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PELAGIC CNIDARIA OF MISSISSIPPI SOUND AND ADJACENT WATERS¹

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ABSTRACT Investigations were made in Mississippi Sound and adjacent waters from March 1968 through March 1971 to record the occurrence and seasonality of planktonic cnidarians. About 700 plankton samples were taken from estuarine and oceanic areas. From these samples, 26 species of hydromedusae were identified, 12 of which were collected from Mississippi Sound. In addition, 25 species of siphonophorae were identified from Mississippi waters, although only 6 species were collected in Mississippi Sound. From an examination of about 500 trawl samples taken during this period, 10 species of Scyphozoa were found in Mississippi waters, 6 of which occurred in Mississippi Sound.

INTRODUCTION

Plankton samples taken from the shallow waters of Mississippi Sound frequently disclose large numbers of hydromedusae, and it is a rare sample that fails to contain cnidarians. Yet there is a paucity of published information concerning the seasonal composition and distribution of the coelenterates of Mississippi Sound or indeed of the entire northern Gulf of Mexico.

Mayer's (1900) work in the Tortugas was the first substantive catalogue of Cnidaria from a specific location within the Gulf of Mexico. Mayer's publication provided the data for Sears' (1954a) compilation of hydromedusae presumed to occur within the Gulf. Kramp (1959) catalogued the hydromedusae of the Atlantic coast of the United States and supposed that Atlantic cnidarian assemblages would not necessarily characterize Gulf of Mexico populations. The distribution of the anthomedusa *Nemopsis bachei* L. Agassiz 1849 along the northern Gulf of Mexico was discussed by Moore (1962). Hopkins (1966) published a comprehensive list of hydromedusae known to occur in St. Andrew Bay, Florida. Generally, however, most recent papers on zooplankton of the Gulf of Mexico have afforded the hydromedusae only cursory attention.

Although the littoral region of the northern Gulf of Mexico has a relatively rich scyphozoan fauna, workers in this part of the world have tended to treat these medusae in only a perfunctory manner. Hedgpeth (1954), drawing largely from Mayer (1900, 1910), produced a checklist of Scyphozoa likely to occur within the Gulf of Mexico. Guest (1959) and Phillips and Burke (1970) discussed the distribution of *Chiropsalmus quadrumanus* (Müller 1859) along the coasts of Texas and Mississippi respectively. Hoese et al. (1964) recorded *Cyanea capillata* (L) as a faunal element at Port Aransas, Texas. Sanders and Sanders (1963) erected a tenuous subspecies of *Pelagia noctiluca* Forskål 1775 based on specimens collected near Galveston, Texas. Phillips et al. (1969) discussed the trophic significance of several species

of coelenterates from Mississippi waters. Several workers along the northern Gulf of Mexico have made reference to a few species of scyphomedusae occurring in their respective study areas (Whitten et al. 1950; Gunter 1950; Simmons 1957; Menzel 1971). Sears (1954b) briefly concluded that it would not be surprising to find in the Gulf of Mexico any one of the 140 or more siphonophore species now known.

THE WORK AREA: MISSISSIPPI SOUND

Mississippi Sound is an elongate, shallow body of water extending from Lake Borgne in Louisiana to Mobile Bay in Alabama, and is bounded to the south by a series of five low barrier islands. The shallowly submerged bars between the barrier islands are cut by several natural deep passes, and three channels into Mississippi Sound are maintained for navigation purposes. Five major watersheds introduce fresh water into Mississippi Sound. The sound is typically shallow (ca. 10 feet) and is subject to extreme variations of salinity and temperature. The bottom is soft mud except in the sandy areas adjacent to the barrier islands.

METHODS: PLANKTON SAMPLING

From March 1968 until August 1969 numerous stations in Mississippi Sound (Figure 1) were sampled at approximately monthly intervals. Surface samples were collected by towing an 18-inch zooplankton net, equipped with 330-micron netting, for 1 mile at each site. During the same period, monthly surface samples were taken in similar fashion offshore (Figure 2) using 1-meter plankton nets. August 1969 witnessed the onslaught of Hurricane Camille, which destroyed all project facilities, the backlog of unexamined samples, and all curated specimens. Routine monthly plankton sampling was resumed in January 1970 and continued through March 1971. At each of the stations indicated in Figure 3, monthly surface and bottom plankton samples were collected. Additional midwater plankton samples were regularly collected at stations 9 and 10. Standard 12-inch plankton nets were employed to obtain surface samples and 12-inch Clarke-Bumpus plankton samplers were used to obtain subsurface samples. All nets used subsequent to

¹This study was conducted in cooperation with the Department of Commerce, NOAA, National Marine Fisheries Service, under Public Law 89-720, Project No. JF-2-1.

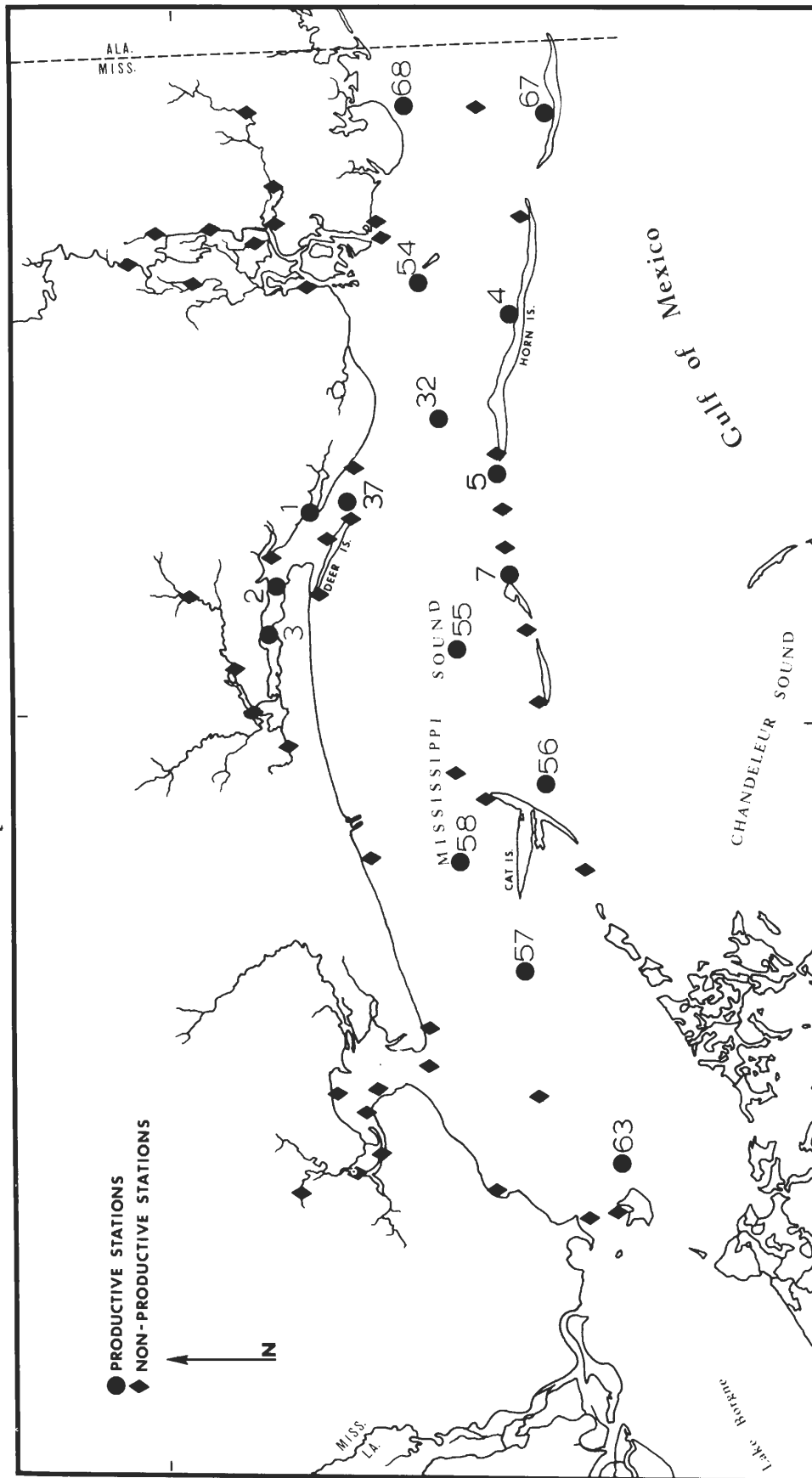


Figure 1. Sites of monthly surface plankton collections in Mississippi Sound, March 1968–August 1969.

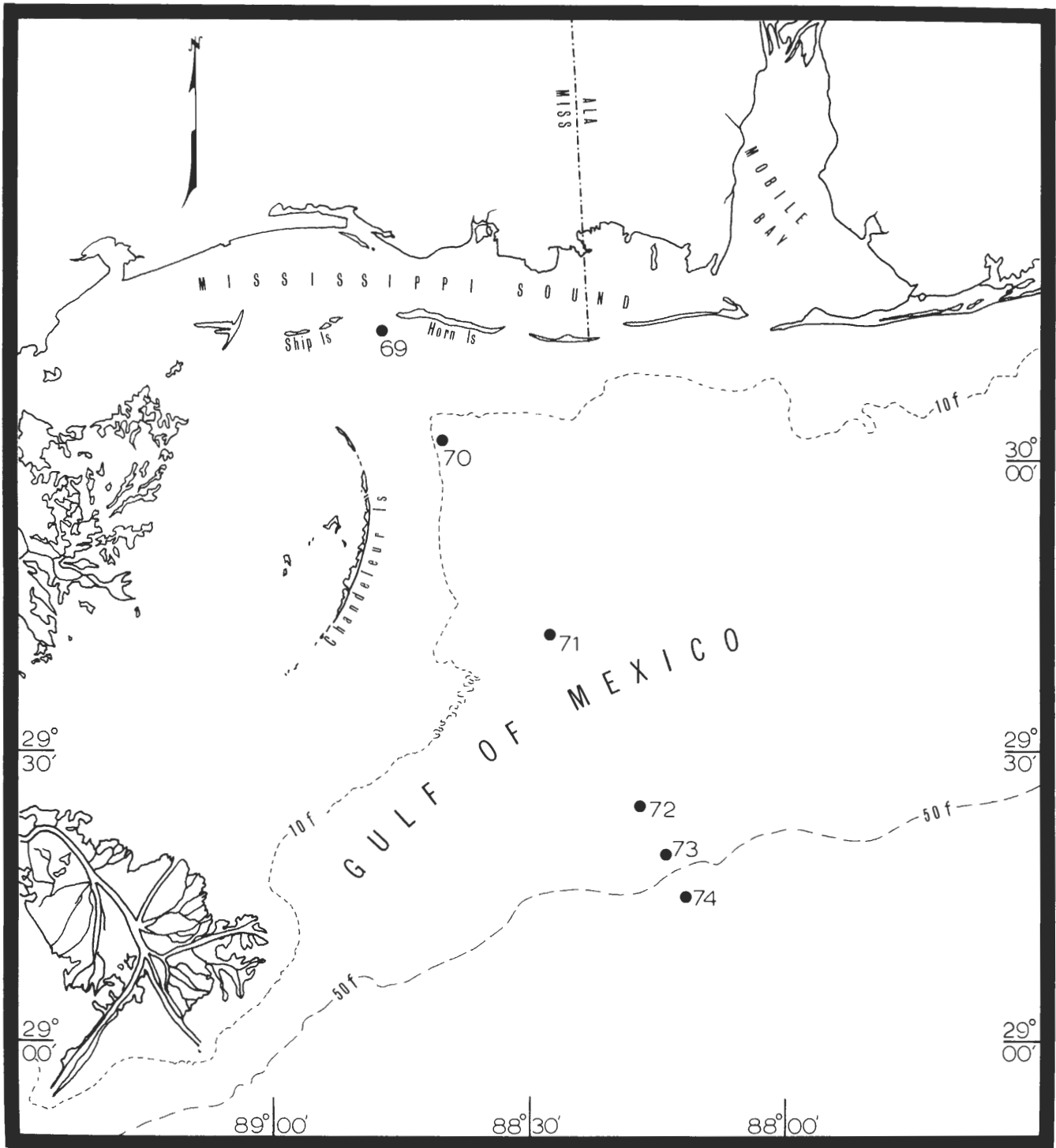


Figure 2. Sites of monthly surface plankton collections in the northern Gulf of Mexico, March 1968–August 1969.

January 1970 were equipped with No. 8 mesh (193 microns). Since it was necessary to trail the surface net a considerable distance behind the boat to avoid the tremendous wash produced by jet-pump propelled boats, yet at sufficiently great speed to prevent nets sinking very far below the surface, samples were collected at fairly high speeds. Nets were

operated at each collecting site for 10 minutes at a speed of 3 knots. All plankton samples collected during the 3-year period were preserved in 5% formalin-seawater solutions and were brought to the laboratory for analysis. Twenty-four-hour settled plankton volumes were determined for all samples and medusae were subsequently sorted, identified

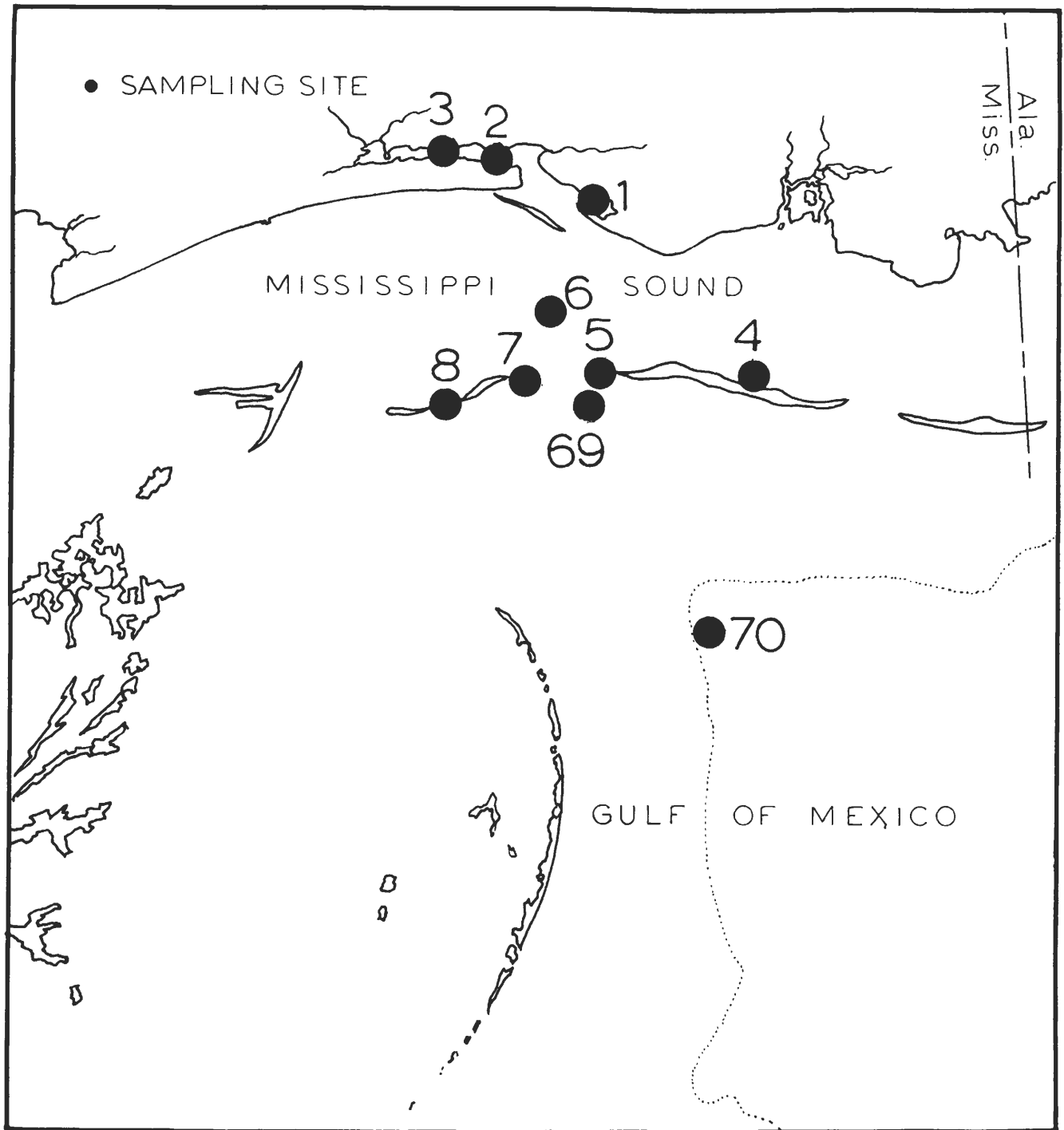


Figure 3. Sites of monthly bottom trawl, surface, midwater and bottom plankton collections in Mississippi Sound and the adjacent Gulf of Mexico, January 1970–March 1971.

and curated. Species determinations were largely based on the works of Mayer (1910) and Kramp (1959).

METHODS: SCYPHOMEDUSAE SAMPLING

Concurrent with each inshore plankton sampling effort,

larger medusae were routinely collected with bottom trawls. Otter trawls employed at inshore stations were 16 feet wide semi-balloons made of 1-inch stretch nylon, and were dragged for 10 minutes at a speed of 3 knots. Larger nets were dragged a distance of 1 mile at offshore sampling sites. Discrepancies between the sampling procedures employed in

the two areas essentially precluded quantitative analyses but did serve to provide data of qualitative nature.

Additional specimens of scyphomedusae were collected by dipnetting or by gathering specimens stranded along the swash lines of the mainland and along the beaches of the several islands.

DREDGING OPERATIONS

During the late summer of 1968 and again during the summer of 1970, dredge samples were taken from 118 stations near the mouth of the Mississippi River, throughout the Chandeleur Islands in Louisiana and within Mobile Bay, Alabama. These dredge samples were meticulously examined for the sessile stages of Cnidaria. No scyphozoan polyps and only seven species of hydroids were present. The silt-laden waters characteristic of Mississippi Sound are likely inimical to polyp production. However, if viable polyp beds ever existed in or near Mississippi Sound, they would have likely been buried by the force of the August 1969 hurricane, and presumably would not be re-established for several seasons.

HYDROLOGICAL TECHNIQUES

Hydrologic data were collected at levels corresponding to biological sampling activity. Temperature, salinity and dissolved oxygen were routinely determined in the field with portable instruments. Occasional failure of instrumentation dictated that parameters would be determined in the field with hand-held or reversing thermometers, and Goldberg refractometers. Some water samples were collected, chilled on ice, and brought to the laboratory where dissolved oxygen and pH were determined by appropriate laboratory procedures. Additionally, water transparency of each collecting site was estimated by observing extinction points of standard Secchi discs. Although all parameters were seasonally, areally and vertically variable it was statistically demonstrable that neither transparency, pH nor dissolved oxygen was a factor in limiting the distribution of any given species of medusa.

Critical oxygen concentrations or pH values were found only in freshwater areas subject to industrial or domestic pollution.

Temperatures followed a fairly predictable seasonal cycle averaging about 10°C during winter and about 30°C in summer. Temperature extremes of 7.7°C and 32.7°C were observed during the study period.

Salinities ranged from fresh in the upper bay areas to oceanic at the offshore stations. Salinity throughout most of the sound is subject to considerable local variations determined by prevailing wind conditions, rainfall and subsequent river discharge. Salinity extremes of 0.4 ppt and 37.7 ppt were encountered during the study period.

RESULTS

Sixty-one species of cnidarians were collected from Mississippi Sound and the adjacent Gulf of Mexico. Open Gulf waters south of the barrier islands displayed considerably greater faunal diversity than the relatively impoverished sound. Present in the samples were 26 species of hydro-

medusae, 25 species of siphonophores, and 10 species of scyphomedusae.

Among the few species of hydromedusae found to be capable of long-term survival in Mississippi Sound were *Liriope tetraphylla* (Chamisso and Eysenhardt 1821), *Nemopsis bachei* L. Agassiz 1849, *Bougainvillia carolinensis* (McCrary 1857), and *Persa incolorata* McCrary 1857. These four species were often so abundant in Mississippi Sound as to represent the bulk of a given plankton sample. *L. tetraphylla*, the most abundant hydromedusa in Mississippi Sound, displayed an affinity for warm, high-salinity water masses and apparently occurred in Mississippi Sound as a result of the intrusion of Gulf waters during summers. *P. incolorata*, although associated with fairly high marine masses, displayed a considerable tolerance to variations in temperature, occurring at temperatures ranging from below 10°C to about 30°C. *Persa* was found to be abundant in the island passes from midwinter through late summer.

The anthomedusa *N. bachei* displayed the ability to survive a wide range of both salinity and temperature. *Nemopsis* was the only hydromedusa regularly collected in brackish water (ca. 5 ppt salinity), and occurred in Mississippi Sound from late fall through early spring. *B. carolinensis*, although not as eurytopic as *N. bachei*, was abundant in Mississippi Sound during all but the midwinter months. *B. carolinensis* occurred year-round in the northern Gulf adjacent to the sound.

Generally, hydromedusae were more abundant at salinities between 25 and 30 ppt. There was a gradual decline in numbers with decreasing salinities, and a marked decline with increasing salinities. Under conditions of higher salinities hydromedusae were apparently ecologically displaced by the oceanic siphonophores. Presumably the bulk of both hydromedusae and scyphomedusae were recruited into Mississippi Sound from the Gulf of Mexico as adults or near adults.

In Mississippi Sound, hydromedusae were generally more numerous at higher temperatures, achieving maximum numbers during the summers and declining drastically during the winters. Offshore, where environmental conditions were somewhat more stable, populations were fairly constant year-round. Vertical stratification of hydromedusae was not demonstrable in either Mississippi Sound or the immediately adjacent Gulf of Mexico. There was no direct correlation between numbers of hydromedusae and the volume of residual planktonic elements within given plankton samples, suggesting that in an area as placid as Mississippi Sound frequently becomes, hydromedusae are not strictly planktonic but are capable of exhibiting a nearly nektonic mode of life.

The areal and seasonal distributions of all species of hydromedusae collected in Mississippi Sound are indicated in Tables 1 and 2 respectively.

Diagnoses, previous geographic distributions, and line drawings of all species of hydromedusae known to occur in Mississippi waters are given in the following section. The diagnoses and distributions are those of P. L. Kramp (1959). The line drawings were executed by Harry L. Moore, Gulf Coast Research Laboratory, and are after various authors.

TABLE 1.
Medusae of 1968–1971 inshore and offshore plankton
collections; Mississippi waters

Species	Inshore	Offshore
Class: Hydrozoa		
Order: Anthomedusae/Athecata		
<i>Amphinema dinema</i> (Péron & Lesueur 1809)		X
<i>Bougainvillia carolinensis</i> (McCrary 1857)	X	X
<i>Bougainvillia frondosa</i> Mayer 1900		X
<i>Cytaeis tetrastyla</i> Eschscholtz 1829		X
<i>Dipurena ophiogaster</i> Haeckel 1879	X	X
<i>Euphysora gracilis</i> (Brooks 1882)	X	X
<i>Hybocodon forbesi</i> Mayer 1894		X
<i>Lizzia gracilis</i> (Mayer 1900)		X
<i>Nemopsis bachei</i> L. Agassiz 1849	X	X
<i>Steenstrupia nutans</i> (M. Sars 1835)		X
Order: Leptomedusae/Thecata		
<i>Eirene pyramidalis</i> (L. Agassiz 1862)		X
<i>Eirene viridula</i> (Péron & Lesueur 1809)	X	X
<i>Eutima mira</i> McCrary 1857	X	X
<i>Eutima variabilis</i> McCrary 1857	X	X
<i>Laodicea undulata</i> (Forbes & Goodsir 1853)		X
<i>Obelia</i> spp.	X	X
<i>Phialidium languidum</i> (A. Agassiz 1862)	X	X
Order: Trachymedusae		
<i>Aglaura hemistoma</i> Péron & Lesueur 1809		X
<i>Geryonia proboscidalis</i> (Forskål 1775)	X	
<i>Liriope tetraphylla</i> (Chamisso & Eysenhardt 1821)	X	X
<i>Persa incolorata</i> McCrary 1857	X	X
<i>Rhopalonema velatum</i> Gegenbaur 1856		X
Order: Narcomedusae		
<i>Cunina octonaria</i> McCrary 1857		X
<i>Cunina peregrina</i> Bigelow 1909		X
<i>Solmundella bitentaculata</i> (Quoy & Gaimard 1833)		X
Order: Limnomedusae		
<i>Proboscidactyla ornata</i> (McCrary 1857)		X
Order: Siphonophorae		
Sub-Order: Cystonectae		
<i>Physalia physalis</i> (L)	X	X
<i>Rhizophysa filiformis</i> Forskål 1775		X
Sub-Order: Physonectae		
<i>Agalma okeni</i> Eschscholtz 1825	X	X
<i>Cordagalma cordiformis</i> Totton 1932		X
<i>Nanomia bijuga</i> Chiaje 1841	X	X
Sub-Order: Calyophorae		
<i>Abylopsis eschscholtzi</i> Huxley 1859		X
<i>Abylopsis tetragona</i> Otto 1823		X
<i>Bassia bassensis</i> Quoy & Gaimard 1833	X	X
<i>Ceratocymba leukartii</i> (Huxley 1859)		X
<i>Ceratocymba sagittata</i> Quoy & Gaimard 1827		X
<i>Chelophyes appendiculata</i> Eschscholtz 1829		X
<i>Diphyes bojani</i> Eschscholtz 1829		X
<i>Diphyes dispar</i> Chamisso & Eysenhardt 1821		X

TABLE 1 – Continued

Species	Inshore	Offshore
Sub-Order: Calyophorae – Continued		
<i>Enneagonium hyalinum</i> Quoy & Gaimard 1827		X
<i>Eudoxoides mitra</i> Huxley 1859		X
<i>Eudoxoides spiralis</i> Bigelow 1911		X
<i>Hippopodius hippopus</i> Forskål 1776		X
<i>Lensia campanella</i> Moser 1925		X
<i>Lensia subtilis</i> Chun 1886		X
<i>Muggiaea kochi</i> Will 1844	X	X
<i>Sulceolaria biloba</i> Sars 1846		X
<i>Sulceolaria chuni</i> Lens & Van Riemsdijk 1908		X
<i>Sulceolaria quadrivalis</i> Blainville 1834		X
<i>Vogtia glabra</i> Bigelow 1918		X
Order: Chondrophora		
<i>Velella velella</i> (L)	X	X
Class: Scyphozoa		
Order: Coronatae		
<i>Nausithoe punctata</i> Kölliker 1853		X
<i>Paraphyllina</i> sp		X
Order: Semaestomeae		
<i>Aurelia aurita</i> (L)	X	
<i>Chrysaora quinquecirrha</i> (Desor 1848)	X	X
<i>Cyanea capillata</i> (L)	X	
<i>Pelagia noctiluca</i> Forskål 1775	X	X
Order: Cubomedusae		
<i>Chiropsalmus quadrumanus</i> (Müller 1859)	X	X
<i>Tamoya haplonema</i> Müller 1859		X
Order: Rhizostomeae		
<i>Rhopilema verrillii</i> (Fewkes 1887)	X	X
<i>Stomolophus meleagris</i> L. Agassiz 1862	X	X

DIAGNOSES AND ACCOUNTS OF CERTAIN OF THE
MEDUSAE OF MISSISSIPPI WATERS:

HYDROZOA

CLASS HYDROZOA: Medusae with a velum or membrane, which partially closes the marginal opening of the bell. Reproductive organs ectodermal. Development direct or alternating with a sessile hydroid, neither stage possessing gastric filaments or ridges.

Order 1. Anthomedusae/Athecata: Hydromedusae with gonads typically on the manubrium. No lithocysts, may possess photoreceptors (ocelli). Umbrella usually deep bell-shaped.

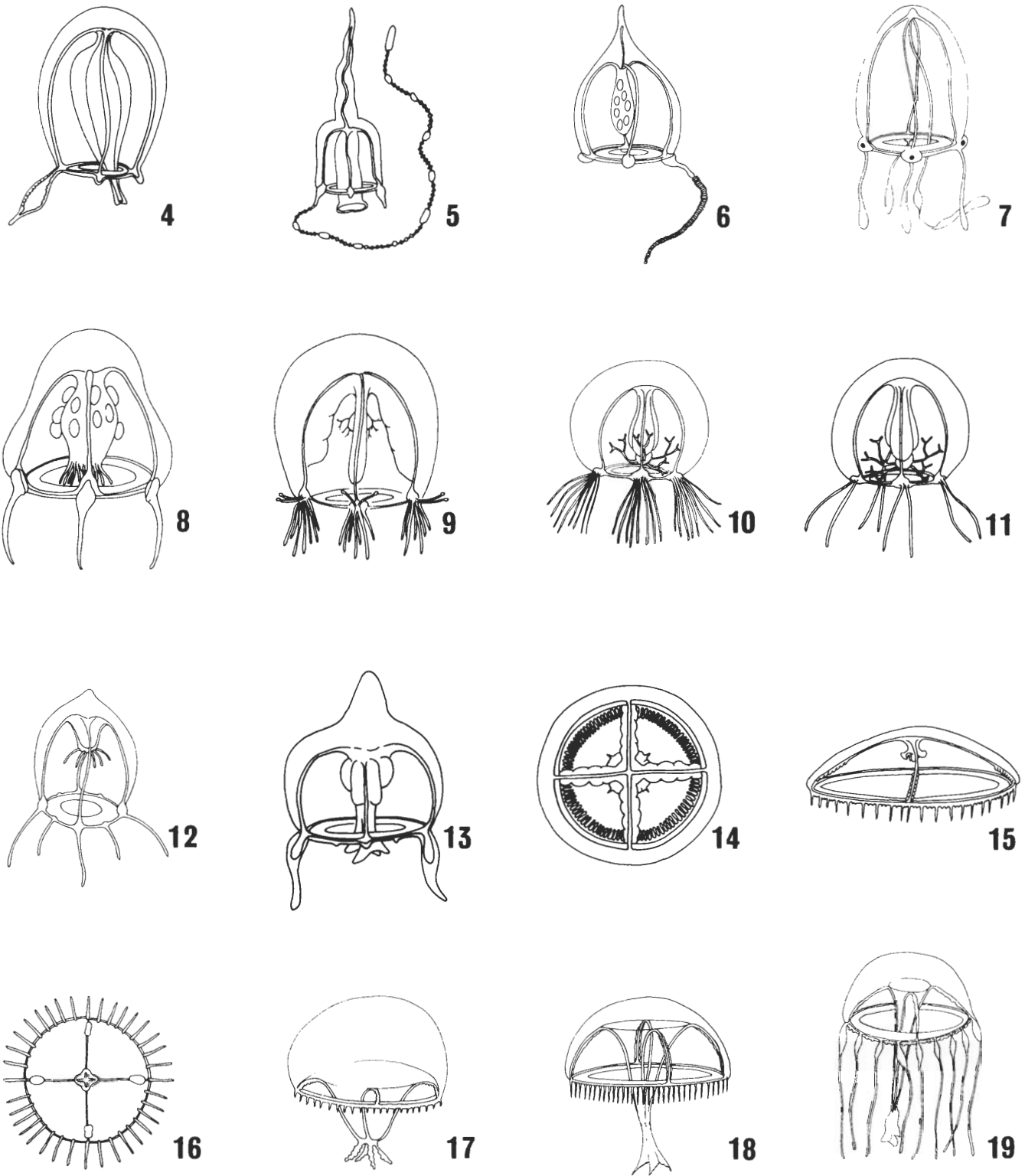
Family 1. Tubulariidae: Anthomedusae with simple tubular mouth; 4 radial canals; short manubrium; 1–4 tentacles, alike or dissimilar; no ocelli. Three representative species in Mississippi waters:

Hybocodon forbesi Mayer 1894 (Figure 4)

Euphysora gracilis (Brooks 1882) (Figure 5)

Steenstrupia nutans (M. Sars 1835) (Figure 6)

Diagnosis: *Hybocodon forbesi*. 3 mm high, bell-shaped, jelly uniformly thin. With short manubrium; 4 radial canals;



Figures 4–19. 4. *Hybocodon forbesi* Mayer 1894. 5. *Euphysora gracilis* (Brooks 1882). 6. *Steenstrupia nutans* (M. Sars 1835). 7. *Dipurena ophiogaster* Haeckel 1879. 8. *Cytaeis tetrastyla* Eschscholtz 1829. 9. *Nemopsis bachei* L. Agassiz 1849. 10. *Bougainvillia carolinensis* (McCrary 1857). 11. *Bougainvillia frondosa* Mayer 1900. 12. *Lizzia gracilis* (Mayer 1900). 13. *Amphinema dinema* (Péron & Lesueur 1809). 14. *Laodicea undulata* (Forbes & Goodsir 1853). Aboral view. 15. *Phialidium languidum* (A. Agassiz 1862). 16. *Obelia* sp. Oral view. 17. *Eirene pyramidalis* (L. Agassiz 1862). 18. *Eirene viridula* (Péron & Lesueur 1809). 19. *Eutima variabilis* McCrary 1857.

1 well developed tentacle and 3 rudimentary knob-like tentacles.

Previous recorded distribution: Bahamas, Tortugas, India, Japan. Rare in Mississippi waters, one specimen collected at station 69 on 7 April 1971.

Diagnosis: *Euphysora gracilis*. 5 mm high inclusive of prominent apical projection, bell slender, jelly thin. With massive manubrium, surrounded by the gonad; 4 radial canals; long cordlike major tentacle; opposite tentacle cone-shaped, the 2 others mere bulbs.

Previous recorded distribution: New England coast to Florida, Brazil. Common in Mississippi waters, occurs most months of the year both inshore and offshore.

Diagnosis: *Steenstrupia nutans*. 5 mm high inclusive of prominent apical projection. With massive manubrium, surrounded by gonad; 4 radial canals; major tentacle long, other 3 mere bulbs.

Previous recorded distribution: Northwestern Europe, Mediterranean Sea. Rare in Mississippi waters. One specimen collected on 17 January 1968 at station 71, and another on 27 March 1968 at station 74.

Family 2. Corynidae: Anthomedusae with simple tubular mouth; 4 radial canals; gonad surrounding the manubrium; usually 4 tentacles (occasionally only 2); ocelli present. One representative in Mississippi waters:

Dipurena ophiogaster Haeckel 1879 (Figure 7).

Diagnosis: 5 mm high, bell-shaped, jelly thick. With gonads in 2 to several segments along manubrium; 4 radial canals; 4 perradial tentacles; distinct apical chamber. Tentacles bulbs with ocelli.

Previous recorded distribution: Southern coast of Britain, Ceylon, Japan, west coast of Mexico. Rare in Mississippi waters. One specimen collected at station 69 on 14 August 1968; a second specimen collected at station 72 on 23 August 1968.

Family 3. Cytaeidae: Anthomedusae with simple mouths; unbranched oral tentacles or with 4 clusters of cnidophores; 4 radial canals; 4 solid marginal tentacles. One representative in Mississippi waters:

Cytaeis tetrastyla Eschscholtz 1829 (Figure 8).

Diagnosis: 5 mm high, bell-shaped, jelly moderately thick. With interradial gonads; 4 radial canals; 4 perradial marginal tentacles; unbranched oral tentacles; no ocelli.

Previous recorded distribution: All tropical and subtropical waters. Rare in Mississippi waters. Six specimens collected at station 74 on 27 March 1968, 2 specimens collected at station 73 on 10 December 1968, and 6 additional specimens collected at station 74 on 30 April 1969.

Family 4. Bougainvilliidae: Anthomedusae with simple tubular mouth with branched or unbranched oral tentacles; with 4 radial canals; marginal tentacles solitary or grouped in multiple marginal bulbs; may possess ocelli. Four representative species occur in Mississippi waters:

Nemopsis bachei L. Agassiz 1849 (Figure 9)

Bougainvillia carolinensis (McCrary 1857) (Figure 10)

Bougainvillia frondosa Mayer 1900 (Figure 11)

Lizzia gracilis (Mayer 1900) (Figure 12).

Diagnosis: *Nemopsis bachei*. 10–15 mm high, globular, jelly moderately thick, with short manubrium; 4 radial

canals; repeatedly branched oral tentacles; marginal tentacles clustered in 4 groups of 15–20 (median pair of clavate tentacles in each group); 4 lobes of stomach extending along radial canals from which append the 4 ribbon like gonads.

Previous recorded distribution: Atlantic coast of United States, northern Gulf of Mexico, Holland. Extremely abundant in Mississippi waters during fall and winter.

Diagnosis: *Bougainvillia carolinensis*. 4–5 mm high, globular, jelly thick. With long slender manubrium; dichotomously branched oral tentacles; 4 radial canals; interradial gonads; 4 groups of 8 or 9 marginal tentacles. Tentacle bulbs contain ocelli.

Previous recorded distribution: Atlantic coast of United States, Gulf of Guinea. Occasionally abundant in Mississippi waters and occurs during all but winter months.

Diagnosis: *Bougainvillia frondosa*. 2–3 mm high, bell-shaped, jelly moderately thick. With 8 adradial gonads; 4 pairs of perradial marginal tentacles; oral tentacles branched dichotomously; no ocelli.

Previous recorded distribution: Florida. Rare in Mississippi waters. One specimen collected at station 71 on 19 June 1968.

Diagnosis: *Lizzia gracilis*. 3 mm high, bell-shaped with vague apical projection, jelly moderately thick. With short manubrium; 4 perradial and 4 interradial oral tentacles; 8 marginal tentacles arranged in similar fashion; no ocelli.

Previous recorded distribution: Florida, Sunda Strait. Collected twice in Mississippi waters. Three specimens collected 27 March 1968 at station 74; and 2 specimens 20 May 1968 at station 71.

Family 5. Pandeidae: Anthomedusae with large apedunculate stomach; simple or lipped mouth; 4 radial canals; gonads on stomach walls; 2–8 hollow marginal tentacles. Ocelli present or absent. One representative in Mississippi waters:

Amphinema dinema (Péron & Lesueur 1809)
(Figure 13)

Diagnosis: 5–6 mm high, including prominent apical projection, width greater than 1/2 height; 4 adradial gonads attached to cruciform stomach; 4 radial canals; 2 long major tentacles; 2 bulbous alternate tentacles; numerous marginal warts; no ocelli.

Previous recorded distribution: Western Europe, entire Atlantic coast of United States, India, Australia. Common in offshore waters of Mississippi where it apparently occurs year round.

Order 2. Leptomedusae/Thecata: Hydromedusae with discoidal or hemispherical bell; gonads on radial canals. Sense organs, if present, cordyli or marginal vesicles. With or without ocelli.

Family 1. Laodiceidae: Leptomedusae with marginal cordyli. One representative in Mississippi waters:

Laodicea undulata (Forbes & Goodsir 1853)
(Figure 14).

Diagnosis: Large (ca. 30 mm), flatter than a hemisphere. With 4 sinuous gonads appended from the 4 radial canals; apedunculate stomach; 400–600 tentacles about 1/4 of which possess ocelli; a cirrus or cordylus between successive tentacles.

Previous recorded distribution: Entire east and west coasts of the Atlantic Ocean, Mediterranean Sea. A total of 35 specimens were collected from stations 71, 72 and 73 during two consecutive cruises, 24 through 26 September 1968 and 9 and 10 October 1968.

Family 2. Campanulariidae: Leptomedusae with small apedunculate stomachs; typically with 4 radial canals; gonads completely surrounding radial canals and separated from stomach; numerous closed marginal vesicles; no ocelli. Two representatives of the family occur in Mississippi waters:

Phialidium languidum (A. Agassiz 1862) (Figure 15)

Obelia sp. (Figure 16).

Diagnosis: *Phialidium languidum*. Campanulariidae with normal velum, 10–20 mm in diameter, bell flatter than a hemisphere, jelly thin. With about 32 hollow marginal tentacles; about 64 marginal vesicles; ovate gonads on each of 4 radial canals near bell margin.

Previous recorded distribution: Atlantic coast of United States. A total of 21 specimens were collected on 13 May 1968 at stations 57, 58 and 63. One specimen collected at station 70 on 18 May 1968, and another from that station on 30 July 1968.

Diagnosis: *Obelia* sp. Campanulariidae, 1–2 mm in diameter, with an extremely thin discoidal bell. With short stomach; 4 sac-like gonads near middle of each of 4 radial canals; numerous solid tentacles; 8 marginal vesicles. This genus was established by Péron & Lesueur in 1809.

Although the medusae are fairly common in all seas, no satisfactory means has been devised to specifically distinguish them. A total of 27 specimens of *Obelia* were collected during the following months at the corresponding sampling sites: May 1968, stations 63 and 68; June 1968, station 37; August 1968, station 32; September 1968, station 55; July 1970, station 5; September 1970, station 6; November 1970, station 5; and January 1971, station 69.

Family 3. Eirenidae: Leptomedusae with short pedunculate stomach; 4–6 radial canals; gonads surrounding radial canals; hollow marginal tentacles; closed marginal vesicles; no ocelli. With or without marginal cirri. Only the nominate genus occurs in Mississippi waters and is represented by two species:

Eirene pyramidalis (L. Agassiz 1862) (Figure 17)

Eirene viridula (Péron & Lesueur 1809) (Figure 18).

Diagnosis: *Eirene pyramidalis*. Eirenidae lacking lateral cirri, 30–40 mm wide, flatter than a hemisphere, jelly thick. With peduncle almost as wide as bell; linear gonads appended from distal end of each of 4 radial canals. The 100 or so marginal tentacles are similar, marginal vesicles of about same number as tentacles. Stomach small, lips much folded.

Previous recorded distribution: Bahamas; Florida; Jamaica; Beaufort, North Carolina. One hundred twenty-four specimens were collected during the following months at the corresponding stations: May 1968, station 69; September 1968, stations 71 and 73; October 1968, stations 70, 71 and 73.

Diagnosis: *Eirene viridula*. Eirenidae lacking lateral cirri. 20–30 mm wide, hemispherical, jelly thick. With long slender peduncle; linear gonads appended from distal end

of each of 4 radial canals; about 60 dissimilar marginal tentacles; marginal vesicles about as numerous as tentacles; small stomach with 4 pointed, much folded lips.

Previous recorded distribution: Northwestern Europe, Mediterranean Sea, Africa, Ceylon. One specimen of *E. viridula* was collected at station 68 on 6 May 1968 and a second one from station 70 on 18 June 1968.

Family 4. Eutimidae: Leptomedusae with short pedunculate stomach; 4 radial canals, from which append longitudinally divided gonads; hollow marginal tentacles; no marginal cirri; 8 closed marginal vesicles; no ocelli. With or without lateral cirri. Only the nominate genus occurs in Mississippi waters and is represented by two species:

Eutima variabilis McCrady 1857 (Figure 19)

Eutima mira McCrady 1857 (Figure 20).

Diagnosis: *Eutima variabilis*. About 30 mm wide, about 10 mm high; bell lens-like, jelly moderately thick. Peduncle twice bell diameter. With 8 gonads, 4 on peduncle, 4 on radial canals; 16 long marginal tentacles; lateral cirri present; marginal warts between tentacles; usually 8 closed marginal vesicles.

Previous recorded distribution: Atlantic coast of United States. A total of 18 specimens were collected on the following dates at the corresponding stations: March 1968, station 70; May 1968, stations 54 and 70; June 1968, station 72 and station 7; July 1968, stations 37 and 70; August 1968, station 4; and September 1970, station 7.

Diagnosis: *Eutima mira*. 30 mm diameter, bell lens-like, jelly thick. With long peduncle supporting short stomach; 8 gonads, 4 on peduncle, 4 on radial canals; 4 long tentacles; numerous marginal warts; 8 closed marginal vesicles.

Previous recorded distribution: Atlantic coast of United States. Two specimens collected at station 56 on 17 April 1968, 11 additional specimens collected at station 69 on 14 August 1968.

Order 3. Trachymedusae: Hydromedusae with umbrella margin entire and not lobate; gonads typically confined to radial canals; solid marginal tentacles, or both solid and hollow tentacles; marginal sensory clubs.

Family 1. Geryonidae: Trachymedusae with pedunculate stomach; 4 or 6 radial canals; centripetal canals present; phyllose gonads on radial canals; hollow and solid marginal tentacles. Two representatives of the family occur in Mississippi waters:

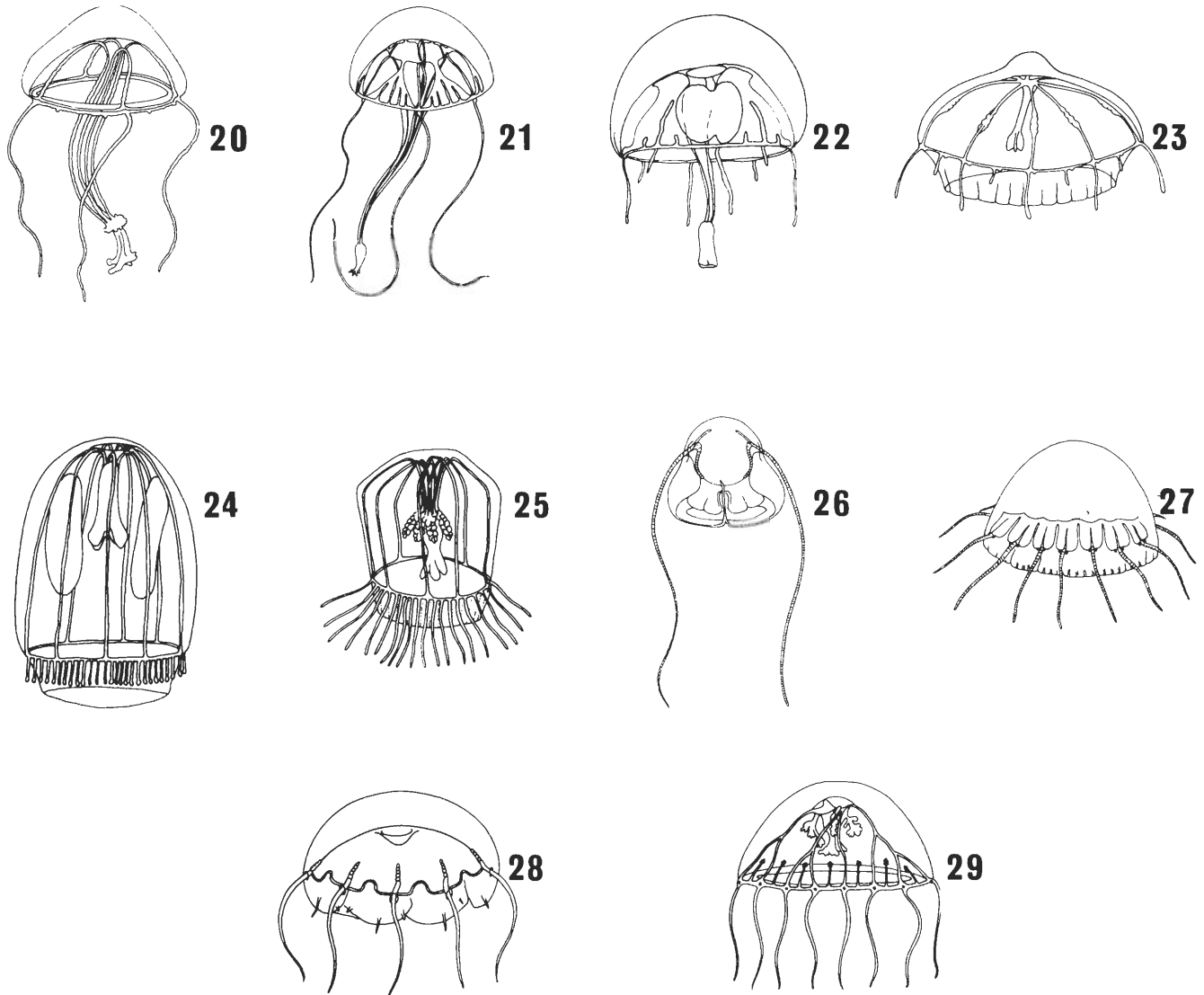
Geryonia proboscidalis (Forskål 1775) (Figure 21)

Liriope tetraphylla (Chamisso & Eysenhardt 1821) (Figure 22)

Diagnosis: *Geryonia proboscidalis*. Large 35–80 mm, hemispherical, jelly thick. With small stomach on long peduncle; 6 lips; 6 radial canals; centripetal canals between radial canals; 6 phylloid gonads; 6 hollow periradial marginal tentacles; 6 solid interradial marginal tentacles; 12 statocysts.

Previous recorded distribution: Worldwide in warm seas. One mature specimen was collected on 10 April 1968 at station 67.

Diagnosis: *Liriope tetraphylla*. 10–30 mm wide, hemispherical, thick-walled. With 4 phylloid gonads on each of 4 radial canals; interradial centripetal canals; 4 hollow periradial tentacles; 4 solid interradial tentacles; 8 statocysts.



Figures 20–29. 20. *Eutima mira* McCrady 1857. 21. *Geryonia proboscidalis* (Forskål 1775). 22. *Liriope tetraphylla* (Chamisso & Eysenhardt 1821). 23. *Rhopalonema velatum* Gegenbaur 1856. 24. *Persa incolorata* McCrady 1857. 25. *Aglaura hemistoma* Péron & Lesueur 1809. 26. *Solmundella bitentaculata* (Quoy & Gaimard 1833). 27. *Cunina peregrina* Bigelow 1909. 28. *Cunina octonaria* McCrady 1857. 29. *Proboscidactyla ornata* (McCrady 1857).

Previous recorded distribution: Worldwide in warm seas. Most abundant medusa in Mississippi waters. Occurs in virtually all high-salinity, high-temperature water masses.

Family 2. Rhopalonematidae: Trachymedusae with stomach with or without peduncle; usually 8 radial canals; no centripetal canals; globular pendent or linear gonads restricted to radial canals; 8 to many similar or dissimilar marginal tentacles; marginal clubs. Three representative genera occur in Mississippi waters:

Rhopalonema velatum Gegenbaur 1856 (Figure 23)

Persa incolorata McCrady 1857 (Figure 24)

Aglaura hemistoma Péron & Lesueur 1809 (Figure 25).

Diagnosis: *Rhopalonema velatum*. Hemispherical bell, 8–10 mm inclusive of apical prominence. With apedunculate stomach, ovate gonads at midpoint of 8 radial canals;

2 kinds of marginal tentacles; interradial and adradial cirri; 16 enclosed statocysts; broad curtainlike velum.

Previous recorded distribution: Worldwide in all warm seas. Twenty-eight specimens were collected during the following months at the corresponding offshore stations: June 1968, station 69; October 1968, station 74; December 1968, stations 71, 72, 73 and 74; January 1969, stations 73 and 74; April 1969, station 74.

Diagnosis: *Persa incolorata*. 2–3 mm high, distinctly bell-shaped, jelly thin. With tubular stomach on short peduncle; 8 radial canals; 2 ovate gonads near middle of 2 opposite radial canals; about 48 marginal tentacles; 8 statocysts.

Previous recorded distribution: Mediterranean Sea; tropical and southern Atlantic; southeast Australia; Beaufort, North Carolina. Common in Mississippi waters where it

occurs year-round.

Diagnosis: *Aglaura hemistoma*. About 5 mm high, thin-walled, somewhat prismatic. With rather long peduncle; short stomach; mouth with 4 small simple lips; 8 oval gonads on elongate peduncle; 8 statocysts; numerous marginal tentacles.

Previous recorded distribution: Worldwide in warm seas. Common in offshore waters of Mississippi, where it occurs year-round.

Order 4. Narcomedusae: Hydromedusae with lobate bell margins; gonads confined to stomach; no radial canals; 2–8 primary perradial tentacles arising aborally from the umbrella. Secondary tentacles may arise from the bell margin. Sense organs are free sensory clubs.

Family 1. Aeginidae: Narcomedusae with interradial stomach pouches; primary perradial tentacles leaving umbrella between marginal pouches. With or without secondary tentacles arising from bell margin; with or without otoporpa. One representative of the family occurs in Mississippi waters:

Solmundella bitentaculata (Quoy & Gaimard 1833)
(Figure 26).

Diagnosis: Aeginidae about 5 mm wide, higher than wide, jelly thick. With no peripheral canal system; 2 primary tentacles; no secondary tentacles; 8–32 statocysts.

Previous recorded distribution: Widely distributed in all seas; known to occur from Florida to Beaufort, North Carolina in United States. This medusa is fairly common year-round in offshore Mississippi waters.

Family 2. Cuninidae: Narcomedusae with undivided perradial stomach pouches with or without peripheral canal system; with tentacles leaving umbrella opposite center of each stomach pouch, equal in number to that of pouches; pouches not extending beyond points of origin of tentacles. Without secondary tentacles on umbrella margin; with or without otoporpa. The nominate genus is represented in Mississippi waters by two species:

Cunina peregrina Bigelow 1909 (Figure 27)

Cunina octonaria McCrady 1857 (Figure 28).

Diagnosis: *Cunina peregrina*. 10–14 mm wide, highly domed, jelly thick. With no peduncle; 8–14 (usually 12) well-rounded stomach pouches; broad marginal lappets, each with 4–10 statocysts; with narrow otoporpa; no peripheral canals.

Previous recorded distribution: Tropical Pacific and Atlantic Oceans; western region of Indian Ocean; recently found in Beaufort, North Carolina. Three specimens collected at station 73 on 26 March 1968.

Diagnosis: *Cunina octonaria*. 5–7 mm wide, flatter than a hemisphere, jelly thick. With 8 square stomach pouches; no peduncle; marginal lappets with 2–5 statocysts each; small otoporpa; no peripheral canals.

Previous recorded distribution: Worldwide in warm seas. One hundred forty-two specimens were collected in Mississippi waters during the following months at the corresponding stations; September 1968, stations 71, 72, 73 and 74; October 1968, stations 70, 71, 73 and 74; November 1968, station 73; January 1969, station 70; April 1969, station 74.

Order 5. Limnomedusae: Hydromedusae with gonads either only on stomach, or both on stomach and extending a short distance along radial canal, or only on radial canals; with or without statocysts; statocysts in form of enclosed sensory clubs; hollow marginal tentacles.

Family 1. Proboscicylidae: Limnomedusae without statocysts; stomach usually with 4, 6 or more radial lobes along proximal portions of radial canals; gonads surrounding stomach and appending somewhat onto radial canals; with branched radial canals; no ocelli. One representative of the family occurs in Mississippi waters:

Proboscicylula ornata (McCrady 1857) (Figure 29).

Diagnosis: 9 mm high, somewhat higher than a hemisphere, thick jelly. With 4-lobed stomach; mouth with 4 crenated lips; 4 primary radial canals; 16–20 terminal canal branches with corresponding number of tentacles; no ring canal.

Previous recorded distribution: Circumglobal in warm coastal waters. A total of 45 specimens were collected in Mississippi waters during the following months at the corresponding sampling sites: May 1968, station 71; June 1968, stations 72, 73 and 74; September 1968, stations 72 and 74; October 1968, stations 72 and 73; November 1968, station 71; December 1968, stations 72 and 73; January 1969, station 70; April 1969, station 74.

Order 6. Siphonophorae: Six species of siphonophores were collected in Mississippi Sound during the first year of the study period. An additional 19 species were collected from stations located south of Mississippi Sound. The occurrence of all these species is recorded in Tables 1 and 2. The occurrence of siphonophores in Mississippi Sound was reported in an earlier publication (Phillips and Burke 1970). Accounts of the species known to occur in the open waters south of Mississippi Sound are given by Phillips (1971, unpublished MS).

SCYPHOZOA

The scyphozoan medusae collected in Mississippi waters during the study period represented four orders, perhaps nine families and ten species. Areal and seasonal distributions of all species of Scyphozoa collected in Mississippi are indicated in Tables 1 and 2 respectively. The salinities and temperatures with which these medusae were associated are given in Table 3. Accounts, diagnoses, and previous known distributions are given in the following section. The diagnoses and distributions are those of Russell (1970) and Mayer (1910).

CLASS SCYPHOZOA: Polyp small, if present; gastric ridges present. Medusa almost always present but without a velum.

Order 1. Coronatae: Scyphomedusae with umbrella with coronal groove surrounding a central disk and with peripheral pedalia corresponding to numbers of solid marginal tentacles and marginal sense organs, and with marginal lappets. The mouth is simple, short and provided with simple lips.

Family 1. Nausithoidae: Coronate scyphomedusae with 4 perradial and 4 interradial marginal sense organs; with 8 adradial marginal sense organs; with 8 adradial marginal

TABLE 3.

Maximum and minimum values of salinities and temperatures at which various species of scyphomedusae were collected in Mississippi waters, 1968–1971.

Species	Salinity (ppt)	Temperature (°C)
<i>Aurelia aurita</i>	29.2–31.6	24.1–25.8
<i>Chiropsalmus quadrumanus</i>	18.2–34.0	15.0–30.1
<i>Chrysaora quinquecirrha</i>	10.6–31.3	20.9–32.0
<i>Cyanea capillata</i>	23.2–29.6	14.0–16.0
<i>Nausithoë punctata</i>	35.3	18.8
<i>Pelagia noctiluca</i>	32.0–33.9	17.8–23.6
<i>Stomolophus meleagris</i>	19.4–25.7	17.1–33.0

tentacles; without sac-like pouches on subumbrella; with 4 or 8 gonads. There is one representative of the family in Mississippi waters:

Nausithoë punctata Kölliker 1853.

Diagnosis: Nausithoidea about 10 mm wide, umbrella discoidal, jelly thick. Central disk thick, raised, and finely punctate. Eight adradial gonads; 8 marginal sense organs, 4 radial, 4 perradial; alternating with 8 short adradial tentacles. The 4 lips are simple; the mouth is central and cruciform. Bell translucent; gonads reddish brown.

Previous recorded distribution: Mediterranean Sea, Atlantic, Pacific and Indian Oceans, and in all tropical or warm seas. One such specimen was collected at station 69 in November 1970.

Family 2. Paraphyllinidae: Coronate scyphomedusae with 4 perradial marginal sense organs and 4 or more marginal tentacles in groups of 3 between adjacent marginal sense organs. One specimen of *Paraphyllina* was collected in 1968 from station 73. The specimen was never satisfactorily identified and was lost in the August 1969 hurricane.

Order 2. Semaestomeae: Scyphomedusae without coronal furrow and without pedalia, with hollow marginal tentacles, interradial gastric septa lacking; with radial septa in gastrovascular sinus or without gastrovascular canal system; with 4 simple oral arms with crenulated lips.

Family 1. Pelagiidae: Semaestome medusae with gastrovascular sinus divided by radial septa into separate simple rhopalar and tentacular pouches. Tentacles arise along the margin of the bell. The family is represented in Mississippi waters by two species:

Pelagia noctiluca Forskål 1775

Chrysaora quinquecirrha (Desor 1848)

Diagnosis: *Pelagia noctiluca*. Pelagiidae about 50 mm in diameter, somewhat dome-shaped. Sides of bell straight and sloping, apex flat. Eight adradial tentacles alternate with 8 rhopalia, bell thus with 16 marginal lappets. Stomach with 16 radiating pouches in the rhopalar and tentacular radii. No ring canal.

Previous recorded distribution: Circumglobal in all warm and temperate waters. *Pelagia* is an oceanic form and occurs in Mississippi waters only erratically. Moribund specimens were collected in Mississippi Sound in March 1968. Adult medusae and juveniles ranging from 10 mm in bell diameter

were fairly common in offshore waters during spring and summer. Four hundred nineteen specimens were collected during the study period.

Diagnosis: *Chrysaora quinquecirrha*. Pelagiidae 60–190 mm in diameter, with 8 marginal sense organs, 24–40 marginal tentacles, and 32–48 or more marginal lappets. Bell variously pigmented, 16 radiating russet stripes with central pigmented spot on apex most common. Gastrovascular cavity divided as in *Pelagia*.

Previous recorded distribution: Atlantic coast of America from New England to tropics. *Chrysaora quinquecirrha* is the most abundant scyphomedusa in Mississippi waters. This form is tolerant of wide variations of environment and occurs in Mississippi Sound and the adjacent Gulf from April through September inclusive.

Family 2. Cyaneidae: Semaestome medusae with gastrovascular sinus divided by radial septa into branched rhopalar and tentacular pouches. Tentacles arise from subumbrella surface some distance from the umbrella margin. The family is represented in Mississippi waters by one species:

Cyanea capillata (L).

Diagnosis: Cyaneidae 60–150 mm in diameter, rather flat. Eight deep adradial tentacular clefts, 8 shallow perradial and interradial rhopalar clefts. Tentacles arranged in 8 crescentic adradial clusters, each cluster with multiple rows of tentacles. Tentacle numbers vary but several hundred present in fully developed specimens. Gastrovascular radial pouches much ramified. Oral arms curtainous and about as long as bell diameter. Color of live Mississippi specimens usually deep russet.

Previous recorded distribution: Boreally circumpolar, possibly cosmopolitan as systematics of the group is vague. *Cyanea* is not common in Mississippi waters. About 200 specimens were collected during the early springs of 1968, 1969 and 1970.

Family 3. Ulmaridae: Semaestome medusae with gastrovascular system of unbranched and branched radial canals with varying degrees of anastomosis, producing a functional ring canal. Tentacles hollow, 4 interradial gonads. The 4 oral arms are much folded and curtainous. The family is represented in Mississippi waters by one species:

Aurelia aurita (L)

Diagnosis: Ulmaridae 90–400 mm in diameter, rather flat, exumbrella smooth. Margin with 8 broad lobes; very numerous small hollow marginal tentacles on exumbrella slightly above margin, 1–3 of which alternate with minute lappets. Four perradial and 4 interradial rhopalia; 4 interradial folded gonads in a crescentic or circular configuration; stomach with 4 interradial circular gastric pouches; 8 unbranched adradial canals, 4 branched perradial and 4 branched interradial canals, all communicating with a marginal ring canal. Four perradial oral arms about as long as bell radius. Basal portions of manubrium fused to form 4 subgenital pits with circular orifices. Live specimens translucent with pink radial canals, oral arms and gonads.

Previous recorded distribution: Generally distributed from boreal to tropical waters. *Aurelia* is a winter form in Mississippi and was fairly common during the winter of

1969–70 and again during the 1970–71 winter. Thousands of specimens flowed into Mississippi Sound during December 1966, then *Aurelia* was peculiarly absent from Mississippi waters until the winter of 1969.

Order 3. Rhizostomeae. Scyphomedusae lacking marginal tentacles, and with numerous mouths which are borne upon 8 adradial, fused oral arms arising from the center of the umbrella. The order is represented by two species in Mississippi waters:

Stomolophus meleagris (L. Agassiz 1862)

Rhopilema verrillii (Fewkes 1887).

Diagnosis: *Stomolophus meleagris*. Rhizostome medusae, 100–380 mm in diameter, hemispherical or globular with thick jelly. With a central mouth opening, with a well-developed, tube-like manubrium formed by the fusion of 8 primitive oral arms. Only the most distal portions of the oral arms are free and ramify extensively. With 8 pairs of scapulets, and 4 separate invaginated gonads. The central gastrovascular cavity produces 16 radial canals which are freely connected through anastomosing vessels. Eight marginal sense organs. Frequently highly pigmented. Extremely young specimens are flatter than a hemisphere.

Stomolophus, almost always present in Mississippi Sound in varying numbers, was most abundant during winters. Specimens were collected which ranged from 3.0 mm to 380 mm, suggesting that a few medusae may survive for periods of time in excess of one year.

Previous recorded distribution: Atlantic coasts of America from Chesapeake Bay to Tortugas, Florida; Gulf of Mexico; Atlantic coast of South America.

Diagnosis: *Rhopilema verrillii*. Rhizostome medusae 60–600 mm in diameter, flatter than a hemisphere; with 8 marginal sense organs; 64 marginal lappets, 6 large oval lappets in each octant of the margin together with 2 small lappets adjacent to each sense organ. The 16 radial canals anastomose freely. The arm-disk is cruciform and about half as wide as the bell. The 8 short lower oral arms, which arise from the arm-disk are about as long as the bell radius and are Y-shaped in cross section. The oral arms branch sparingly and bear numerous mouths on their lower and inner sides, finger-like appendages borne terminally; a pair of lateral scapulets arise from the outer side of each of the oral arms. The bells of specimens in Mississippi are translucent; gonads, mouth and radial canals are yellowish.

Previous recorded distribution: Atlantic coasts of United States and Gulf of Mexico. Most of the specimens collected in Mississippi waters were found stranded along the swash

lines of the several barrier islands. Eleven specimens were collected in this fashion in March, April and May 1968 and in March, May and December 1970.

Order 4. Cubomedusae: Scyphomedusae with 4 per-radial, knob-shaped marginal sense organs located in niches upon the sides of bell; with 4 interradial tentacles or groups of tentacles. Four wide perradial sacs extend outward from stomach into the interstitial space of the bell. These sacs are partially separated from each other by 4 interradial septa. There are 8 leaf-shaped gonads. The subumbrella forms an annular diaphragm (velarium) which partially closes the opening of the bell cavity. The proximal parts of the tentacles are developed into tough spatula-like structures (pedalia). The mouth is cruciform and simple. Like the Coronatae, this order has interradial septa in the stomach. Two representatives of this order occur in Mississippi waters:

Chiropsalmus quadrumanus (Müller 1859)

Tamoya haplonema Müller 1859.

Diagnosis: *Chiropsalmus quadrumanus*. Cubomedusae, 28–130 mm high, dome-shaped, with 4 prominent pedalia bearing 7–9 hollow tentacles each; with 4 sense organs within 4 covered niches upon the bell some distance above the bell margin. Elaborate ectodermal eyes upon sense clubs. Velarium wide with branched pouches communicating with stomach. Stomach globular, mouth simple with 4 triangular lips; 4 wide perradial pouches extend from stomach into bell wall, from each pouch append 2 hollow sacs which extend well into the cavity of the bell.

Previous recorded distribution: Atlantic Ocean from Brazil to Beaufort, North Carolina; Sumatra; Australia; West Africa; the Indian Ocean and the Gulf of Mexico. *Chiropsalmus* appeared in Mississippi waters during the late summer or winter of each of the three years of the study period, and was occasionally locally abundant. The ecology of this animal in Mississippi waters was discussed by Phillips and Burke (1970).

Tamoya haplonema, a species closely related to *Chiropsalmus*, was collected in October 1968 at station 74. The two specimens were lost to the August 1969 hurricane; however, a specimen of *Tamoya* collected in 1959 by a shrimp boat off the coast of Alabama remains extant in the Gulf Coast Research Laboratory Museum, Ocean Springs, Mississippi.

Tamoya apparently occurs in all warm seas of the world and may be readily distinguished from *Chiropsalmus* in that the pedalia of the former are unbranched and bear but a single tentacle.

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