SEA GRANT SESSION

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Chairman – R. B. Abel, *Director, National Sea Grant Program, NOAA, Rockville, Maryland*

Estimating Abundance of Sardine-like Fishes from Egg and Larval Surveys, Eastern Gulf of Mexico: Preliminary Report [1]

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INTRODUCTION

Reports of apparent abundance of sardine-like fishes in the Eastern Gulf of Mexico and their possible potential for commercial fisheries often have appeared in discussions of fishery potential (Bullis and Carpenter, 1968; Bullis and Thompson, 1970; Fuss, Kelly and Prest, 1969; Klima, 1971; Wise, 1972). Only the Gulf menhaden presently supports a large commercial fishery; record catches in recent years may have exceeded the sustainable yield for that species (Chapoton, 1972). Other sardine-like fishes that might have potential for reduction or foodfish fisheries include thread herring, round herring, Spanish sardines, scaled sardines and one or more species of anchovies. No good estimates of stock size are available for any of these fishes, although some of these stocks may exceed Gulf menhaden in abundance (Bullis and Carpenter, 1968).

My research to assess clupeoid populations in the Eastern Gulf is based on seasonal surveys of planktonic eggs and larvae. Distribution and abundance of these stages will reflect adult distribution and abundance because eggs and larvae are planktonic for only a few days after being spawned. Rearing experiments demonstrated that clupeoid eggs hatch from 20 to 45 hours after spawning at temperatures found in the Eastern Gulf. Presence of eggs and newly hatched larvae in plankton catches, therefore, suggests proximity of adult spawning con-

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centrations. Adult biomass estimates from egg abundance can be obtained (Ahlstrom, 1968) if the mean fecundity, mean size and sex ratio of adults are known.

My objectives are to determine commercial potential of clupeoid species that are presently virtually unexploited by estimating biomass of the populations and, what may be as important, annual fluctuations in biomass. Spawning areas and seasons will be examined to determine where and when exploitable quantities of adults may be available to a commercial fishery. I hope that a good understanding of the basic biology of these stocks will lead to effective management techniques when the stocks are fished.

BACKGROUND

The survey began as part of a cooperative investigation during 1970-1972 of physical, chemical and biological phenomena in the Eastern Gulf of Mexico (EGMEX) (Rinkel, 1971). Ichthyoplankton sampling became a specific objective of EGMEX in May 1971. Cooperators included the Florida State University System's Institute of Oceanography (SUSIO) and the National Marine Fisheries Service (NMFS). This survey has served in many respects as a pilot program for development of the NMFS Marine Resources Monitoring, Assessment and Prediction Program (MARMAP).

A grid of 185 stations, mostly spaced at 15-mile intervals and on transects 15 miles apart, was designed for 1971 surveys (Fig. 1). Stations extended from the 5-fathom line to the 100-fathom line, with a few stations over deeper water. Five cruises in 1971 sampled as many stations as possible within the limits of avail-

Table 1. Cruises and number of stations sampled in Eastern Gulf of Mexico during 1971 and 1972 egg and larval surveys

Cruise Month	Number of Stations
1971	
February	20
May	123
June-July	31
August	150
November	88
1972	
February	32
May	30
June	13
September	34
November	50

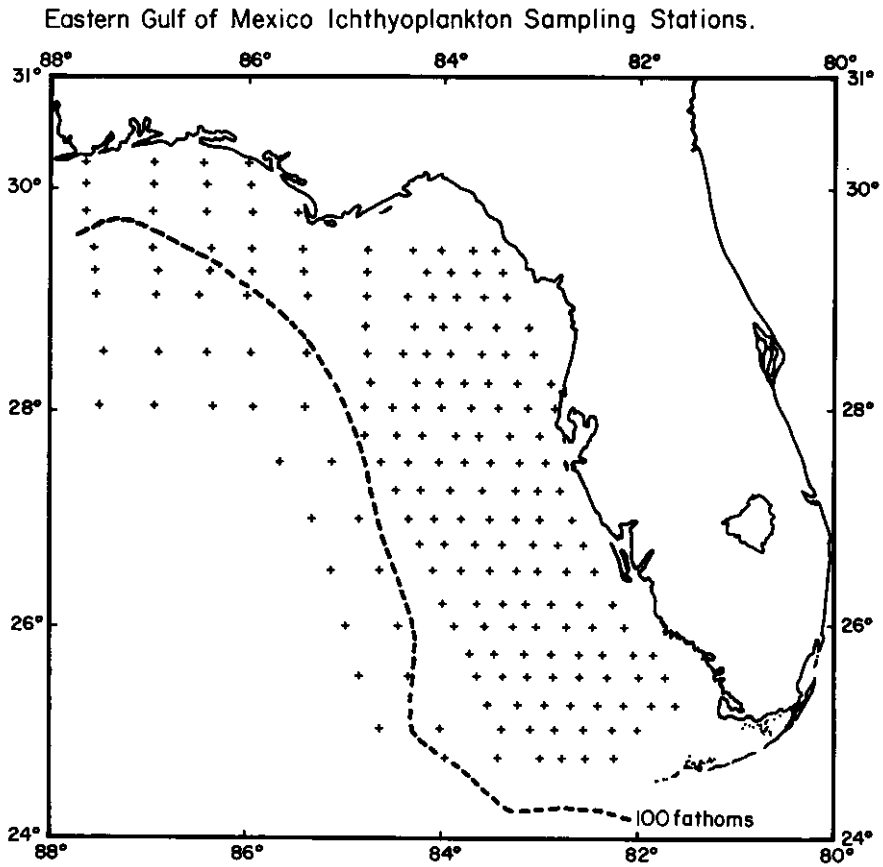

Fig. 1. The sampling grid used to determine distribution and abundance of eggs and larvae of sardine-like fishes in the Eastern Gulf of Mexico during 1971.

able vessels and time (Table 1). Three of the 1971 cruises were extensive; these were in May, August and November. Two additional cruises, February and June-July, covered smaller parts of the grid. Fewer stations were sampled in 1972 on 5 cruises because transects were spaced at 30-mile intervals, and most stations were spaced 30 miles apart. Only data from 1971 cruises were incorporated into this report.

METHODS

A Bongo net plankton-sampler (Posgay, Marak and Hennemuth, 1968) has been used to collect ichthyoplankton. Double oblique tows of paired 60-cm Bongos with 333 and 505-micron-mesh nets from near bottom to surface, or from 200 m to surface at deep stations, were made at a ship speed of about 2 knots. The gear was lowered at a wire release rate of 50 m per minute and retrieved at 15 m per minute. A flow meter inside the 505-micron-mesh Bongo

sampler was used to determine volume strained during tows. Preserved eggs and larvae were removed from plankton collected in the 505-micron-mesh net after samples were brought to the laboratory. A 1-m, 505-micron-mesh ICITA plankton net was substituted for the Bongo net at a few stations during 1971 cruises.

Clupeoid eggs and larvae were identified and counted. Numbers at each station during each cruise were reported as numbers under $100m^2$ of sea surface using the technique of Sette and Ahlstrom (1948). Catches at stations of different depths are directly comparable when reported in this manner. Sette and Ahlstrom (1948) outlined a method of integrating over time and space to estimate total abundance of eggs or larvae represented by a station during a particular cruise. Their method was used to obtain an estimate of thread herring eggs spawned during the time period represented by the May 1971 cruise.

RESULTS

THREAD HERRING

Thread herring *(Opisthonema oglinum)* spawn during spring and summer months. Prest[2] studied maturity and fecundity and concluded that adults were ripe from April to August. Fuss *et al* (1969) implied a similar spawning season. My egg and larvae collections confirm their results. Eggs and larvae were common in collections made during May, June-July and August but did not occur in February or November.

Most thread herring eggs were collected within 40 miles of shore (out to about the 20-fathom line), but some occurred at distances up to 75 miles from shore (depth about 30 fathoms) (Fig. 2). The smallest size classes of larvae (≤5.00 mm) reflected the egg distribution (Fig. 3) and may be better indicators of spawning areas than eggs because they are less than 4 days old and because they are less "patchily" distributed than are eggs. Distribution of all thread herring larvae in 1971 was more widespread than that for eggs or larvae ≤5.00 mm (Fig. 4). Larvae occurred as far as 105 miles offshore (depth about 75 fathoms), but were most common within 55 miles of shore (depth about 25 fathoms).

Most adult spawners apparently inhabited areas closer than 40 miles from shore during the 1971 spawning season. Kinnear and Fuss (1971) made highest gill net catches of adults less than 9 miles from shore near Tampa Bay in 1969 and 1970. A significant number of adults occurred farther offshore in 1971, based on my egg and larvae distribution data, but most probably were within 20 miles of shore in the Eastern Gulf. A seasonal north-south migration of adult thread herring occurs (Kinnear and Fuss, 1971) in which northerly migrations occur during spring and southerly migrations occur in fall, apparently in response to seasonal temperature changes. Nevertheless, many eggs and larvae

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[2]Prest, K. W., Jr. (unpublished typewritten manuscript). Fundamentals of sexual maturation, spawning and fecundity of thread herring *(Opisthonema oglinum)* in the Eastern Gulf of Mexico. National Marine Fisheries Service, St. Petersburg Beach, Florida.

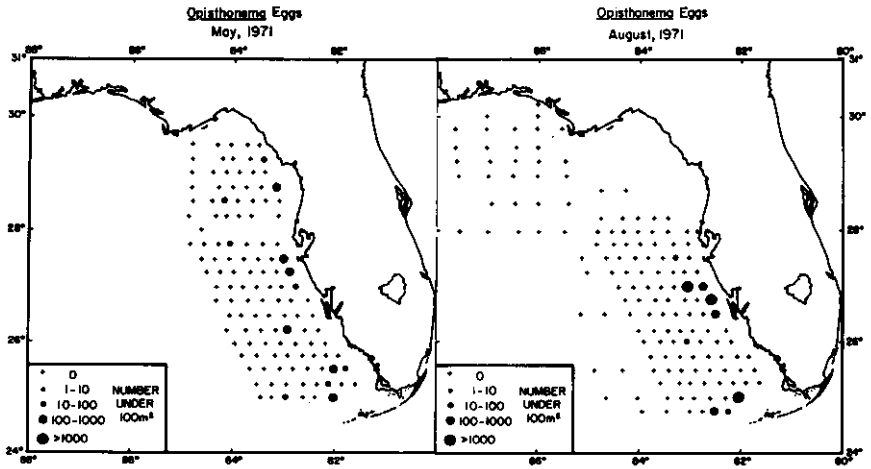

Fig. 2. Distribution of thread herring eggs in the Eastern Gulf of Mexico during May and August, 1971.

occurred south of Tampa Bay in both May and August (Figs. 2, 3 and 4), indicating that much of the adult population was distributed between Ft. Myers and Tampa Bay, even in summer months.

I have estimated thread herring biomass based on the egg distribution observed during the May 1971 cruise. The estimate is preliminary because it is derived from data representing only a part of one spawning season. Basically, the estimating procedure is that outlined by Ahlstrom (1968). I have considered the 1971 spawning season as extending from April 1 to August 31. Within the

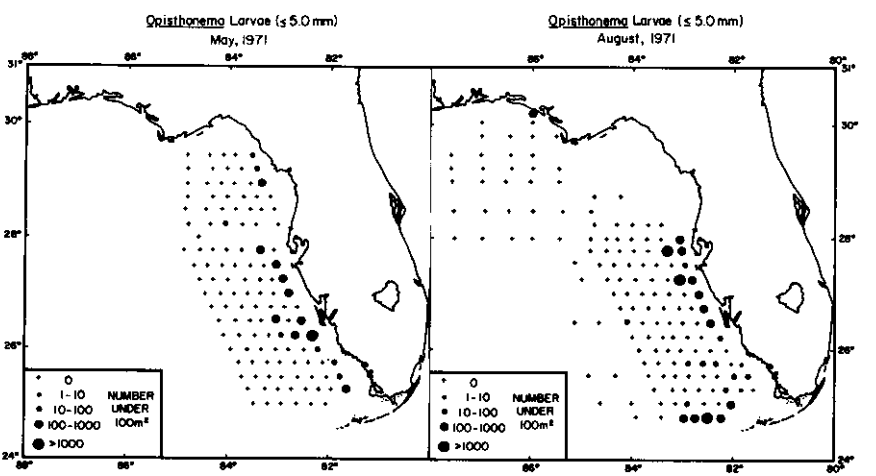

Fig. 3. Distribution of thread herring larvae ≤5.00 mm in the Eastern Gulf of Mexico during May and August, 1971.

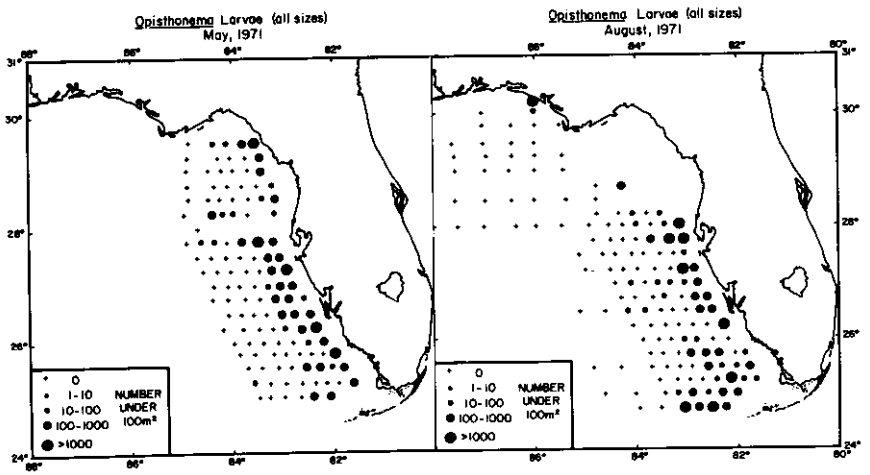

Fig. 4. Distribution of thread herring larvae of all sizes in the Eastern Gulf of Mexico during May and August, 1971.

season, I have assumed that frequency of spawning by the population more or less follows a normal distribution. In this case, the May cruise represents 73.5 days, or 31% of the area under a normal curve encompassing a spawning season of 153 days. Prest's[2] data gave mean fecundity of thread herring as about 30,900 and mean adult weight about 65 g. I assumed that the sex ratio was one to one. The estimated number of spawned eggs was 226.65 x 10^{11} south of Tampa Bay, but only 25.01 x 10^{11} north of Tampa Bay during the period represented by the May cruise.

Estimates of adult biomass were 308,600 metric tons south of Tampa Bay and 34,000 tons north of Tampa Bay in May. I feel that these estimates, though preliminary, are conservative because egg abundance probably increased in areas shallower than 5 fathoms where I did not sample.

ROUND HERRING

Eggs of round herring *(Etrumeus teres)* occurred commonly in February and November, and rarely in May at stations where depths exceeded 20 fathoms (Fig. 5). The very distinctive larvae were common in February, May and November at stations deeper than 20 fathoms, except for one catch at a shallow station (Fig. 6). Fore (1971) reported eggs of this species from December to March in the northern Gulf. Some spawning may have occurred in the Eastern Gulf at stations deeper than those included in the survey, but the November distribution data suggest that most spawning, and therefore adult concentrations, may be confined to the survey area (Fig. 5).

The abundant eggs and larvae of this species, particularly at stations where depths ranged from 30 to 100 fathoms, indicates a large biomass of adults that might be exploitable. Little is known at present regarding biology of this species and no estimates of adult biomass have been made.

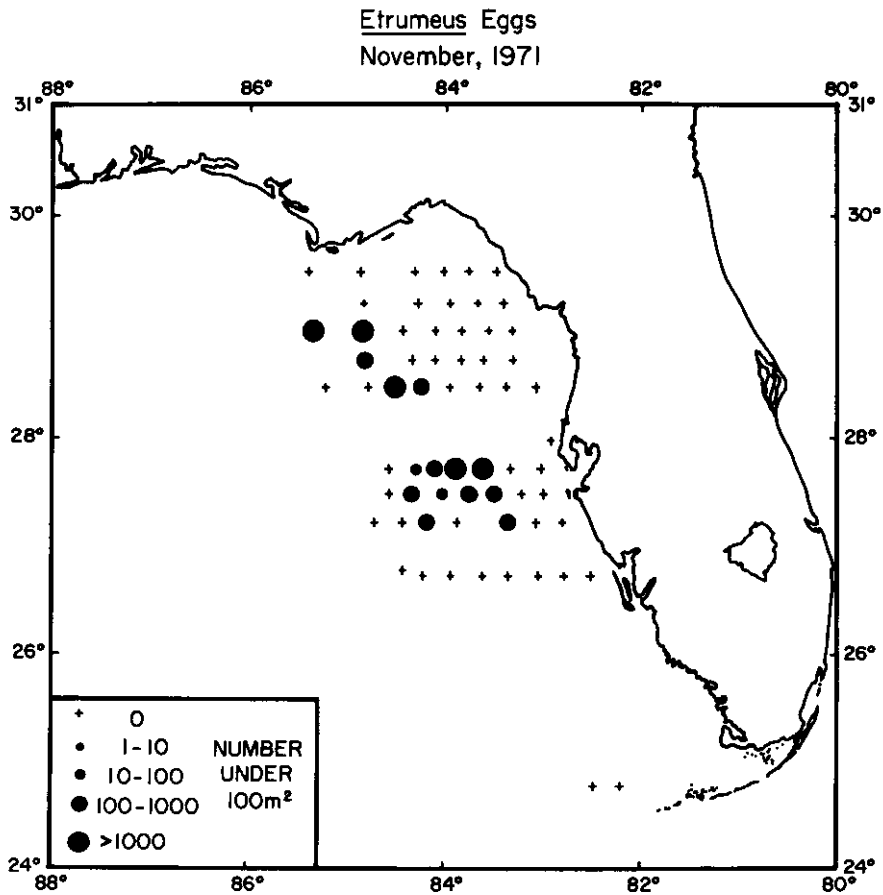

Fig. 5. Distribution of round herring eggs in the Eastern Gulf of Mexico during November, 1971.

SCALED SARDINES

Scaled sardine *(Harengula pensacolae)* eggs and larvae occurred together with thread herring in May, June-July and August. They occurred only at stations nearest to shore and were not common in 1971. Most spawning in 1971 apparently took place closer to shore than the innermost stations of the grid. Although scaled sardines may be common, abundance estimates probably will be possible only when sampling stations are extended closer to the coast.

SPANISH SARDINES

Data from 1971 are in preliminary analysis stages. Eggs and larvae of Spanish sardines *(Sardinella anchovia)* were common in February and November, and a few occurred in May. Most spawning apparently occurred during winter and fall.

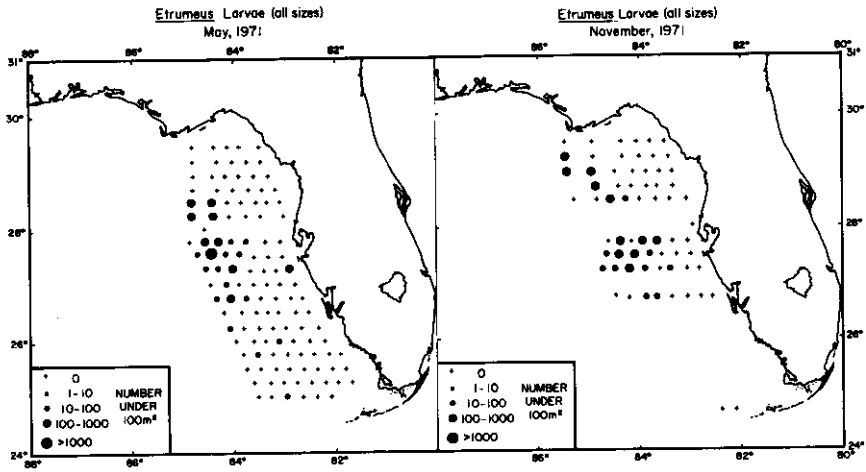

Fig. 6. Distribution of round herring larvae of all sizes in the Eastern Gulf of Mexico during May and November, 1971.

Eggs and larvae appear to be more widely distributed than those of other clupeid species in the Eastern Gulf.

ANCHOVIES

Larvae of anchovies, perhaps of several species, occurred in catches from all cruises in 1971. Eggs occurred rather uncommonly; elliptical anchovy eggs may have been extruded through meshes of 505-micron-nets. I also believe, based on laboratory rearing experiments, that some species of Gulf anchovies have spherical eggs and that such eggs have not been identified in our catches. Distribution

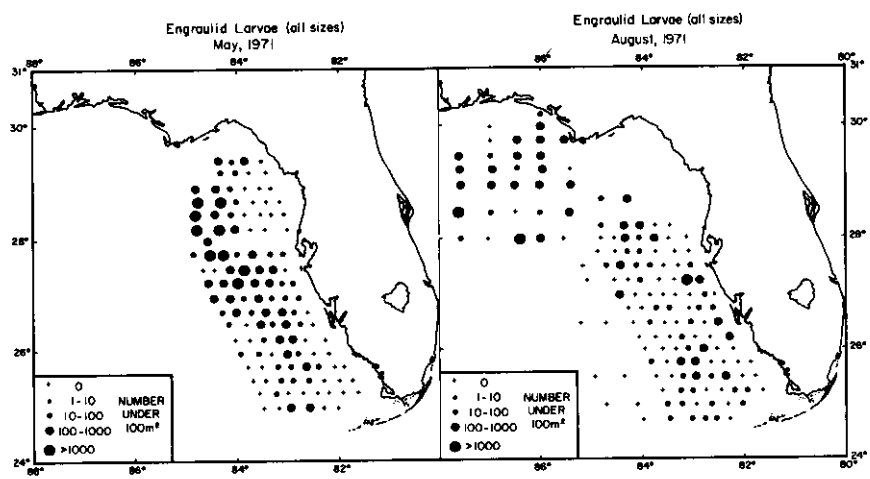

Fig. 7. Distribution of larval anchovies of all sizes in the Eastern Gulf of Mexico during May and August, 1971.

of larvae was widespread (Fig. 7) and they were abundant, particularly at stations deeper than 20 fathoms. Larvae were common even at depths of 100 fathoms or more. This suggests that a significant part of anchovy stocks in the Eastern Gulf lives well offshore.

At this time it is impossible to estimate abundance of the stocks because I cannot specifically identify larvae. It has been suggested that anchovy stocks may be the largest unfished potential resource in the Gulf (Bullis and Carpenter, 1968). Larval catches attest to the abundance of anchovies, but the relatively high fecundity of adults, coupled with small body size, may be misleading. Total biomass of adults possibly is not as great as larval catches suggest.

OTHER CLUPEOIDS

A single menhaden larva *(Brevoortia* sp.) was collected in November near Tampa Bay. Yellowfin menhaden *(Brevoortia smithi)* eggs and larvae should be common in winter in some parts of the Eastern Gulf (Turner, 1969), but my February and November cruises did not sample those areas in 1971.

A few unidentified clupeid larvae were collected. Some of these could be dwarf herrings *(Jenkinsia* spp.).

SUMMARY AND CONCLUSIONS

Assessment of distribution and abundance of eggs and larvae promises to be a good technique for evaluating fishery potential of sardine-like fishes in the Eastern Gulf. Preliminary analyses have demonstrated that areal distribution, spawning seasons and presence of spawning concentrations of adults can be quickly determined. Biomass estimates and yearly fluctuations in stock size will be possible. The same techniques can be applied to assess species other than clupeoids. Snappers, groupers and mullets are examples of fishes that can be studied by this kind of survey.

I hope that reliable assessments of population size and yearly fluctuations will lead to development of well-managed and productive commercial fisheries for presently underutilized clupeoid populations. Present legal restrictions make it difficult to utilize some of the sardine-like fishes that are within 9 miles of the Florida coastline. Thread herring fall into this category. Data from egg and larvae distribution in 1971 indicated that many adult thread herring were beyond the 9-mile state boundary, at least during the spawning season. Also, round herring and anchovy larvae were common well offshore, suggesting the presence of large adult populations that might be exploited by midwater trawls.

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