

CHAPTER VII
PROTOZOA

GULF OF MEXICO FORAMINIFERA

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Foraminifera are relatively large, marine Protozoa having either a calcareous or an arenaceous test; they are both benthonic and planktonic in habitat. Their tests contribute a large percentage of the material in marine sediments. Study of Foraminifera has been mostly confined to the occurrence of empty tests in marine sediments, and all identifications are based upon test morphology.

Little is known of Gulf of Mexico Foraminifera except from the Dry Tortugas and from the northwest area. Phleger (1951) and Phleger and Parker (1951) have studied living and dead assemblages from plankton tows and cores taken off shore between Point Isabel and Atchafalaya Bay, and the present report is largely a summary of the pertinent features of that work. These samples were collected from 551 stations spaced in 12 traverses extending from the 10-fathom curve to the center of the Sigsbee Deep. Flint (1899) and Cushman (1918-31) have described material collected by the United States Bureau of Fisheries ship, *Albatross*, from the northern part of the Gulf of Mexico east of the Mississippi Delta. Kornfeld (1931) described some shallow-water and littoral Foraminifera from a few stations between the Mississippi Delta and the International Boundary. Cushman and Bermudez (1945) reported a new species of *Rotalia* from the mouth of the Rio Grande. Cushman (1922) has described numerous species from the shallow-water areas of the Tortugas.

BENTHONIC FORAMINIFERA

The area investigated in the northwest Gulf of Mexico between the Mississippi Delta and the International Boundary is one of clastic sediments. Clastic sediments also occur east of the delta as far as Mobile Bay and along the coast of Mexico.

The continental shelf bordering Louisiana and Texas has numerous isolated calcareous reefs. The principal calcareous areas in the region are along the coasts of Florida and Yucatán. The Foraminifera assemblages in these two sedimentary environments are quite distinctive and are treated separately in the following summary. The most extensive sampling and study has been done in the clastic sediments.

Clastic areas.—Figures 55 through 58 list the principal benthonic species found in the northwest Gulf of Mexico; this figure is reproduced from Phleger (1951). The depth range shown for each species is a generalization based upon distributions from samples in all 12 traverses taken. This assemblage is related to the Atlantic assemblage but contains some elements reported only from the Gulf of Mexico.

The benthonic faunas in the northwest Gulf may be grouped into six depth biofacies with boundaries at the following approximate depths: 100 m., 200 m., 600 m., 1,000 m., and 2,000 m. In addition, there are three subfacies in the upper 100 m. of water depth. The boundaries between these biofacies are not sharp but vary through about 10-20 percent of the depth involved. Figure 59 summarizes the depth of biofacies and gives depth ranges of representative species as an illustration of the basis for distinguishing the facies.

The most striking depth biofacies boundary in this area is at about 100 m. This coincides with the depth of the water layer which is affected by changing seasons and therefore shows seasonal temperature ranges, in which the greatest organic production occurs, and which is turbulent, at least in part. Deeper biofacies boundaries may be correlated with the temperature ranges if they occur in the permanent thermocline. The boundary at about 2,000 m. is believed to be due to some environmental factor other than temperature, since there is no significant temperature change

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DEPTH IN METERS

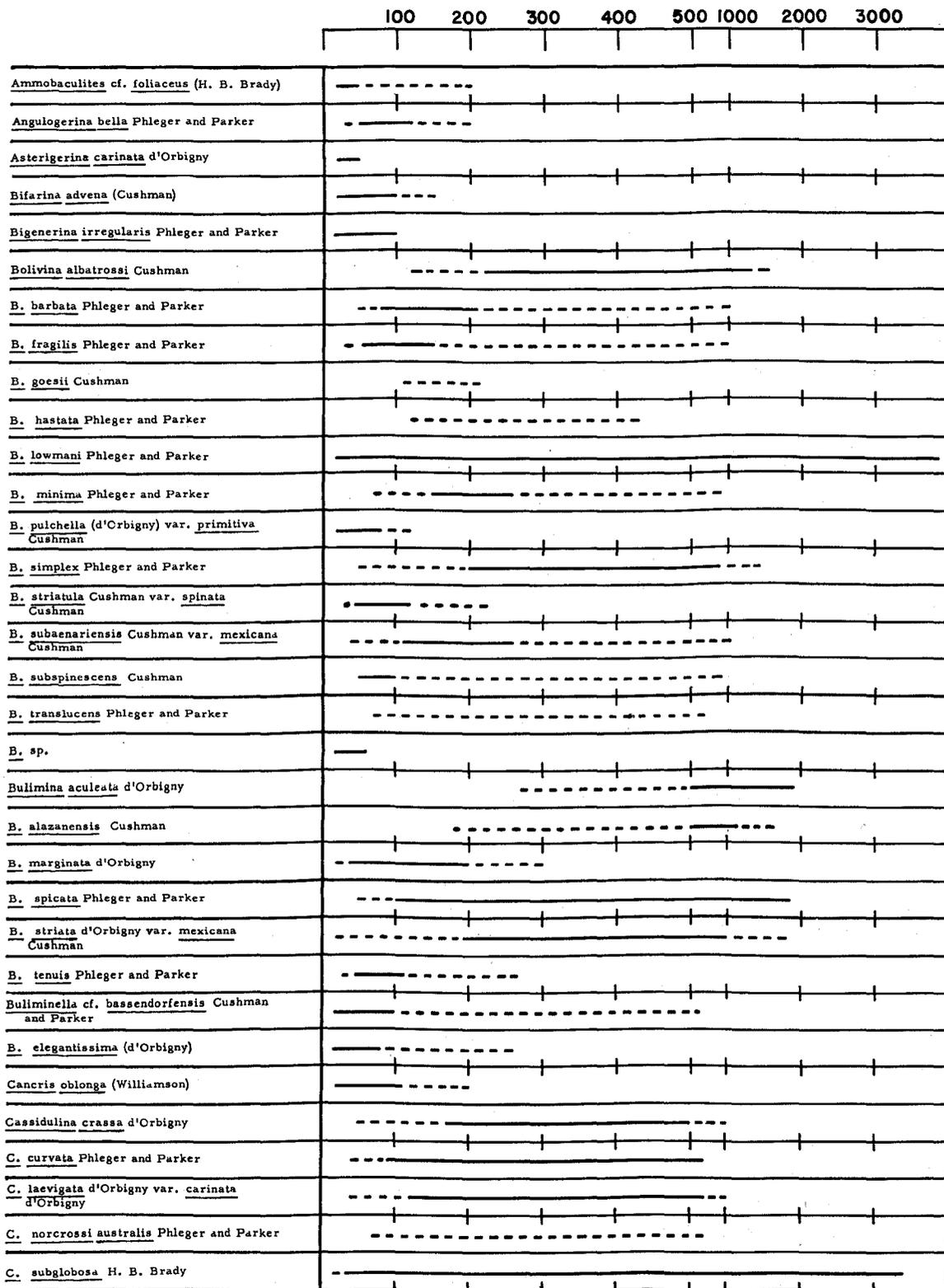


FIGURE 55.—Generalized depth ranges of benthonic Foraminifera in the Gulf of Mexico. Solid lines indicate relatively greater abundance than dashed lines.

DEPTH IN METERS

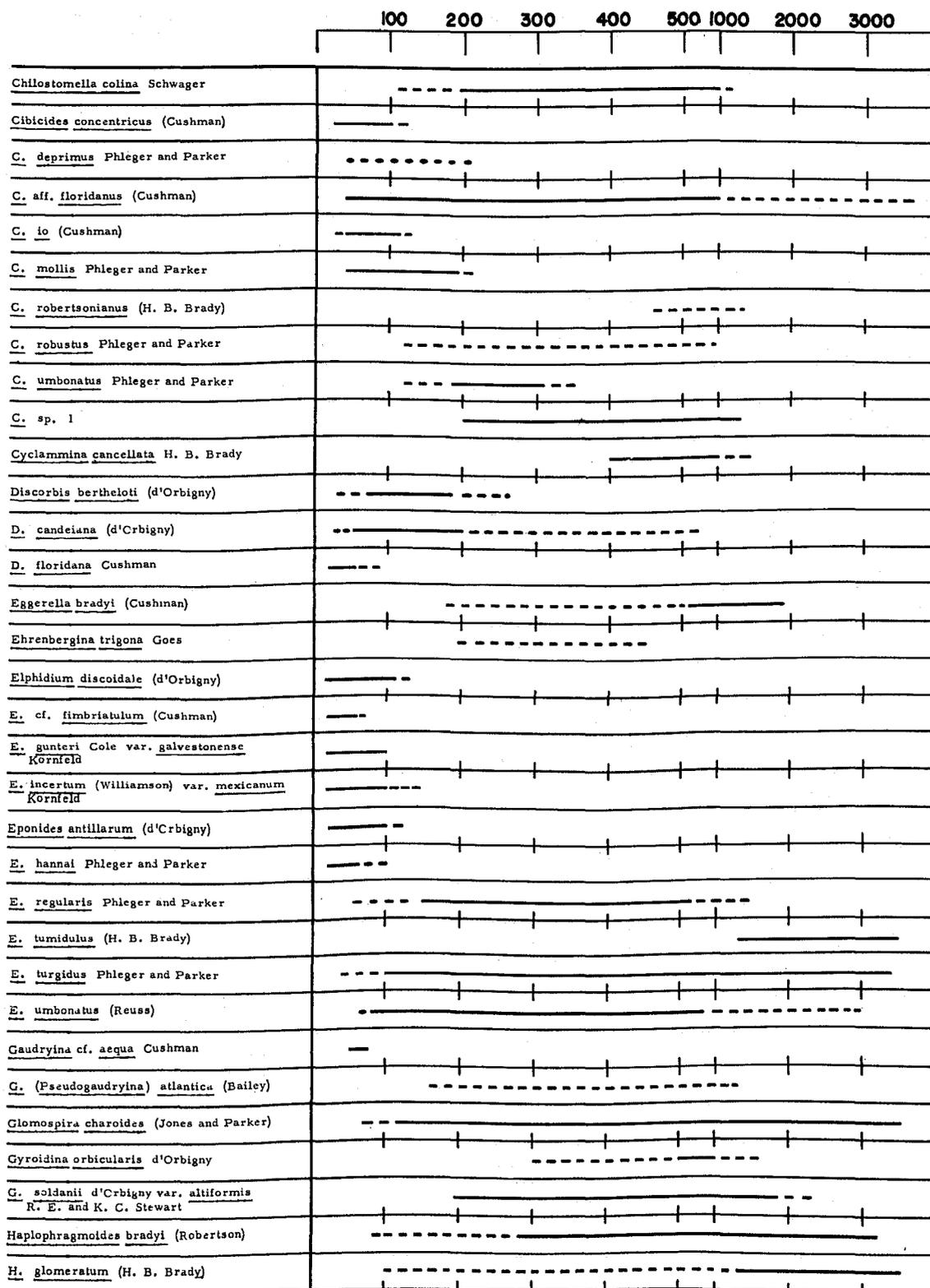


FIGURE 56.—Generalized depth ranges of benthonic Foraminifera in the Gulf of Mexico. Solid lines indicate relatively greater abundance than dashed lines.

DEPTH IN METERS

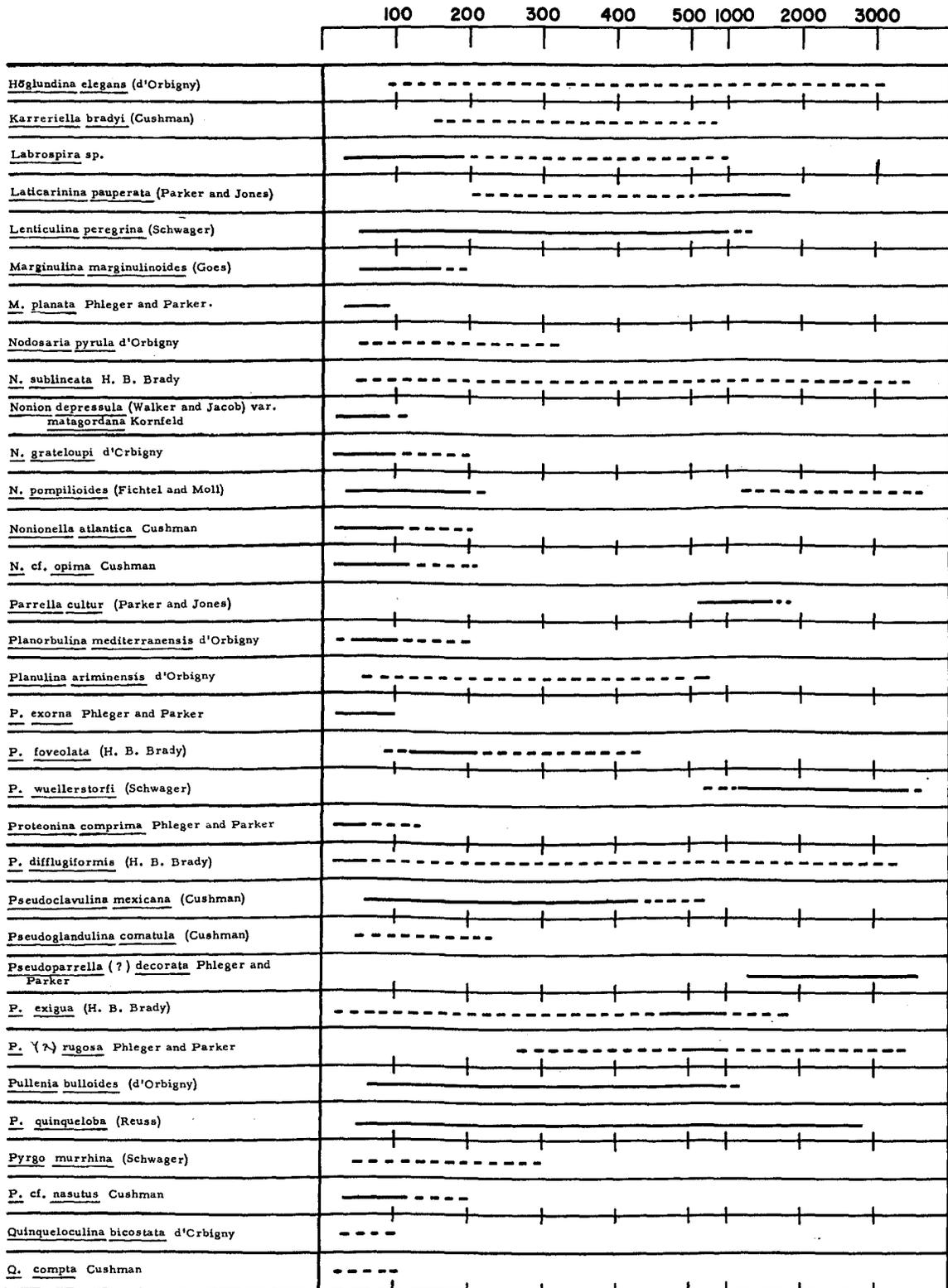


FIGURE 57.—Generalized depth ranges of benthonic Foraminifera in the Gulf of Mexico. Solid lines indicate relatively greater abundance than dashed lines.

GULF OF MEXICO
DEPTH IN METERS

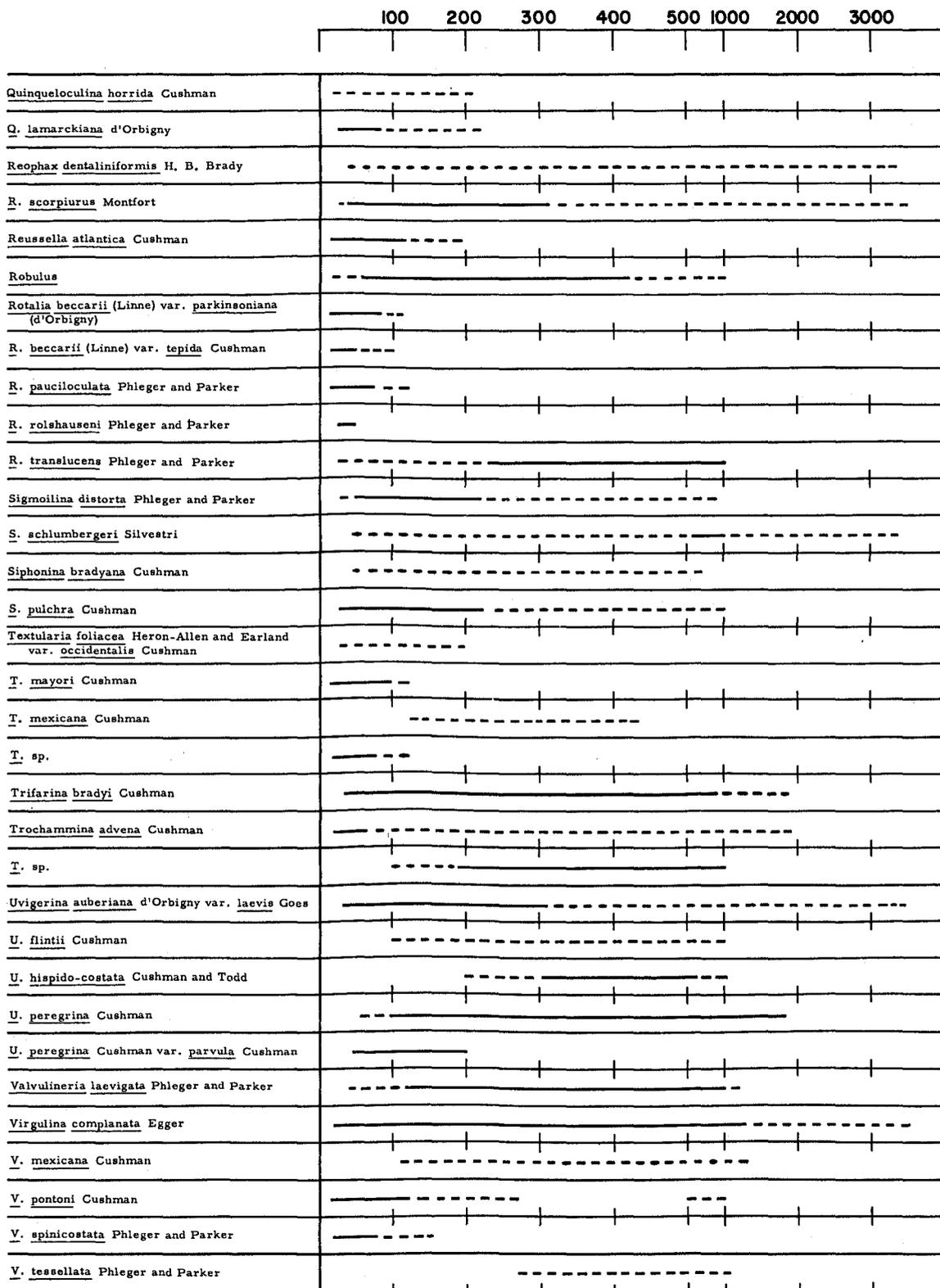


FIGURE 58.—Generalized depth ranges of benthonic Foraminifera in the Gulf of Mexico. Solid lines indicate relatively greater abundance than dashed lines.

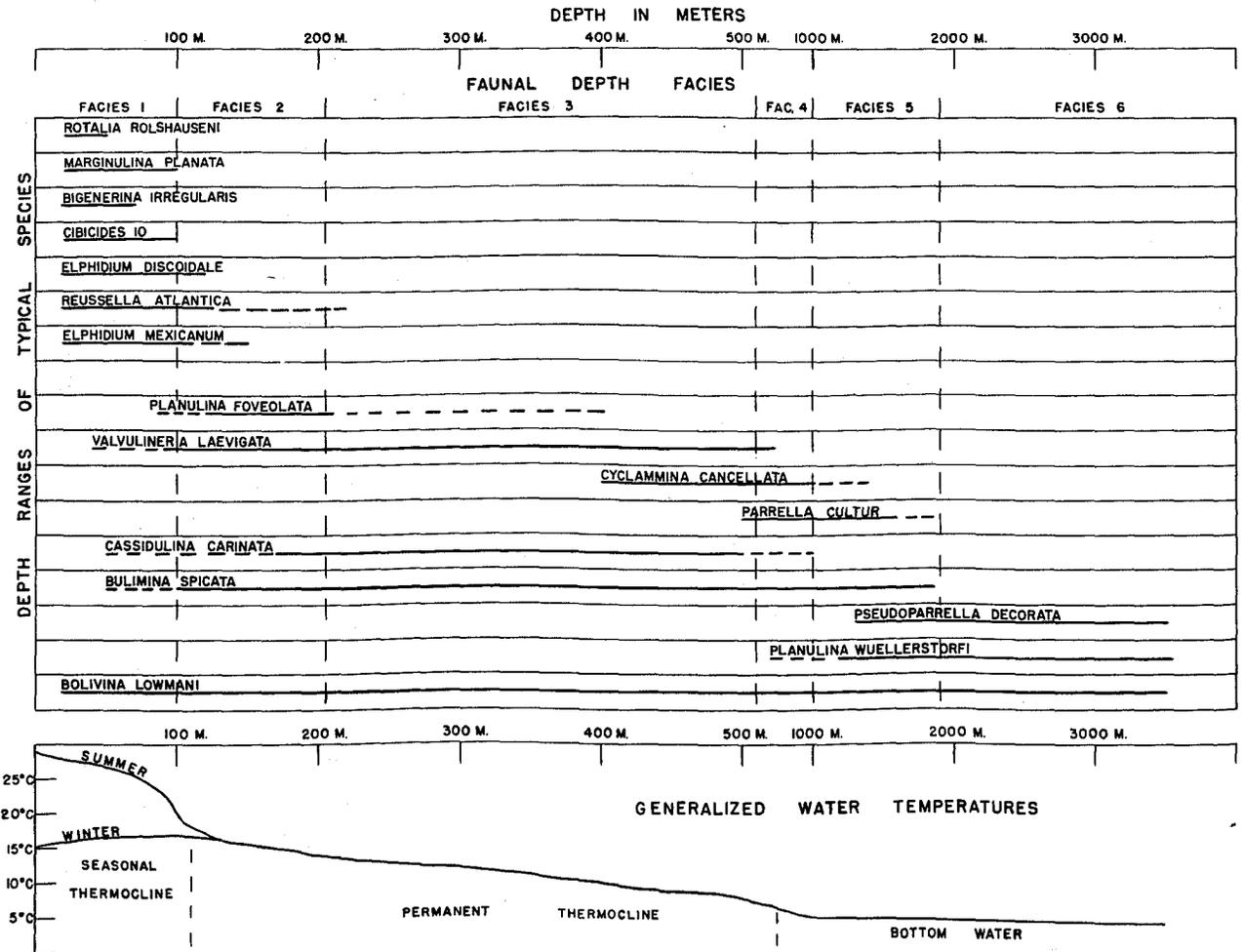


FIGURE 59.—Generalized chart showing depth biofacies of benthonic Foraminifera in the Gulf of Mexico and correlation between depth biofacies and temperature. Depth range lines are of benthonic Foraminifera used to illustrate types of depth distributions found.

below the bottom of the permanent thermocline at about 800–1,000 m.

Living specimens have been collected of 78 benthonic species. The greatest number of living specimens were found of the following species, all of which are characteristic of the facies above 100 m.:

- Bifarina advena* (Cushman).
- Bolivina lowmani* Phleger and Parker.
- B. striatula* Cushman var. *spinata* Cushman.
- Bulminella* cf. *bassendorfensis* Cushman and Parker.
- Cancris oblonga* (Williamson).
- Cibicides concentricus* (Cushman).
- Elphidium discoidale* (d'Orbigny).
- Nonionella atlantica* Cushman.
- Protonina comprima* Phleger and Parker.
- Rotalia beccarii* (Linné).
- Virgulina pontoni* Cushman.

The highest production rate of benthonic Foraminifera is in the upper facies, although the largest population of accumulated empty tests in bottom sediments usually is at intermediate depths.

Calcareous areas.—The Foraminifera fauna of the calcareous areas is quite distinctive from that of the clastic areas and is dominated by *Amphistegina lessonii* d'Orbigny, a typical calcareous species.

Cushman (1922) described the Foraminifera from several environments of the Dry Tortugas area off the southwest coast of Florida. The sampling was too scattered to give dependable results of the distribution in these environments, some being represented by only one or two stations. For this reason, the following description

includes only the outstanding characteristics of the area.

The area sampled is in shallow water with a maximum depth of 33 m. but chiefly 20 m. or less. The bottom sediment at the majority of stations is described as "fine white sand" or "sand"; this is calcareous sand. The fauna closely resembles that of the general West Indies region which, in turn, is similar to the warm, shallow faunas of the Indo-Pacific. Cushman described about 150 species from the area. The following list includes many of the most widely distributed and common species described:

Amphistegina lessonii d'Orbigny.
Archaias angulatus (Fichtel and Moll).
A. compressus (d'Orbigny).
Asterigerina carinata d'Orbigny.
Bigenenerina irregularis Cushman and Parker.
Bolivina pulchella (d'Orbigny).
Cymbalopora squammosa (d'Orbigny).
Discorbis candeiana (Cushman).
D. mira Cushman.
D. subaraucana Cushman.
Elphidium discoidale (d'Orbigny).
E. poeyanum (d'Orbigny).
Triloculinella circularis (Bornemann).
Nonion grateloupi (d'Orbigny).
Pyrgo subsphaerica (d'Orbigny).
Quinqueloculina agglutinans d'Orbigny.
Q. lamarckiana d'Orbigny.
Q. laevigata d'Orbigny.
Rotalia rosea (d'Orbigny).
Spiroloculina antillarum d'Orbigny.
Textularia agglutinans d'Orbigny.
T. candeiana d'Orbigny.
Triloculina rotunda d'Orbigny.
Virgulina punctata d'Orbigny.

The *Amphistegina* fauna also is reported from an isolated calcareous reef area in the northwest Gulf of Mexico.

PLANKTONIC FORAMINIFERA

Planktonic Foraminifera are abundant in off-shore areas of the northwest Gulf of Mexico off the continental shelf both as accumulations of tests in the sediments and as living members of the planktonic population. Occasional concentrations of planktonic specimens are found in shallow water. The planktonic fauna is dominated by great abundance of *Globigerinoides rubra* (d'Orbigny) and contains the following additional species in the surface bottom sediments:

Candeina nitida d'Orbigny.
Globigerina bulloides d'Orbigny.
G. eggeri Rhumbler.

G. inflata d'Orbigny.
Globigerinella aequilateralis (H. B. Brady).
Globigerinoides conglobata (H. B. Brady).
G. sacculifera (H. B. Brady).
Globorotalia menardii (d'Orbigny).
G. punctulata (d'Orbigny).
G. scitula (H. B. Brady).
G. truncatulinoides (d'Orbigny).
G. tumida (H. B. Brady).
Orbulina universa d'Orbigny.
Pulleniatina obliquiloculata (Parker and Jones).
Sphaeroidina bulloides d'Orbigny.
Sphaeroidinella dehiscens (Parker and Jones).

Living specimens of all but 6 of these species have been found in serial plankton tows taken from various depths of water at 27 stations occupied during February and March 1947. The average living planktonic Foraminifera population from these samples is about 5-6 specimens a cu. m. of water at 25-50 m. water depth, and much larger shallow-water populations are found in certain localities. Living specimens were collected at all depths of water sampled down to about 1400 m., but the largest population is in the upper layers at most stations. At a few stations there was a larger population collected at considerable depth than from near the surface. Nine specimens of planktonic Foraminifera, comprising six species, were found living on the surface of the bottom sediments.

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PROTOZOA ¹

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The Protozoa considered here include all the orders recognized by Pearse (1949) excepting Dinoflagellata and Foraminifera,² these two groups being so abundantly represented in the Gulf of Mexico and relatively so well-known that they are given separate treatment. Nothing which is said below, therefore, is to be construed as applying to those orders excepting when they are specifically mentioned. An attempt has been made to list in this paper every protozoan which has been reported from the Gulf. Although it is believed that most of the important papers have been reviewed, it is quite possible that some of them have been overlooked.

The number of species in any particular order which have been recorded in the literature pertaining to the Gulf does not by any means give an indication of the extent to which that order is actually represented there, since relatively only a very few studies on Protozoa of the Gulf of Mexico have been conducted. When each order is considered below, therefore, not only are the reported species (if any) listed but a statement is usually made to indicate whether or not an investigator would expect to find numerous representatives of that group living under the conditions existing in the Gulf. For instance, one would not expect to find in the marine habitats many representatives of Euglenoidina or Heliozoa, which are predominantly fresh water forms, or members of Hypermastigina, which are exclusively inhabitants of the alimentary canal of certain land dwelling insects. On the other hand, such orders as Radiolaria, which are exclusively marine, and Microsporidia, which are common parasites of invertebrates and lower vertebrates living in almost any conceivable habitat, are probably very

abundantly represented both in variety of species and numbers of individuals.

To anyone interested in Protozoa of the Gulf of Mexico there is a striking contrast between the apparently limitless variety of species there and the very scant attention which protozoologists have given them. The semitropical climate and the great diversity of habitats found in the Gulf proper and its contiguous waters undoubtedly provide suitable environments wherein a corresponding diversity of species of free-living protozoan fauna not only are able to live but can reproduce rapidly and flourish. The same favorable conditions give rise, also, to a great abundance and variety of other invertebrates and fishes which serve as hosts of protozoan parasites. Numerous species of the parasitic Protozoa not only find suitable hosts, but the relatively high temperatures of the southern waters are accompanied by rapid multiplication of these parasites and, consequently, their occurrence in great abundance. Although several of the species of Protozoa reported to occur in the Gulf were previously known ones, the overwhelming majority have been new. This fact alone suggests that any serious investigator would be richly rewarded for his efforts by many discoveries. The Protozoa of the Gulf of Mexico, both free-living and parasitic, constitute one of the great American frontiers in protozoology. A few individuals have probed its fringes, but its thorough exploration is a task for future investigators to undertake.

SURVEY OF THE LITERATURE

The known Protozoa of the Gulf of Mexico (exclusive of Dinoflagellata and Foraminifera) are mostly free-living amoebae, ciliates (both free-living and parasitic), and Sporozoa. The first two groups have been studied chiefly along the Florida coast and the third along the coasts of Texas, Louisiana, and Mississippi, especially at Louisiana State University Marine Laboratory located on

¹ The writer is indebted to Paul S. Galtsoff and Harold W. Harry for invaluable aid in obtaining pertinent literature and to Sewell H. Hopkins for criticism of one portion of the manuscript.

² See articles by H. W. Graham, Dinoflagellates of the Gulf of Mexico, pp. 223-226 of this book, and by F. B. Phleger and F. L. Parker, Gulf of Mexico Foraminifera, pp. 235-241.

Grand Isle, La. Jacobs (1912) made physiological studies on four unidentified species of ciliates infesting sea urchins in the vicinity of the former Biological Laboratory of Carnegie Institution at Dry Tortugas, a group of islands located approximately 60 miles west of Key West, Fla. Powers (1933 and 1935) studied about 13 species of ciliates (including those observed by Jacobs) at Tortugas, describing and naming 6 new ones. He described, also, one new flagellate. More recently, Wichterman (1940, 1942, and 1942a) described 3 new ciliates from an oligochaete and 1 on coral, all at Tortugas. He observed in the same oligochaete host an unidentified gregarine. Bullington (1931, 1935, 1939, 1939a, and 1940) made a series of studies on 15 free-living ciliates at Tortugas, a dozen of which were new species, and observed many unidentified ones as well. Noland (1937) studied 18 species of free-living ciliates, 6 of which were new, at Bass Biological Laboratory, Englewood, Fla. Schaeffer (1926) has been the chief student of the amoebae. He made a series of studies which culminated in a lengthy paper on taxonomy of the amoebae with description of 23 (?) new species from Tortugas and Key West, Fla. Hopkins (1931) made life history studies on 2 of the same amoebae at Tortugas and 1 mycetozoon. Apparently, Prytherch (1938, 1940) made the first noteworthy observations on a sporozoon of the Gulf of Mexico. He observed *Nematopsis* in oysters from Lake Barre and vicinity in Louisiana to Mobjack Bay, Va., and described the first member of the genus known in American waters. Later, Sprague (1949, 1950, 1950a, and this paper) studied 7 sporozoon parasites, 6 of them new, of mollusks and decapod Crustacea along the Louisiana coast. Mackin et al. (1950) described a sporozoon (?) parasite, *Dermocystidium marinum*,³ of widespread occurrence in oysters along the Gulf coast. Most of the other Protozoa considered here have been mentioned only casually in the literature or called to the attention of the writer in personal correspondence.

DISTRIBUTION OF PROTOZOA

Most of the known Protozoa of the Gulf of Mexico have been reported as new species.

³ Taxonomic position of *Dermocystidium* was rather uncertain. In 1952 Ray found that this microorganism is a fungus (Ray, Sammy M., 1952, A Culture Technique for the Diagnosis of Infections with *Dermocystidium marinum* Mackin, Owen and Collier, in *Oysters*, Science 116: 360-361).

These and the previously known ones have usually been reported only from particular localities. Not much about their general distribution, therefore, seems to be known. We may reasonably suppose, however, that certain generalizations about distribution of free-living Protozoa elsewhere in the world may give us some idea about the expected distribution of those known in the Gulf since particular species generally tend to occur wherever the particular conditions favoring their life processes exist. Pertinent remarks on distribution of free-living forms can be found in Calkins' (1933, pp. 25-26) book on biology of Protozoa.

The distribution of parasitic Protozoa is necessarily limited to that of their hosts. The hosts themselves are not generally so widely distributed as are the free-living Protozoa, one reason being, perhaps, that the means of dispersal available to them are somewhat more limited. Furthermore, distribution of parasitic Protozoa is not necessarily so extensive as that of their hosts, since environmental conditions tolerated by the latter may be unfavorable to the former. Protozoa with alternation of hosts (such as many of the Sporozoa) are further limited in distribution, since the definitive and intermediate hosts, both necessary for survival of the parasite, may not have the same range of adaptability to different habitats. While the host species living in geographical isolation have been undergoing evolutionary divergence their parasites have likewise diverged to give rise to separate varieties and species. In view of these considerations, the parasitic Protozoa occurring in the Gulf of Mexico are less likely to be identical with species found in similar habitats elsewhere than are the free-living ones. To phrase the same idea in positive terms, one would expect, a priori, to find that many of the parasitic Protozoa in the Gulf of Mexico are new ones. The limited information we have about them, in fact, tends to support that conclusion, since the overwhelming majority of them have been previously unrecorded species. The noteworthy exceptions were some of the ciliates observed by Powers (1935) in sea urchins; about half of them had previously been described at Bermuda and Beaufort, North Carolina. With one or two exceptions, as far as the writer knows, each of the parasitic species known in the Gulf of Mexico has been observed only in one or few

localities, and little attempt has been made to determine the extent of distribution. The exceptions are *Nematopsis ostrearum* and *Dermocystidium marinum* (see footnote, p. 244), both parasites of the oyster *Crassostrea virginica*. Although much information accumulated by numerous investigators relative to these two parasites remains unpublished, a comprehensive report by Landau and Galtsoff (1951) on the Distribution of *Nematopsis* has recently appeared. Since little can be said positively about the distribution of parasitic Protozoa in general, and those in the Gulf of Mexico in particular, this is a subject full of promise for future study. It would be of particular interest, from the economic point of view, to add to our meager information more data on the distribution of the protozoan parasites of such commercially important seafood animals as the shrimp, crabs, and oysters.

Subphylum 1 PLASMODROMA Doflein 1901

Class 1 MASTIGOPHORA Diesing 1865

Subclass 1 *Phytomastigina* Doflein 1916

The *Phytomastigina* include those flagellates in which the plant characteristics are either predominant or clearly marked. Of the six orders, two (*Phytomonadina* and *Euglenoidina*) are predominantly freshwater forms commonly considered to be Algae as well as Protozoa, one (*Chloromonadina*) consists of rare and little known flagellates, another (*Dinoflagellata*) is so prominently represented in the Gulf that it is given separate treatment, and the other two (*Chrysomonadina* and *Cryptomonadina*) are commonly represented in salt water, but the writer knows of practically no reports on them from the Gulf. The *Phytomastigina* are, therefore, given very little consideration here.

Order 1 CHRYSOMONADINA Stein 1878

Although the *Silicoflagellidae* are exclusively marine plankton, and the *Coccolithidae* are mostly marine, the writer is not familiar with reports of members of this order from the Gulf of Mexico.

Order 2 CRYPTOMONADINA Stein 1878

"The *Cryptomonadina* occur in fresh or sea water, living also often as symbionts in marine organisms." (Kudo, 1946, p. 213).

Suborder 1 EUCRYPTOMONADINA Pascher 1913

Family CRYPTOMONADIDAE Stein

1. *Chilomonas* (?)

This organism was observed by Pearse (1932) in a brackish water pool (Pool 5) at Garden Key, Tortugas.

Order 3 PHYTOMONADINA Blochmann 1895

These are mostly fresh water Algae.

Order 4 EUGLENOIDINA Bütschli 1884

Members of this order are likewise mostly fresh water Algae.

Order 5 CHLOROMONADINA Klebs 1892

"The chloromonads are of rare occurrence and consequently not well known." (Kudo, 1946, p. 243.)

Order 6 DINOFLAGELLATA Bütschli 1885

The dinoflagellates, which include many well-known planktonic forms in the Gulf, are treated separately (pp. 223-226).

Subclass 2 *Zoomastigina* Doflein 1916

The majority of this subclass are either parasitic in land dwelling or fresh water animals or free living in fresh water.

Order 1 RHIZOMASTIGINA Bütschli 1883

Although some members of this group occur in salt water, the writer is not aware of reports of any of them from the Gulf of Mexico.

Order 2 PROTOMONADINA Blochmann 1895

Organisms belonging definitely to this order seem not to have been reported from the Gulf. However, certain trypanosomelike organisms (now generally regarded as spirochaetes) very commonly occur in the intestinal tracts, especially in the crystalline styles, of various lamellibranch mollusks in many parts of the world. It is common knowledge among oyster biologists that they occur in oysters of the Gulf, although no one seems to have recorded the fact. Those organisms are mentioned here for lack of a better place to consider them. Dimitroff (1926) made an intensive study of the spirochaetes of Baltimore market oysters. He gave a complete review of the literature and listed 11 species or varieties which he found. He assigned 4 of the types to *Saprospira* Gross, 1910, and 7 to *Cristispira* Gross, 1910. Possibly the spirochaetes of Gulf coast oysters,

when identified, will be found to be similar to those studied by Dimitroff.

Order 3 POLYMASTIGINA Blochmann 1895

Suborder 1 MONOMONADINA Kudo 1939

Family CHILOMASTIGIDAE Wenyon

1. *Chilomastix echinorum* Powers, 1935.

In intestinal ceca of the sea urchin, *Tripneustes esculentus*. Discovered by Powers (1935) in the vicinity of Bird Key, Tortugas.

Class 2 SARCODINA Hertwig and Lesser 1874

Subclass 1 *Rhizopoda* von Siebold 1845

Order 1 PROTEOMYXA Lankester 1885

The writer is not familiar with reports of representatives of this group in the Gulf.

Order 2 MYCETOOZOA de Bary 1859

1. A mycetozoan. Hopkins (1931) made observations on an unidentified mycetozoan at Tortugas.

Order 3 AMOEBINA Ehrenberg 1830

The principal report on the amoebae of the Gulf which has come to the attention of the writer is Schaeffer's (1926) lengthy paper on taxonomy of the amoebae. He described a number of new species from Key West and Tortugas and proposed an extensive revision of the nomenclature of the free-living amoebae. As Hyman (1940) has pointed out, Schaeffer's terminology has not been generally accepted. Nevertheless, the nomenclature of this group has remained unsettled and has given rise to a considerable body of literature which was recently reviewed briefly by King and Jahn (1948). For the sake of convenience, Schaeffer's terminology is followed here in listing the species he reported. This is not intended to imply that the writer holds any opinion concerning the taxonomy of the group.

Family CHAIDAE Poche

1. *Trichamoeba sphaerarum* Schaeffer, 1926.

Schaeffer (1926) observed this amoeba in towings and upon floating seaweed. He found it to be a common species in the vicinity of Tortugas.

2. *Trichamoeba pallida* Schaeffer, 1926.

Schaeffer (1926) easily obtained this organism in Tortugas by letting a small stream of sea water filter through a small wad of cotton for a few days.

3. *Metachaos fulvum* Schaeffer, 1926.

Found by Schaeffer (1926) in irrigated cultures in Tortugas.

Family MAYORELLIDAE Schaeffer

4. *Flabellula mira* Schaeffer, 1926.

According to Schaeffer (1926, p. 48), found in Key West, Tortugas, and Cold Spring Harbor, Long Island, among blue-green algae. Hopkins (1931) studied the life history of this amoeba at Tortugas.

5. *Flabellula citata* Schaeffer, 1926.

Schaeffer (1926) saw this amoeba in salt water at Tortugas, at Cold Spring Harbor, and at Casco Bay, Maine. Hopkins (1931) studied, also, the life history of this amoeba at Tortugas.

6. *Flabellula crassa* Schaeffer, 1926.

Discovered by Schaeffer (1926) in irrigated sea water cultures in the laboratory at Tortugas.

7. *Flabellula pellucida* Schaeffer, 1926.

In describing this species Schaeffer (1926, p. 54) stated that this marine amoeba was found with blue-green algae from Key West harbor, Florida. His tabulation of species (p. 22) indicates that it was found at Tortugas.

8. *Mayorella conipes* Schaeffer, 1926.

Found by Schaeffer (1926) at Tortugas and at Long Island Sound and Great South Bay, Long Island.

9. *Mayorella gemmifera* Schaeffer, 1926.

According to Schaeffer's (1926) description (p. 50), this organism was observed both at Tortugas and Cold Spring Harbor. His tabulation (p. 22), however, indicates that it was found only at Tortugas where it was collected by running sea water through cotton.

10. *Mayorella crystallus* Schaeffer, 1926.

Discovered by Schaeffer (1926) in salt water aquaria in the laboratory at Tortugas.

11. *Vexillifera aurea* Schaeffer, 1926.

Found by Schaeffer (1926) in salt water aquaria at the laboratory at Tortugas and also at Cold Spring Harbor.

12. *Striolatus tardus* Schaeffer, 1926.

Schaeffer (1926) stated (p. 26) that this amoeba was collected with blue-green algae in shallow water near a dock at Key West harbor. His table (p. 22) indicates that it was found at Tortugas.

13. *Dactylosphaerium acuum* Schaeffer, 1926.

Found by Schaeffer (1926) among blue-green algae in very shallow water at Key West harbor and also in salt water aquaria in the laboratory at Tortugas.

14. *Pontifex maximus* Schaeffer, 1926.

Schaeffer (1926) discovered this species in cultures from Casco Bay, Maine, and observed it, also (p. 22) in Tortugas.

Family THECAMOEBIDAE Schaeffer

15. *Rugipes vivax* Schaeffer, 1926.

Schaeffer (1926) collected this species at Tortugas and in tidal pools at Cold Spring Harbor.

16. *Thecamoeba orbis* Schaeffer, 1926.

This amoeba was discovered by Schaeffer (1926) on floating seaweeds in the vicinity of Tortugas, and it was also seen at Cold Spring Harbor.

17. *Thecamoeba munda* Schaeffer, 1926.

Found by Schaeffer (1926) among blue-green algae in Key West harbor and in cultures of seaweeds from Tortugas.

18. *Thecamoeba hilla* Schaeffer, 1926.

Found by Schaeffer (1926) in cultures in the laboratory at Tortugas and in Cold Spring Harbor.

19. *Thecamoeba rugosa* Schaeffer, 1926.

Found by Schaeffer (1926) among blue-green algae at Key West harbor, in a salt water tank in the laboratory at Tortugas, and at Cold Spring Harbor.

Family HYALODISCIDAE Poche20. *Unda maris* Schaeffer, 1926.

Schaeffer (1926) discovered this amoeba in the salt water tank in the laboratory at Tortugas.

21. *Gobodiscus gemma* Schaeffer, 1926.

Found by Schaeffer (1926) in the salt water tank of the laboratory at Tortugas.

22. *Flamella magnifica* Schaeffer, 1926.

Schaeffer (1926) discovered this amoeba among blue-green algae in cultures from Key West and Tortugas.

23. *Cochliopodium gulosum* Schaeffer, 1926.

In his description of the species Schaeffer (1926) gave the localities (p. 106) as Cold Spring Harbor and Great South Bay, Long Island, where the organism was found on eelgrass and other seaweed. His table (p. 22) indicates that it was also observed at Tortugas.

Order 4 TESTACEA Schultze 1854

Most of the Testacea are fresh-water forms. The writer knows of none reported from the Gulf of Mexico.

Order 5 FORAMINIFERA D'Orbigny 1826

This large group, with many representatives in the Gulf of Mexico, is treated separately.⁴

Subclass 2 Actinopoda Calkins 1909**Order 1 HELIOZOA Haeckel 1866**

Most of these organisms are inhabitants of fresh water. The writer does not know of any which have been reported from the Gulf of Mexico.

Order 2 RADIOLARIA J. Müller 1858

The Radiolaria, a very large order, are exclusively marine and are widely distributed in the warmer waters of the seas. Although they may occur in the Gulf of Mexico, the writer is not familiar with studies on them there.

Class 3 SPOROZOA Leukart 1879

Our knowledge of the Sporozoa of the Gulf of Mexico is practically limited to the information which has grown out of investigations into

causes of oyster mortality, especially those recently conducted by the Texas Agricultural and Mechanical Research Foundation along the coasts of Louisiana, Texas, and Mississippi. Although the Sporozoa studied in investigations were primarily those parasitic in oysters, several were observed, also, in various decapod Crustacea, and very limited observations were made on forms in annelids. Sporozoa are common parasites in essentially all the major groups of animals, and the few studies on forms from the Gulf give promise that intensive search for members of this neglected group would reveal a great wealth of new and known species there. With one or two exceptions, which are considered below, nothing is known about the general distribution of most species.

Subclass 1 Telosporidia Schaudinn 1900**Order 1 GREGARINIDA Lankester 1866****Suborder 1 EUGREGARINARIA Dofle in 1901****Tribe 1 Haplocyta Lankester 1885****Family MONOCYSTIDAE Stein**

1. An "acephaline gregarine" Wichterman, 1942.
Host: *Pontodrilus bermudensis* Beddard, a littoral oligochaete.

Organs involved: Intestine and seminal vesicles.

Locality: Observed at Loggerhead Key, Tortugas.

Remarks: Wichterman's (1942) figures 18-20 suggest that this gregarine may be one of the Monocystidae. Hence, it is placed provisionally in this family.

Tribe 2 Septata Lankester 1885**Family POROSPORIDAE Labbé**

2. *Nematopsis ostrrearum* Prytherch, 1938 (partim) Sprague, 1949.

Hosts: Molluscan host the oyster *Crassostrea virginica* (Gmelin); decapodan hosts the mud crabs *Panopeus herbstii* Milne Edwards, *Eurypanopeus depressus* (Smith) and *Eurytium limosum* (Say).

Organs involved: The intestinal tract of the crab and almost all the organs (especially mantle) of the oyster. The gamontocysts attached to the rectum of the crab occur only in the extreme posterior portion of the organ.

Widely distributed along the Gulf and Atlantic coasts. Landau and Galtsoff (1951) found *Nema-*

⁴ See article by F. B. Phleger and F. L. Parker, pp. 235-241 of this book.

topsis spores, probably this species, in Delaware Bay and as far north as Great South Bay, New York.

The northern limit of the known range is based on Prytherch's (1938, 1940) observation of *Nematopsis* spores in oysters as far north as Mobjack Bay, Virginia.⁶ Although *N. ostrearum*, as originally described, contained two species, it is believed that only the one considered at this time extends as far north as Virginia. (See *N. prytherchi* below.)

3. *Nematopsis prytherchi* Sprague, 1949.

Hosts: Molluscan host the oyster *Crassostrea virginica* (Gmelin), decapodan host the stone crab *Menippe mercenaria* (Say).

Organs involved: The intestinal tract of the crab and the gills (principally) of the oyster. The gamontocysts are distributed along the entire rectum of the crab.

Distribution: Widely distributed along the Gulf coast and probably to North Carolina on the Atlantic coast. North Carolina is presumed to be the northern limit of the range of this species since its only known decapodan host, according to Rathbun (1930), occurs only that far north.

Remarks: This species was separated from *Nematopsis ostrearum* Prytherch, 1938, in a preliminary note by Sprague in 1949 and described in detail later (1950), with an account of extensive infection experiments, in an unpublished report submitted to Texas Agricultural and Mechanical Research Foundation.

4. *Nematopsis penaeus* n. sp. = *Nematopsis* (?) sp. Sprague, 1950.

Hosts: *Penaeus aztecus* Ives, one of the common commercial shrimp, is here designated as the host, although the parasite seems to be identical with one in *P. setiferus* (Linn.). No intermediate host is known. The oyster, *Crassostrea virginica* (Gmelin), has been eliminated, by means of infection experiments, as a possible host.

Organs involved: Intestinal tract of the decapod.

Vegetative stages: Similar to those of well-known species of *Nematopsis*. Early stages are small spherical bodies intracellular in the intestinal epithelium. Epimerite spherical. Young gregarines early become associated in chains of two or more individuals in linear or bifurcated syzygy.

The posterior extremity in older associations often appears somewhat more truncate than in the described species of *Nematopsis*.

Gamontocysts: Spherical; 132-260 microns in diameter, the mean diameter being 177 microns (based on measurements of 35 cysts from 2 host specimens); attached to the chitinous lining of the rectum and distributed along its entire length. Note: "Gamontocyst" is used here in accordance with the new terminology recently proposed by Filipponi (1949).

Gymnospores: Smooth, spherical aggregates of cells when mature. They are among the largest known, being comparable in size with only those of *N. prytherchi*. (Unfortunately, measurements on living gymnospores are not on hand, and measurements of stained ones are of little value for comparing with living gymnospores of other species.)

Distribution: Barataria Bay, Louisiana, is here designated as the type locality. The organism, however, is probably widely distributed along the Gulf and Atlantic coasts, since it has been found in every one of hundreds of shrimp examined from the Louisiana coast when the examination was made soon after the shrimp were collected.

Comparison and affinities: The vegetative stages are similar to those of known species of *Nematopsis*. Gymnospores are very large, only those of *N. prytherchi* being comparable in size. Gamontocysts are about the same size as those of *N. maraisi* (Léger and Duboscq, 1911) in the crab *Portunus depurator* and are exceeded in size only by those of *Porospora gigantea* (Van Beneden 1869); in being distributed along the entire rectum of the host they are like *P. gigantea* in the European lobster and different from any known species of *Nematopsis* excepting *N. prytherchi* in the stone crab. To summarize, *N. penaeus* resembles *N. maraisi* in size of gamontocyst but is distinctly different in having a larger gymnospore; it resembles *N. prytherchi* in size of gymnospore and distribution of gamontocyst but has a larger gamontocyst and different host specificity; it resembles *Porospora gigantea* also in distribution of the gamontocysts in the rectum of the host and by being an inhabitant of one of the macroura but has a distinctly larger gymnospore and is strikingly different in the vegetative stages.

The writer's attention was first called to this gregarine, the third member of the Porosporidae

⁶ Reported also from Delaware Bay and Great South Bay, New York, by H. Landau and P. S. Galtsoff (1951, Texas Jour. Sci., vol. 3).

described from American waters, by Prytherch (personal communication, 1946). Although the known stages of the parasite are indistinguishable from corresponding stages of *Nematopsis* (some of them different from corresponding stages of *Porospora*, the only other genus which it resembles), it cannot be assigned to *Nematopsis* with confidence until its life history is completely known. Since it has gymnospires it can be placed in Porosporidae (members of which are unique among gregarines in having gymnospires and alternation of hosts), but there is not the slightest clue as to what the intermediate host (if any) may be. Since generic characters of the two genera now in the family are based upon stages in the intermediate host, definite generic determination cannot now be made.

Sprague (1950) concluded, primarily on the basis of infection experiments, that the oyster is not the intermediate host of this gregarine. If *Nematopsis penaeus* has an intermediate host one would expect the latter to be an organism (possibly a small mollusk or a worm) which constitutes the chief or a very prominent item in the diet of shrimp. The last statement is based upon the belief that the host must acquire a new infestation almost every day in order to maintain, at all times, a large gregarine population consisting of individuals representing essentially every stage of development. The problem of discovering the possible intermediate host is complicated by the remarkable fact that, as Burkenroad has pointed out in a personal communication, we are almost completely ignorant of the feeding habits of the very familiar decapodan host. The possibility that the shrimp become directly reinfested by ingesting the gymnospires which pass from their intestines requires further consideration, although experimental data by Sprague (1950) suggest that such studies would give negative results. Shrimp maintained in the laboratory and fed upon oysters (containing *Nematopsis* spores) and fish became entirely free of gregarines in less than a week. The tentative conclusion from those data is that the shrimp neither reinfest themselves nor become infested by eating oysters (although *Nematopsis* spores from oysters readily germinate in shrimp), but that they acquire the gregarines by feeding almost daily upon some specific but unknown organism common in their natural habitat.

Since these gregarines are intracellular in the intestinal epithelium of the host during their early development, and since the host seems to acquire great numbers of them almost daily, the intestinal epithelium is subject to appreciable damage by the parasites. In view of the great economic importance of shrimp, the host-parasite relation of these two organisms is of more than academic interest and deserves intensive investigation.

5. "Gregarine cysts" were reported by Pearse (1932a) in the calico crab, *Eriphia gonagra* (Fabricius) in Tortugas.

Although Pearse (1932a) merely mentioned gregarine cysts seen on the walls of the rectum of the crab, it is quite probable that they were *Nematopsis*. Not only are *Nematopsis* cysts attached to the rectum in many species of crabs very common, but *N. legeri* (de Beauchamp, 1910), one of the best known species, occurs in a species of *Eriphia*, *E. spinifrons* Herbst, on the coast of France.

UNIDENTIFIED SPECIES OF NEMATOPSIS

As in Europe, several species of mollusks in American waters have been found to harbor *Nematopsis* spores of undetermined species. Although some of those spores may represent stages of well-known species of *Nematopsis*, it is quite probable that others represent undescribed species. A list of those mollusks is given in the table below.

TABLE 1.—American mollusks in which spores of undetermined species of *Nematopsis* have been observed

Host species	Organs involved	Locality	Author
From Gulf of Mexico:			
<i>Ostrea cristata</i>	(?).....	Port Aransas, Tex.	S. H. Hopkins (unpublished).
<i>Modiolus demissus</i> ..	Mantle and gill.	Grand Isle, La..	Sprague (unpublished).
<i>Mytilus recurvus</i>	(?).....	Barataria Bay, La.	Do.
<i>Ensis minor</i>	Mantle.....	do.....	Do.
From southern waters, possibly including the Gulf of Mexico:			
<i>Pecten gibosus</i>	(?).....	(?).....	Prytherch (1940).
<i>Anomia simplex</i>	(?).....	(?).....	Do.
<i>Ostrea equestris</i> * ..	(?).....	(?).....	Do.
<i>Modiolus demissus</i> ..	(?).....	(?).....	Do.
<i>Venus ziczac</i>	(?).....	(?).....	Do.
<i>Martenia cuneiformis</i> .	(?).....	(?).....	Do.
<i>Urosalpinx cinerea</i> ..	(?).....	(?).....	Do.
From Pacific Coast:			
<i>Ostrea chilensis</i>	(?).....	Gulf of Panama.	Landau and Galtsoff, 1951.

* Hopkins, S. H., has called attention to the fact that this should be *O. cristata* since *O. equestris* occurs not in North America but in South America.

Unidentified gregarines were found in Barataria Bay, Louisiana, by Hopkins (personal communi-

cation, 1950) in a common tube-dwelling annelid, *Spirochaetopterus* sp., and in the intestines of *Polydora websteri* (Hartman), a common polychaete infesting the shells of oysters.

Order 2 COCCIDIA Leuckart 1879

The writer knows of no members of this order which have been reported from the Gulf of Mexico. It is possible, however, that they may be present in some of the numerous species of vertebrates there.

Order 3 HAEMOSPORIDIA Danilewsky 1886

Excepting Plasmodium, which occurs in the vicinity of the Gulf but which does not seem to fall within the scope of this paper, the author knows of no Haemosporidia reported from the area.

Subclass 2 Acnidosporida Cépède 1911

Order 1 SARCOSPORIDIA Balbiani 1882

The Sarcosporidia, being chiefly parasitic in the muscle tissues of mammals, seem not to have been reported from the Gulf.

Order 2 HAPLOSPORIDIA Caullery and Mesnil 1899

It is customary to place in this order any organism which seems to have sporozoan affinities but does not belong to any other order. Consequently, Haplosporidia includes a heterogeneous assemblage of unrelated organisms. Some of them should probably be assigned to new orders, and some others may be more closely related to fungi than to Sporozoa. The one common characteristic is the lack of polar filaments in the spores. Although there are many types of spores represented in this order, some of them have a striking superficial resemblance to those of Microsporidia. Only one species (previously unrecorded) which can unquestionably be properly assigned to Haplosporidia seems to be known from the Gulf. Two others are provisionally included here pending further information.

1. *Haplosporidium* sp.

Observed by Sprague in January 1948 in the vicinity of Grand Isle, Louisiana, in only one of many specimens of the common mud crab, *Panopeus herbstii* Milne Edwards (kindly identified by F. A. Chace, Jr., of the United States National Museum).

The intestine, covered on the outside with the spores, has a conspicuous dark brown appearance.

2. "A haplosporidian (microsporidian?)".

In *Gymnophallus* sp. (metacercariae).

A trematode parasite of the clam *Donax* sp. from Port Aransas, Texas, was reported by Hopkins (1950) in a personal communication to the author.

3. *Dermocystidium marinum* Mackin, Owen and Collier, 1950.

Found to be widely distributed in *Crassostrea virginica* (Gmelin), the commercial oyster, along the Gulf coast. It infects any of the host tissues, especially the intestinal epithelium, adductor muscle, gills, mantle, and heart. Although there is great uncertainty about the taxonomic position of the genus *Dermocystidium*, it is usually placed in the Haplosporidia (see footnote, p. 244). According to Mackin et al. (1950), the parasite has been found associated "with dead or dying oysters under certain environmental conditions, the limits of which can be reasonably well-defined. The chief controlling factors appear to be temperature and salinity, low temperature and low salinity evidently retarding the development of the infestation" (p. 329).

Subclass 2 Cnidosporida Doflein 1901

Order 1 MYXOSPORIDIA Bütschli 1881

The writer knows of no Myxosporidia which have been reported from the Gulf of Mexico, although there is no reason to doubt that they occur there. As Kudo (1946) has pointed out, these organisms are exclusively parasites of lower vertebrates, especially fish. Davis (1917) and others have described numerous species found in various fish of the Atlantic coast. The fact that many of the same species of fish occur also in the Gulf of Mexico is reason to suspect that many of the known Myxosporidia also occur there. Doubtless, a search for these neglected forms would be rewarded by the discovery of many new and known species.

Order 2 ACTINOMYXIDIA Stolç 1899

This order contains but few known species, all occurring in fresh or salt-water annelids, and none apparently having been reported from the Gulf. In view of the great variety and numbers of annelids in the Gulf, however, it is quite possible that species of Actinomyxidida occur there.

Order 3 MICROSPORIDIA Balbiani 1883

The Microsporidia, being typically parasites of arthropods and fish (although they are represented in several animal phyla), are probably common parasites in animals of the Gulf. The

Crustacea, in particular, are very susceptible hosts and are abundantly represented in the Gulf. Nevertheless, Microsporidia occurring in the Gulf, even in economically very important animals, seem to have been almost completely neglected. The writer knows of only three species which have been definitely identified as Microsporidia, although others have probably been observed in the Gulf.

Family NOSEMATIDAE Labbé

1. *Nosema nelsoni* Sprague, 1950.

In the muscles of *Penaeus aztecus* Ives, one of the common commercial shrimp, was reported from Barataria Bay, Louisiana, but apparently is widely distributed along the Gulf and Atlantic coasts.

Burkenroad (personal communication) believes that he has seen the parasite also in *P. setiferus* (Linn.). It is remarkable that this very common parasite which causes a conspicuous discoloration of the host and an appreciable economic loss to the shrimp industry seems never to have been the subject of serious investigation.

2. *Thelohania penaei* Sprague, 1950.

In sex organs of *Penaeus setiferus* (Linn.), a common commercial shrimp, was reported from the vicinity of Grand Isle, Louisiana, but probably is widely distributed.

After Sprague (1950a) described the polar filament of this parasite as being unique in its structure he learned that Jirovec (1937) described a very similar polar filament in a new species of *Plistophora*, *P. schafernai*, which he found in *Daphnia pulex*. The author is pleased to take this opportunity to correct his error.

Burkenroad (personal communication) thinks he has seen this parasite also in *Penaeus aztecus* Ives.

Since species of *Thelohania* in the sex organs of certain other decapods allegedly cause parasitic castration, the possible role of *T. penaei* in the fluctuation of shrimp populations is a matter of considerable economic interest and should be thoroughly investigated. In this connection, Viosca (1943) has made some interesting observations. He stated (p. 276), "Some years ago (1919) about 90 percent of the salt water shrimp, *Penaeus setiferus*, existing in the waters along the Louisiana coast were infected with a protozoan disease which

destroyed their reproductive organs. Yet during the following two years, 1920 and 1921, the shrimp crops were the largest then known and were greater than for several succeeding years. Thus, 10 percent of the adult shrimp population produced a larger succeeding crop than 10 times their number did the preceding year, while the large 1921 crop again produced a smaller number. This evidence shows that with a prolific species, the food supply and other ecological factors are far more important than the actual number of eggs laid."

3. *Thelohania* sp. Sprague, 1950.

In all the muscles of *Petrolisthes armatus* (Gibbes), a small flat crab very common on oyster reefs. Known only from a particular shell reef near Grand Terre Island in Barataria Bay, Louisiana.

Pending further information on the affinities of this parasite, it was not named at the time it was reported. It is now definitely believed to be distinct from previously recorded species.

Order 4 HELICOSPORIDIA Kudo 1931

This order contains only one species, and there is no reason to suspect that any occurs in the Gulf of Mexico.

Subphylum 2 CILIOPHORA Doflein 1901

Class 1 CILIATA Perty 1852

Subclass 1 *Protociliata* Metcalf 1918

Most of the *Protociliata* inhabit the colon of Salientia, rarely marine fish or other vertebrates. Probably none has been observed in vertebrates of the Gulf of Mexico.

Subclass 2 *Euciliata* Metcalf 1918

Although more than half of the ciliates reported from the Gulf of Mexico have been new species, there is no doubt that numerous previously known ones are represented there. Since the free-living ciliates are essentially cosmopolitan, it is not surprising when one finds a particular form in any locality where there is a favorable habitat. Bullington (1940), and undoubtedly many other persons as well, saw many ciliates which he did not have an opportunity to identify.

Order 1 HOLOTRICHA Stein 1859**Suborder 1 ASTOMATA Schwiakoff 1896****Family ANOPLOPHRYIDAE Cépède**

1. *Anoplophrya macronucleata* Wichterman, 1942.

In the intestine of *Pontodrilus bermudensis* Beddard, a littoral oligochaete. Discovered by Wichterman (1942) in the vicinity of Loggerhead Key, Tortugas.

2. "A ciliate resembling Rhizocaryum."

Was found by S. H. Hopkins (personal communication, 1950) in the intestines of *Polydora websteri* (Hartman). Very common in Barataria Bay, Louisiana.

Family INTOSHELLINIDAE Cépède

3. *Maupasella leptas* Wichterman, 1942.

In the intestine of *Pontodrilus bermudensis* Beddard, a littoral oligochaete. Discovered by Wichterman (1942) in the vicinity of Loggerhead Key, Tortugas.

Suborder 2 GYMNOSTOMATA Bütschli 1889**Tribe 1 Prostomata Schewiakoff****Family SPATHIDIIDAE Kahl**

4. *Paraspathidium trichostomum* Noland, 1937

Noland (1937) found a few individuals of this species near Englewood, Florida, and created a new genus to contain the species.

Family DIDINIIDAE Poche

5. *Mesodinium pulex* (Claparède and Lachman, 1858).

Noland (1937) found this species frequently in marine cultures at Bass Biological Laboratory, Englewood, Florida.

6. *Mesodinium acarus* Stein, 1862.

Observed in cultures at Bass Biological Laboratory, Englewood, Florida, by Noland (1937) who stated that he was familiar with the same species in fresh water.

Family COLEPIDAE Claparède and Lachmann

7. *Coleps spiralis* Noland, 1937.

Noland (1937) discovered this ciliate at Bass Biological Laboratory, Englewood, Florida.

8. *Coleps tessellatus* Kahl, 1930.

Noland (1937) observed this ciliate in the vicinity of Englewood, Florida.

9. *Coleps heteracanthus* Noland, 1937.

Discovered by Noland (1937) in the vicinity of Englewood, Florida.

10. *Coleps pulcher* Kahl.

Observed by Noland (1937) in a salt spring near Englewood, Florida.

11. *Coleps* sp. Bullington, 1931.

Bullington (1931) observed two undetermined species of *Coleps* at Tortugas.

Family HOLOPHRYIDAE Schouteden

12. *Plagiocampa marina* Kahl.

Reported by Noland (1937) from the vicinity of Englewood, Florida.

13. *Placus socialis* (Fabre-Domergue, 1889).

Reported by Noland (1937) from the vicinity of Englewood, Florida.

14. *Trachelocera dracontoides* Bullington, 1940.

Discovered by Bullington (1940) in 1930, exact locality unrecorded, and in 1939 in cultures from moat at Fort Jefferson, Garden Key, Tortugas.

15. *Trachelocera subviridis* Sauerbrey, 1928.

Observed by Noland (1937) in a salt spring near Englewood, Florida.

16. *Trachelocera* sp.

Observed by Pearse (1932) in Pond 1 on Long Key, Tortugas.

Tribe 2 Pleurostomata Schewiakoff**Family AMPHILEPTIDAE Schouteden**

17. *Kentrophorus fasciolatum* Sauerbrey, 1928.

Noland (1937) observed this ciliate in sediment over a sandy bottom in sea water near Englewood, Florida.

Tribe 3 Hypostomata Schewiakoff**Family NASSULIDAE Schouteden**

18. *Nassula gigantea* Bullington, 1940.

Found by Bullington (1940) several times on algae in the bottom of the moat on the south side of Fort Jefferson, Garden Key, Tortugas.

19. *Paranassula microstoma* (Claparède and Lachmann, 1858).

Noland (1937, p. 166) found several specimens in "a shallow marine estuary just inside the beach ridge from the Gulf of Mexico, and connected indirectly through a pass with the Gulf."

Suborder 3 TRICHOSTOMATA Bütschli 1889**Family ENTORHIPIDIIDAE Madsen**

20. *Entodiscus sabulonis* Powers, 1935.

Found by Powers (1935) in the intestines of sea urchins, *Clypeaster rosaceus* and *C. subdepressus*, in shallow water at Tortugas.

21. "Form L" Powers, 1935.

Powers (1935) considered this unidentified ciliate infesting *Clypeaster subdepressus* in Tortugas to be either a variety of *E. sabulonis* or a closely related species.

22. *Biggaria bermudensis* (Biggar, 1932).

According to Powers (1933, p. 279), "While this species may be found in any echinoid host, it seems to prefer *Lytechinus variegatus* or *Tripneustes esculentus*," infesting their intestines. The species is considered by Powers (1933, 1935) as identical with form "D" which Jacobs (1911) discovered at Tortugas and indicated that it has been observed also at Bermuda and Beaufort, North Carolina.

23. *Anophrys elongata* Biggar, 1932.

According to Powers (1935) this ciliate is identical with form "C" of Jacobs (1911). It was found at Bermuda and Tortugas in all the species of sea urchins examined. Biggar

(1932) found it in *Lytechinus variegatus* and *Echinometrus lucunter*.

24. *Anophrys aglycus* Powers, 1935.

Powers (1935) found this ciliate present in the intestines of all species of sea urchins living near the tide line in Tortugas though not abundant in any of them. *Trypneustes esculentus* collected near the reef was the best example of infestation with this form.

25. "Form M" Powers, 1935.

In the intestines of the sea urchins *Trypneustes esculentus* and *Lytechinus variegatus* in Tortugas. Powers (1935) noted that this form was similar both to *Cohnilembus caeci* Powers, 1935 (see below), and *Anophrys vermiformis* Powers, 1933, the latter common to *Lytechinus variegatus* at Beaufort, North Carolina. It is listed provisionally here with the Entorhipidiidae simply for the sake of convenience; there is no implication that the writer holds an opinion as to its taxonomic position.

Suborder 4 HYMENOSTOMATA Hickson 1903

Family FRONTONIIDAE Kahl

26. *Frontonia schaefferi* Bullington, 1939.

Discovered by Bullington (1939a, 1940) in a pool at East Key, Tortugas.

27. *Frontonia ocularis* Bullington, 1939.

In Tortugas.

28. *Uronema marina* Dujardin.

Observed by Pearse (1932) in Pool 5 on Garden Key, Tortugas.

29. *Uronema pleuricaudatum* Noland, 1937.

Discovered by Noland (1937) in cultures at Bass Biological Laboratory, Englewood, Florida.

Family OPHRYOGLENIDAE Kent

30. *Ophryoglena frontonia* Bullington, 1940.

Found by Bullington (1930) in a pool on East Key and later (1939) in cultures from the moat around Fort Jefferson on Garden Key, Tortugas.

31. *Pleuronema setigerum* Calkins, 1902.

Originally discovered at Woods Hole, Massachusetts, this species was found by Noland (1937) in the vicinity of Englewood, Florida.

32. *Pleuronema coronatum* Kent.

Observed by Noland (1937) in the vicinity of Englewood, Florida.

33. *Pleuronema marinum* Dujardin, 1841.

Observed by Noland (1937) in the vicinity of Englewood, Florida.

34. *Cyclidium rhabdotectum* Powers, 1935.

In Tortugas found in the sea urchins *Centrochinus antillarum*, *Echinometra lucunter*, *Trypneustes esculentus* and *Clypeaster rosaceus*, being rare in the last host species. Powers (1935) considered it quite likely that this species is the one which Jacobs (1912) designated as form "A."

35. *Histobalantidium semisetatum* Noland, 1937.

Discovered by Noland (1937) in the vicinity of Englewood, Florida.

Family COHNILEMBIDAE Kahl

36. *Cohnilembus caeci* Powers, 1935.

Powers (1935) who discovered the species at Tortugas remarked that *C. caeci*, commonly found in any of the littoral echinoids, has a marked predilection for *Trypneustes esculentus*.

Suborder 5 THIGMOTRICHA Chatton and Lwoff 1926

Family HYSTERICINETIDAE Diesing

37. *Hystericineta pontodrilus* Wichterman, 1942.

In intestines of *Pontodrilus bermudensis* Beddard, a littoral oligochaete in the vicinity of Loggerhead Key, Tortugas (Wichterman 1942).

Order 2 SPIROTRICHA Bütschli 1889

Suborder 1 HETEROTRICHA Stein 1859

Family METOPIDAE Kahl

1. *Metopus brevicristatus* Powers, 1935.

Limited to the intestines of the sea urchin *Clypeaster rosaceus* in Tortugas. This ciliate seems to be the one designated by Powers (1933) in a preliminary note as form "G."

2. *Metopus histophagus* Powers, 1935.

Observed only in intestines of the sea urchin, *Clypeaster subdepressus*, in Tortugas.

3. *Metopus rotundus* Lucas, 1934.

Known only from the intestines of the sea urchin, *Centrochinus antillarum*. Originally described from Bermuda, this ciliate was reported from Tortugas by Powers (1935).

According to Powers (1935, p. 302), "Lucas (1934) reports this form as the sole infestant of three specimens of *Centrochinus antillarum* from Bermuda. At Tortugas, *M. rotundus* was always found in company with other ciliates." In a preliminary note by Powers (1933) this ciliate apparently was designated as form "J."

4. *Metopus circumlabens* Biggar, 1932.

This species has been found in the intestines of various sea urchins in Bermuda and Tortugas. Observed in *Centrochinus antillarum* and *Echinometra lucunter* by Jacobs (1912), Biggar (1932), Lucas (1934), and Powers (1935); in *Lytechinus variegatus* by both Jacobs and Powers; in *Trypneustes esculentus* by Powers (1935); rarely in *Clypeaster rosaceus* and *C. subdepressus* by Powers.

Family SPIROSTOMIDAE Kent

5. *Gruberia lanceolatum* (Gruber 1884).

This free-living ciliate is widely distributed, having been observed by Bullington (1940) not only at Tortugas but also at Cold Spring Harbor, Long Island, and Beaufort, North Carolina.

6. "A form related to *Gruberia calkinsi*" was observed by Anigstein (personal communication 1950) on the northeast shore of Galveston Island in Galveston Channel, Texas.

Family CONDYLOSTOMIDAE Kahl

7. *Condylostoma granulosum* Bullington, 1940.
Bullington (1940) found this ciliate in pools on Bush Key, Tortugas, and in brackish water ponds at Cold Spring Harbor.
8. *Condylostoma minutum* Bullington, 1940.
Discovered by Bullington (1940) at Tortugas, exact locality unrecorded.
9. *Condylostoma magnum* Spiegel, 1926.
Observed by Bullington (1940) in pools on Bush Key Reef, Tortugas, at extreme low tide.
10. Unidentified species of *Condylostoma*.
This species was observed by Pearse (1932) in Pond 1 on Long Key, Tortugas.

Family STENTORIDAE Carus

11. *Stentor auriculatus* Kahl, 1932.
Found by Bullington (1940) in old cultures in the laboratory at Tortugas.
12. Unidentified species of *Stentor*.
Observed by Pearse (1932) in Pond 1 on Long Key, Tortugas.

Family FOLLICULINIDAE Dons

13. A ciliate resembling *Folliculina moebiusi* Kahl.
This specimen was called to the attention of the writer in the summer of 1938 by J. H. Roberts of Louisiana State University. The organism was in a sample of sediment from the bottom of Barataria Bay, Louisiana.

Family PERITROMIDAE Stein

14. *Peritromus tortugensis* Bullington, 1940.
Discovered by Bullington (1940, p. 195) "in algal cultures from near the tip of Long Key at very low tide," Tortugas.

Suborder 2 OLIGOTRICHIA Bütschli 1887

Family HALTERIIDAE Claparède and Lachmann

15. *Halteria*.
Pearse (1932) observed an unidentified species in Pond 1 on Long Key, Tortugas.
16. *Strombidium alveolare* Bullington, 1940.
Discovered by Bullington (1940) in floating material at the dock at Fort Jefferson, Garden Key, Tortugas.

Suborder 4 HYPOTRICHIA Stein 1859

Family OXYTRICHIDAE Kent

17. *Oxytricha*.
Bullington (1935) mentioned having observed *Oxytricha* at Tortugas.
18. *Holosticha rubra* (Ehrenberg 1838).
Found by Bullington (1940) at various localities at Tortugas and at Beaufort, North Carolina.

19. *Epiclintes caudatus* Bullington, 1940.

Discovered by Bullington (1940), exact locality unrecorded, at Tortugas.

20. *Stylonychia* sp. Anigstein, 1950.

Anigstein (personal communication 1950) observed an unidentified species of *Stylonychia* on the northeast shore of Galveston Island in Galveston Channel, Texas.

21. *Stylonychia*.

Pearse (1932) observed an unidentified species of *Stylonychia* in Pond 2 on Long Key, Tortugas.

22. *Strongylidium*.

Pearse (1932) observed an unidentified species of *Strongylidium* in Pond 2 on Long Key, Tortugas.

23. *Uncinata gigantea* Bullington, 1940.

Bullington (1940) discovered this ciliate, for which he created a new genus, at Tortugas. He believed it came from Long Key but was not certain. Although Bullington did not assign the new genus to a family, it apparently belongs to the Oxytrichidae.

24. Unidentified sp.

Anigstein (1949) made physiological studies on an undetermined member of the Oxytrichidae collected along the northeast shore of Galveston Island, Texas.

Family EUPLOTIDAE Claus

25. *Euplotes charon* (Müller).

Observed by Anigstein (personal communication 1950) along the northeast shore of Galveston Island in Galveston Channel, Texas.

26. *Euplotidium agitatedum* Noland, 1937.

Discovered by Noland (1937) in two samples from Lemon Bay near Bass Biological Laboratory and (p. 170) "in squeezings from half-dead sponges brought up by sponge fishermen from about 25 feet of water 10 miles out in the Gulf of Mexico off Tarpon Springs, Florida." Noland created a new genus to contain the species.

27. *Uronychia heinrothi* Buddenbrock, 1920.

Observed by Bullington (1940) in various localities at Tortugas.

Family PARAEUPLOTIDAE Wichterman

28. *Paraeuplotes tortugensis* Wichterman, 1942.

Wichterman (1940, 1942) found this ciliate, for which he created a new family and a new genus, in abundance on the coral, *Eunicea crassa*, at Tortugas.

FAMILY UNKNOWN

29. Unidentified sp.

Pearse (1932) observed unidentified hypotrichous infusorians in Pond 1 on Long Key and Pool 5 on Garden Key, Tortugas.

30. *Gastrocirrhus stentoreus* Bullington, 1940.

Discovered by Bullington from an unrecorded locality believed to have been Long Key, Tortugas.

Bullington (1940) stated that this species is similar to *G. intermedius* Lepsi, 1928, for which the genus was

created, in having characters of both heterotrichs and hypotrichs. He further stated that Kahl (1935) was unable to classify Lepsi's species.

Order 3 CHONOTRICHA Wallengren 1895

The writer does not know of any member of this order which has been reported from the Gulf of Mexico.

Order 4 PERITRICHA Stein 1859

Suborder 1 SESSALIA Kahl 1935

Tribe 1 Aloricata Kahl

Family EPISTYLIDAE Kent

1. *Epistylis*.

Pearse (1932a) found undetermined species of *Epistylis* on the gills of the following crabs at Tortugas: *Coenobita clypeastus* (Herbst) from Garden Key and Long Key, *Geograpsus lividus* (Milne Edwards) from Bird Key Reef, and *Pachygrapsus transversus* (Gibbes) from Long Key. He also found *Epistylis* on the abdominal appendages of the isopod, *Ligyda exotica* (Roux) from the walls of the moat at Fort Jefferson on Garden Key.

Family VORTICELLIDAE Fromental

2. *Vorticella marina* Greeff, 1870.

Observed by Pearse (1932) in Pond 2 on Long Key, Tortugas. Noland and Finley (1931, p. 97) held the opinion that "*V. marina* Greeff, 1870, is possibly identical with *V. nebulifera* O. F. M., which was originally described from salt water. Further study of the marine Vorticellae is necessary before synonymy of the marine species can be definitely settled."

Class SUCTORIA Claparède and Lachmann 1858

Although it is probable that members of this group are common in the Gulf of Mexico, the writer is not familiar with reports of their occurrence there.

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