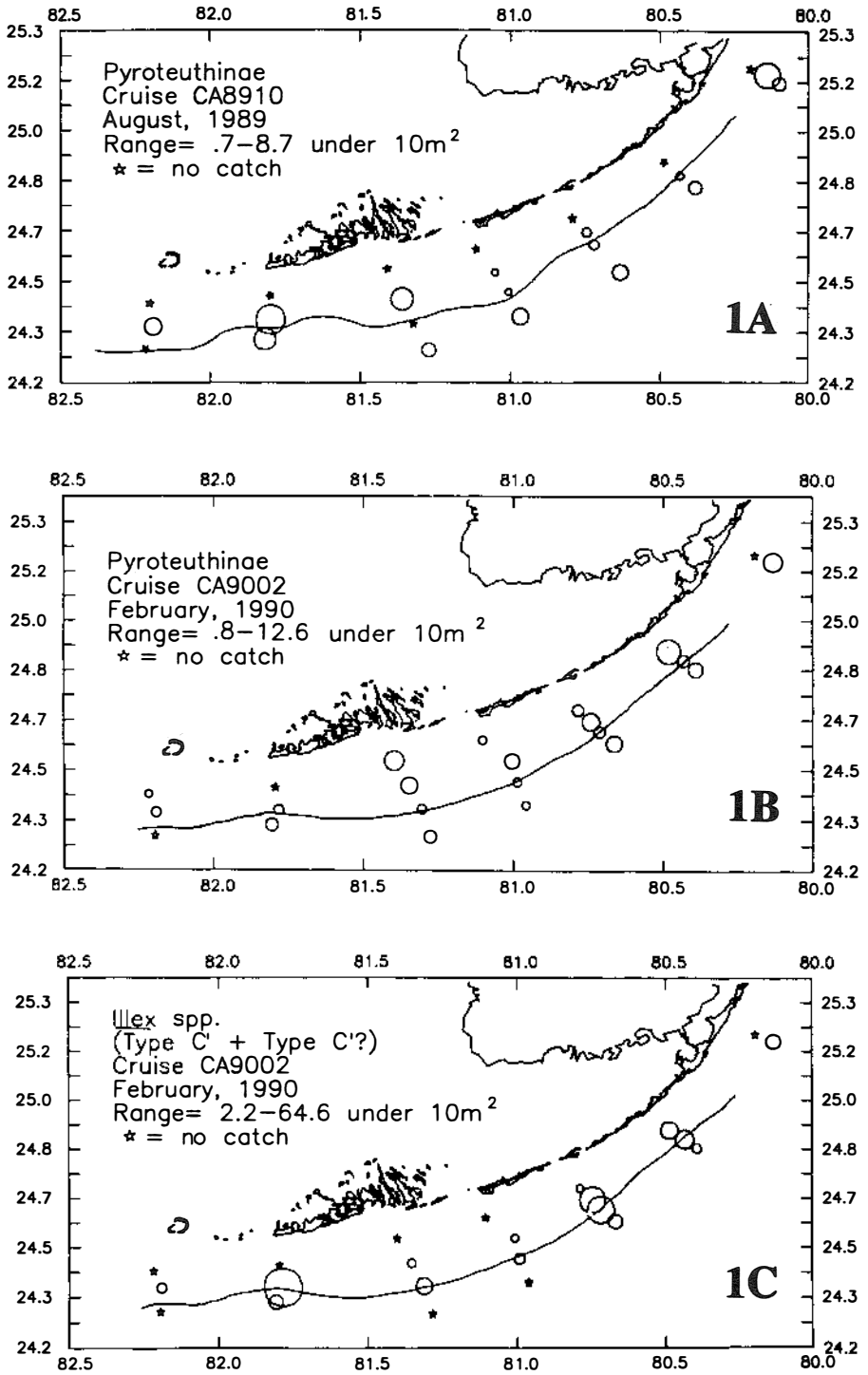

Fig. 1. Florida Keys: distribution and relative abundance of cephalopod paralarvae. Stars indicate stations with zero catch, size of circle is proportional to catch. The line on each chart through the transects indicates the 18° isotherm at 100 m which defined the Florida Current front. 1A. Pyroteuthinae paralarvae in August 1989. 1B. Pyroteuthinae paralarvae in February 1990. 1C. *Illex* spp. paralarvae in February 1990.

studied in the Gulf Stream, they have previously not been studied upstream in the FC off the Keys. However, ecology of *Illex* in the Florida Straits merits study to learn if paralarvae are *I. illecebrosus* which recruit into the fishery off the eastern U.S. and Canada.

Ultimately this work will contribute information missing from our knowledge of paralarval cephalopod ecology. Information on distribution across frontal gradients, details of spawning seasons and locations, vertical distribution and migration patterns, and oceanographic factors effecting survival is needed because many cephalopod taxa have unknown fishery potential (Roper *et al.* 1984), comprise essential components of diets of important food and game fish (Toll and Hess 1981), and are susceptible to dramatic recruitment variation due to short life spans (Pauly 1985). Analysis of horizontal distribution of paralarvae with respect to different water masses off the Keys is relevant to determine what processes effect their recruitment. The preliminary results reported here indicate that different patterns of distribution may be caused by oceanographic advection events. Plankton are subjected to different mechanisms of transport and retention in different areas off the Keys and these features effect distribution and potentially effect recruitment.

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