

ESTUDIOS PRELIMINARES DEL ZOOPLANCTON EN LA REGION DE CARIACO

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RESUMEN

Se llevaron a cabo investigaciones sobre la abundancia, composición y distribución del zooplancton en la región de Cariaco.

Para esta finalidad, se usaron diez estaciones mensuales, desde mayo hasta noviembre de 1960 y se efectuaron dos recolecciones, una vertical y una horizontal. Se utilizaron varios tipos de redes de plancton para que se pudiesen capturar todos los tamaños de animales del zooplancton.

En las muestras verticales, el volumen de concentraciones de zooplancton declinó constantemente desde julio hasta noviembre de 1960 en todo el área del Golfo. Este factor coincidió con la afluencia de aguas desde las afueras del Golfo.

El volumen de zooplancton fue inferior en la Fosa de Cariaco que dentro del Golfo, durante todo o gran parte del estudio.

En las aguas de superficie, el volumen de plancton mostró que en la Fosa las aguas son generalmente pobres en plancton, pero a veces pueden también ser ricas. Cerca de la desembocadura del río Manzanares las aguas de superficie son generalmente ricas en plancton. Sin embargo, las aguas de superficie dentro del Golfo varían, sin orden específico, en zonas ricas o pobres en zooplancton. El volumen indica una distribución "nublada" o del tipo "deshilvanada" (patchy) de zooplancton en la superficie del Golfo.

Se dividieron en cinco grupos las familias de zooplancton, de acuerdo con la densidad e índice de frecuencia. Alta densidad, alta frecuencia; densidad mediana, alta frecuencia; baja densidad, alta frecuencia; densidad al-

ta, mediana y baja, frecuencia mediana; densidad mediana y baja, baja frecuencia. Trataremos aquí de la distribución de animales de zooplancton pertenecientes al primer grupo. Este grupo presentó una tendencia de los individuos a aglomerarse dentro del Golfo mientras que en la Fosa aparecen en número inferior. Presentó también una densidad mayor de animales hacia el extremo Este del Golfo que en la entrada, pero sin diferencias apreciables en densidad entre los lados adyacentes al Golfo, en la Península de Araya y Cumaná.

Se dan informaciones sobre la composición de cada grupo de zooplancton y por medio de tablas se enseñan las densidades de las especies, tales como sifonóforos, cladóceros, copépodos, decápodos, huevos y larvas, apendiculados y doliólidos.

Se trató de descubrir qué clases de comunidades de zooplancton existen en las aguas de la región de Cariaco. Apparently, existen cuatro comunidades: la comunidad de aguas profundas en la Fosa, la comunidad de las aguas de superficie de la Fosa, la comunidad cerca de la desembocadura del río Manzanares, y la comunidad existente dentro del Golfo de Cariaco.

Los análisis cualitativos enseñan un tipo de composición de zooplancton parecido al de las aguas boreales en cuanto pocas especies son compuestas por grande número de individuos. Sin embargo, estas especies son de naturaleza tropical.

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PRELIMINARY SURVEY OF THE ZOOPLANKTON OF THE CARIACO REGION

A B S T R A C T

Investigations of the abundance, composition and distribution of zooplankton within the Cariaco region of Eastern Venezuela were carried out in May to November 1960.

There was evidence from quantitative studies that waters of the Gulf of Cariaco are richer in zooplankton than waters outside the Gulf. Differences in monthly abundance of zooplankton suggest a positive correlation between abundance within the Gulf and fluctuations in hydrographical conditions. Monthly zooplankton volumes at surface indicate that surface zooplankters inside the Gulf are distributed in "clouds" and that variations in numbers take place in no set trend, restricting the effect of changes in hydrographical conditions, to certain restricted areas.

The qualitative analyses have determined the dominant and the secondary groups of zooplankters, the abundance and distribution of the various groups within the region, the species which make up those groups and the different communities that exist within the region.

I N T R O D U C T I O N

This paper constitutes a preliminary report on the zooplankton of the Cariaco region. This region encompasses the Gulf of Cariaco located in Oriente province of Venezuela and the waters outside the Gulf over an area referred to as the "Fosa" or Trench of Cariaco (Richards and Vaccaro, 1956).

Data were obtained during the period May - November 1960 from monthly cruises carried out on the vessel "Guaiqueri" as part of a general oceanographic survey of the region. It was hoped to gain knowledge of abundance and distribution of zooplankton and of the identity of the common spe-

cies. Although most of the zooplankton groups need more study, and in spite of the fragmentary nature of the data, it seems advisable to make them available at this time because of the acute lack of published observations in this part of the world.

MATERIALS AND METHODS

Since this survey was of an exploratory nature, many sizes of plankton nets were used in the hope of sampling all planktonic animals from the minute to the large, active forms. At the same time, to have samples comparable with one another tows were made from one standard net. Thus, all vertical tows taken from June to November were made with a $1\frac{1}{2}$ -meter (diameter) nylon net of N° 20 mesh. In May, a $1\frac{1}{2}$ -meter (diameter) nylon net of N° 0 mesh was used. Sampling was obtained as follows: ten stations (Fig. 1) were visited once a month: c. c. At all stations except K one vertical tow was made from near bottom to surface. At station K a vertical tow was made from 300 meters to surface in May and from 500 meters to surface in the other months. This was followed by a horizontal surface tow of 15-minute duration. The net sizes used in the horizontal tows were a $1\frac{1}{2}$ -meter (diameter) nylon net of N° 0 mesh in July, August, September, and October; a $1\frac{1}{2}$ -meter (diameter) nylon net of N° 10 mesh in May and June; and a $1\frac{1}{2}$ -meter (diameter) nylon net of N° 3 mesh in November.

No flow-meter was available before November so all tows gave a relative and not absolute estimation of zooplankton abundance. However, in November numerous tows were made with a flow-meter and it was found that variations in water volumes filtered from tow to tow were small due to calm weather conditions (also prevailing during most of the time of the survey) and by virtue of an accurate knowledge of the time and constant speed of hauling. We therefore feel that the data gives a good approximation of periods of zooplankton abundance and distribution.

Volume determinations were made on all vertical and horizontal tows (132 tows - 20 in May, June, July, September, October, November, and 12 in August). The displacement method of filtering the zooplankton through a piece of fine silk and adding to a known volume of water was used.

Qualitative analyses were made on all samples taken in May. Counts were made of all animals in vertical tows and notes on sexes

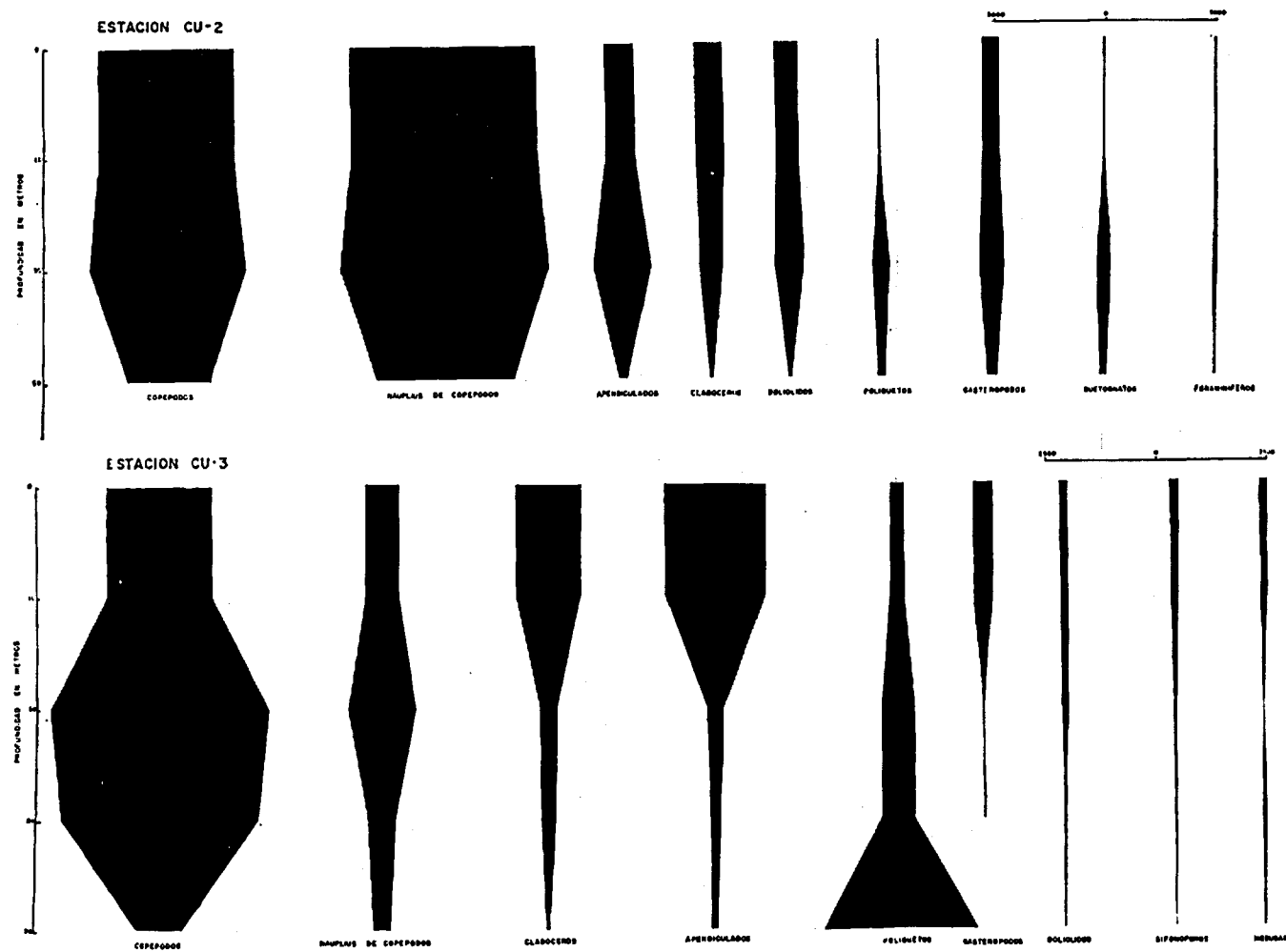


FIG. 5.—Distribución cualitativa del zooplancton vertical para las estaciones cu-2 y cu-3 en mayo y junio de 1960.

TABLA IV. Distribución vertical de los copepodos.

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and stages of development were made. Horizontal hauls were analysed in the same way but as the density of animals was very large, only an aliquot of the sample (5cc) was counted. Total numbers were then estimated. Volumes were expressed in terms of cc/cu. m. for vertical tows. Since all values were very small they were multiplied by a factor of 1000.

In the text, the 10 stations combined will often be referred to as the region or the Cariaco region. Station K will usually be referred to as the "Fosa". The station lettering has been made to correspond to that of other investigations (Gade, 1961). The letter J has been omitted to facilitate enumeration by Spanish-speaking people.

QUANTITATIVE DISTRIBUTION

Monthly volumes of zooplankton taken at surface and in the vertical tows are shown in Fig. 2 and in Table 1. At station A, located near the entrance to the Manzanares river, zooplankton volumes were among the highest for the whole region in May, July, September, October, and November (Fig. 2). In June, volumes were slightly poorer at station A than at other stations in the Gulf. No data are available for August. At station G, surface volumes of zooplankton were high or fairly high in June, July and August (Fig. 2) and poor from September to November. At station K, surface volumes of zooplankton were among the smallest for the whole region in May, June, July and September (Fig. 2). No data are available for August. Surface volumes on the other hand were very high in October and November. At all other stations (B, C, D, E, F, H, I), surface zooplankton volumes varied markedly from month to month in no set pattern (Fig. 2). Volumes oscillated from high to low from one station to another.

At surface, in May, volumes of zooplankton were small (Fig. 3). They were high in June and July. In August, the data are incomplete. In September, volumes were very high at surface, they were small in October and highest in November. For all cruises combined, zooplankton volumes at surface were highest at stations A and I, high at stations B, H, K, and smaller at stations C, D, E, F, and G (Fig. 4).

Zooplankton volumes in the vertical hauls show that:

1. At stations A and I, volumes were very small in comparison with the other stations in May, June, July and September but higher in October and November (Fig. 2). No data are available for August.
2. At station K, when comparing volumes taken with other

stations, it is seen that zooplankton was poorest in all months surveyed except May when volumes were higher at K than at most localities (Fig. 2).

3. At stations E, F, and B volumes were generally higher for most months than at other areas surveyed (Fig. 2).

4. At stations C, D, G, H, volumes of zooplankton were usually average being rarely richer or poorer than at other stations (Fig. 2).

5. For all stations, combined zooplankton volumes were small in May, on the increase in June and high in July. A steady decline in volumes was apparent from July to November (Fig. 3).

6. For all cruises combined, zooplankton volumes were highest at station E and lowest at station K. Stations inside the Gulf (B, F, G, H) had more zooplankton than stations A and I located near the entrance to the Gulf (Fig. 4).

DISCUSSION ON QUANTITATIVE RESULTS

Taking the vertical tows as being more reliable indicators of zooplankton abundance (since they sampled the whole body of water), we find a steady decline of zooplankton volumes over the entire Gulf from July to November (Fig. 3). It has been demonstrated by Gade (1961) that inflow of outside water into the Gulf occurred in August and September causing a depression in the thermocline and resulting in upwelling of nutrient-poor waters. Gade (1961) also reports the presence of deep-blue, transparent water at that time in the Gulf and shows that 30 cm Secchi discs could be read clearly at 15 meters.

We have again found that zooplankton volumes were smallest at the "Fosa" or outside the Gulf for the greater part of the survey. Any inflow "en masse" of such a poorer body of water could account for the decline in zooplankton volumes in the Gulf from July to November. At other times, when such inflow of zooplankton-poor outside water does not take place to any great extent volumes of zooplankton in the Gulf can be anywhere from 5 to 18 times richer than outside.

Let us now analyse the findings of the surface tows. A close examination of zooplankton volumes taken monthly at each station shows that surface waters are generally zooplankton-poor at the "Fosa" but can also be rich in zooplankton at times (November).

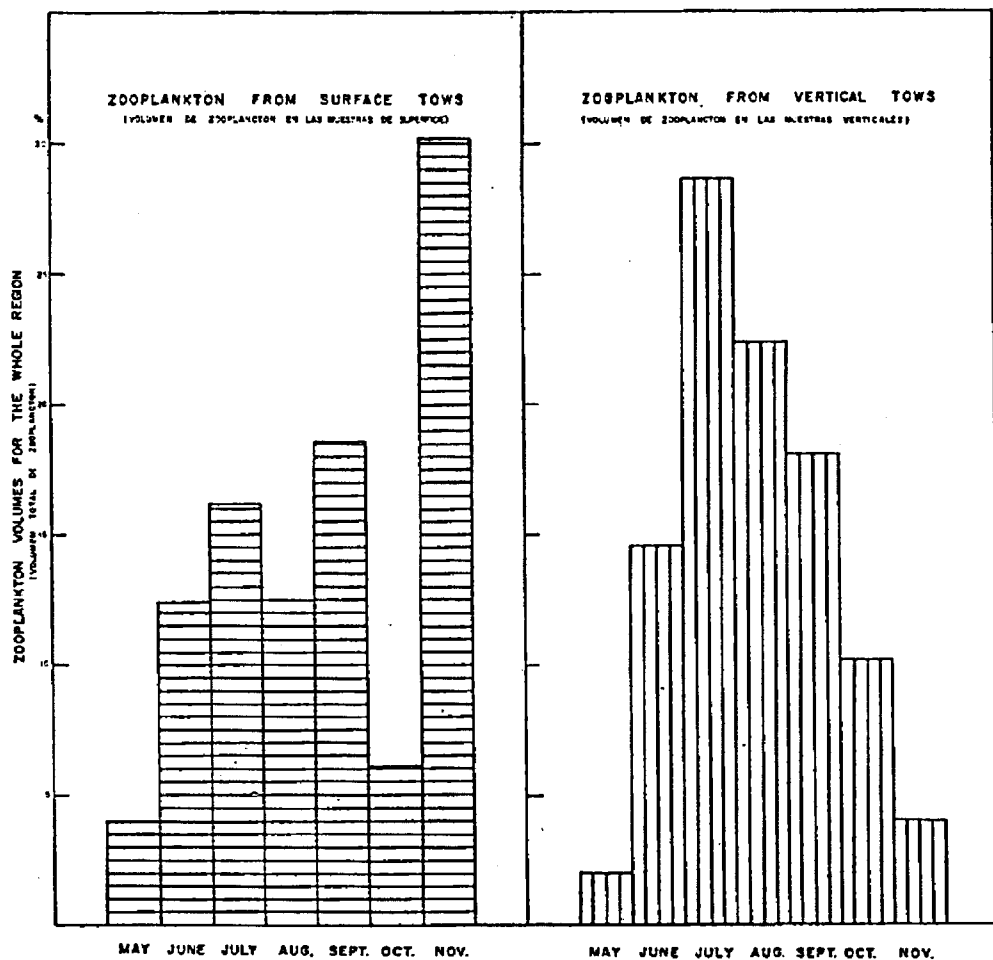


Fig. 3. Distribution of zooplankton volumes, May to November 1960, in the surface tows and vertical tows.

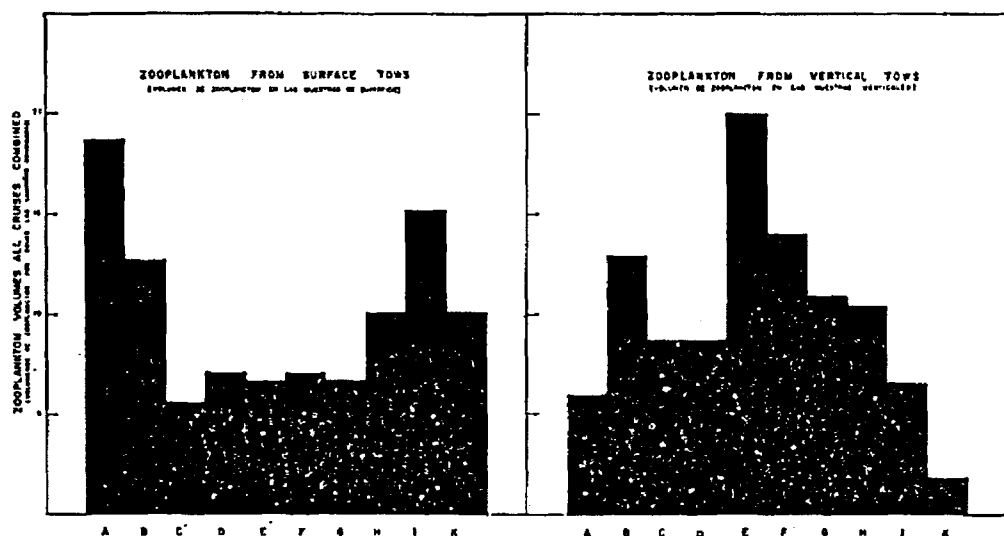


Fig. 4. Percentage distribution of zooplankton volumes, May to November 1960, at stations A to K.

At station A, located near the mouth of the Manzanares river, surface waters are generally zooplankton-rich. At all other stations, zooplankton abundance at surface varies from rich to poor in no set trend. These findings could be interpreted thus; outside surface waters are more oceanic (deep-blue, transparent) and zooplankton-poor. At times, however, depending probably on wind conditions, incursions of zooplankton-rich surface waters take place over the "Fosa". Such inflows of waters over the "Fosa" could originate from the Gulf itself. If such is the case, the great variations observed between October and November could be ascribed to such a cause.

The richness of zooplankton near the mouth of the Manzanares river could be due to the presence of larger concentrations of feeding matter or to the circulation pattern of river water at this area. Data on nutrient abundance are not available.

Inside the Gulf, the great variations in surface abundance of zooplankton clearly show a type of distribution in "clouds" or "patches". Any inflow of zooplankton-poor outside water has only a restricted effect within certain areas.

DENSITY AND FREQUENCY OF GENERAL GROUPS OF ZOOPLANKTON

Density and frequency of the various zooplankton groups are shown in Fig. 5 and in Table II. Copepods were the most abundant group of zooplankton in the region composing 64.7% of all animals counted. In numbers, they were 2.6 times more numerous in the tows than the next most abundant group, the cladocerans.

Cladocerans, gasteropods, appendicularians, pelecypod larvae, chaetognaths and cirriped larvae were also taken in great numbers. Their combined percentage of the catch amounted to 33.3%. All other groups were much less numerous and their combined percentage of the catch was only 2.0%.

Fig. 5 shows that a high or low density of a zooplankton group does not always indicate a high or low frequency of occurrence in the tows. There exists, at most, a small correlation between density and frequency of the groups that are dominant and those that are of secondary importance. It can be seen that groups such as medusae, siphonophores, foraminifers, fish and echinoderm larvae are more frequent than numbers lead to believe and that a group such as cirriped larvae are less frequent than density seems to indicate.

The zooplankton can be divided according to density and frequency into 5 different groups:

1. A group of high density (10,000 and over animals counted) and high frequency of occurrence in the tows (75 to 100%). To this group belong copepods, cladocerans, gasteropods, appendicularians, pelecypod larvae and chaetognaths.
2. A group of medium density (1,000 to 10,000 animals counted) and high frequency. Here belong doliolids, fish eggs, decapod larvae, foraminifers, polychaete larvae, and siphonophores.
3. A group of low density (1 to 1,000 animals counted) and high frequency. Only medusae are thus distributed.
4. A group of high, medium or low densities and medium frequency (25 to 65%). Such groups as cirriped larvae, cyphonautes larvae, euphausiids, ostracods, fish larvae, hydroid fragments, echinoderm larvae, stomatopods, and *Lingula* belong here.
5. A group of medium or low density and low frequency (5 to 20%). Here belong all other groups such as unidentified eggs and larvae, amphipods, salps, nematodes, *Amphioxus*, anthozoa larvae and turbellarians.

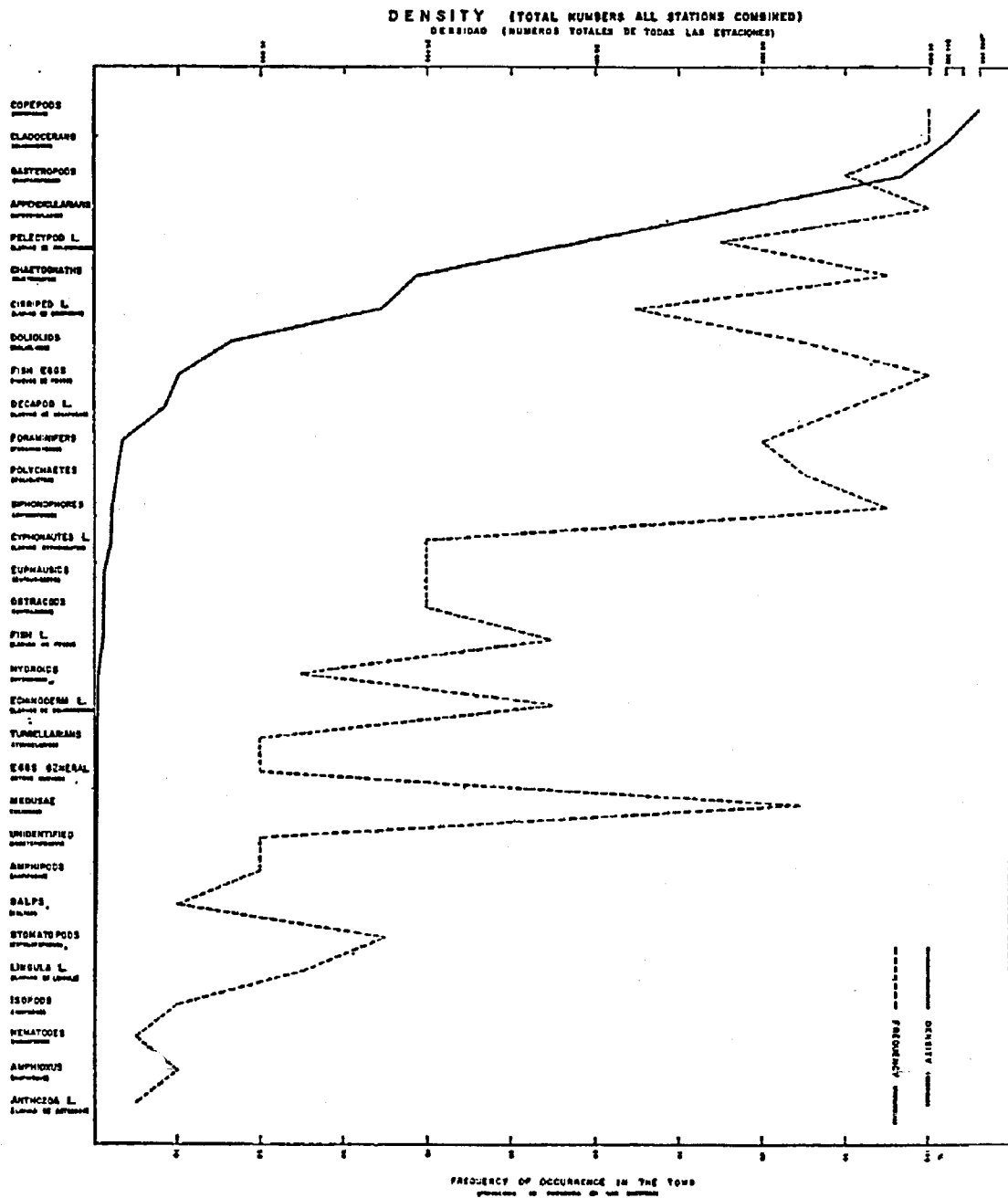


Fig. 5. Density, by number, and frequency percentages of the groups of zooplankton found in May 1960 in the Cariaco region.

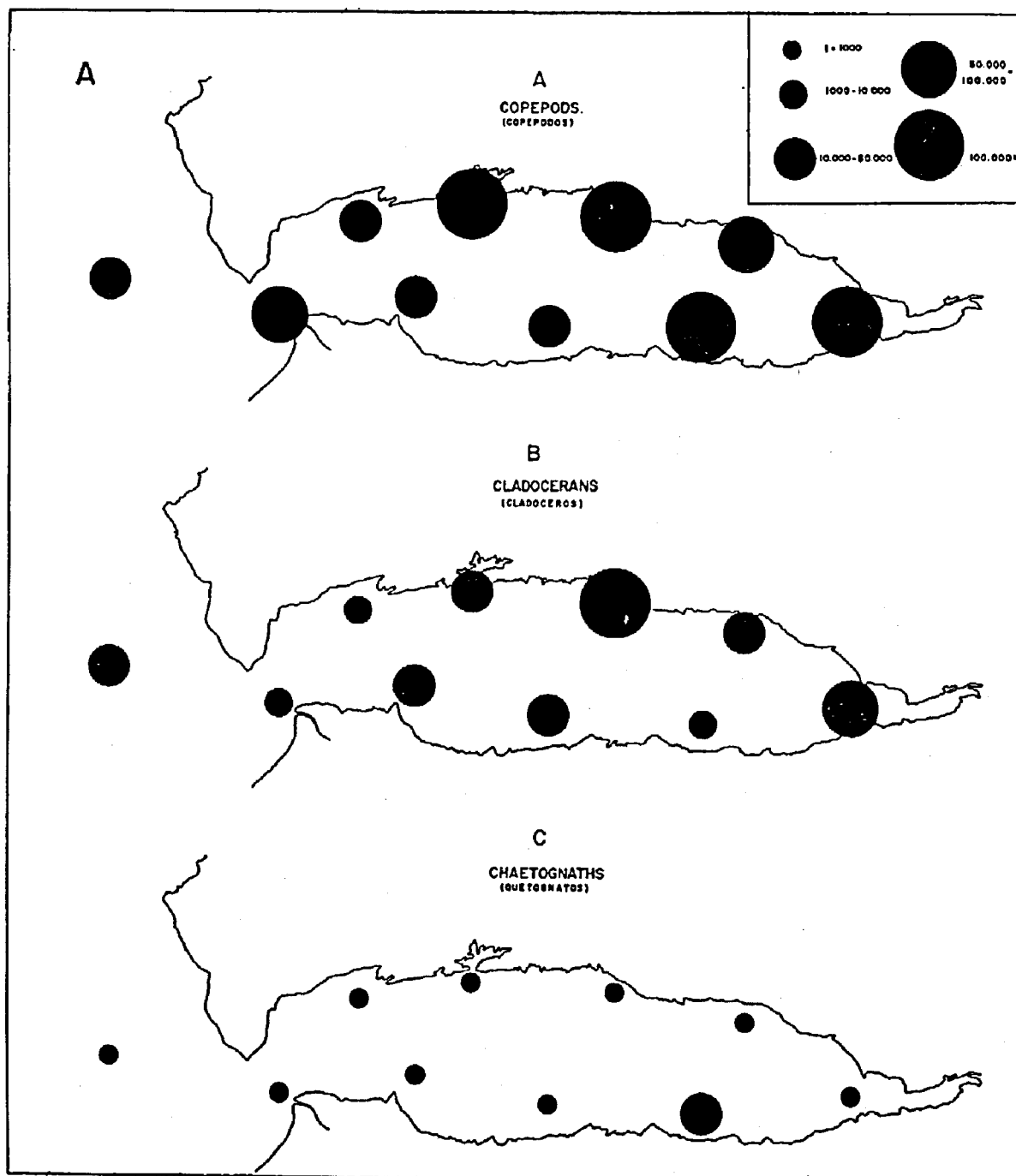


Fig. 6. Horizontal distribution of numbers of: A) copepods, cladocerans, chaetognaths; B) gasteropod larvae, pelecypod larvae, and appendicularians, in May 1960, in the Cariaco region.

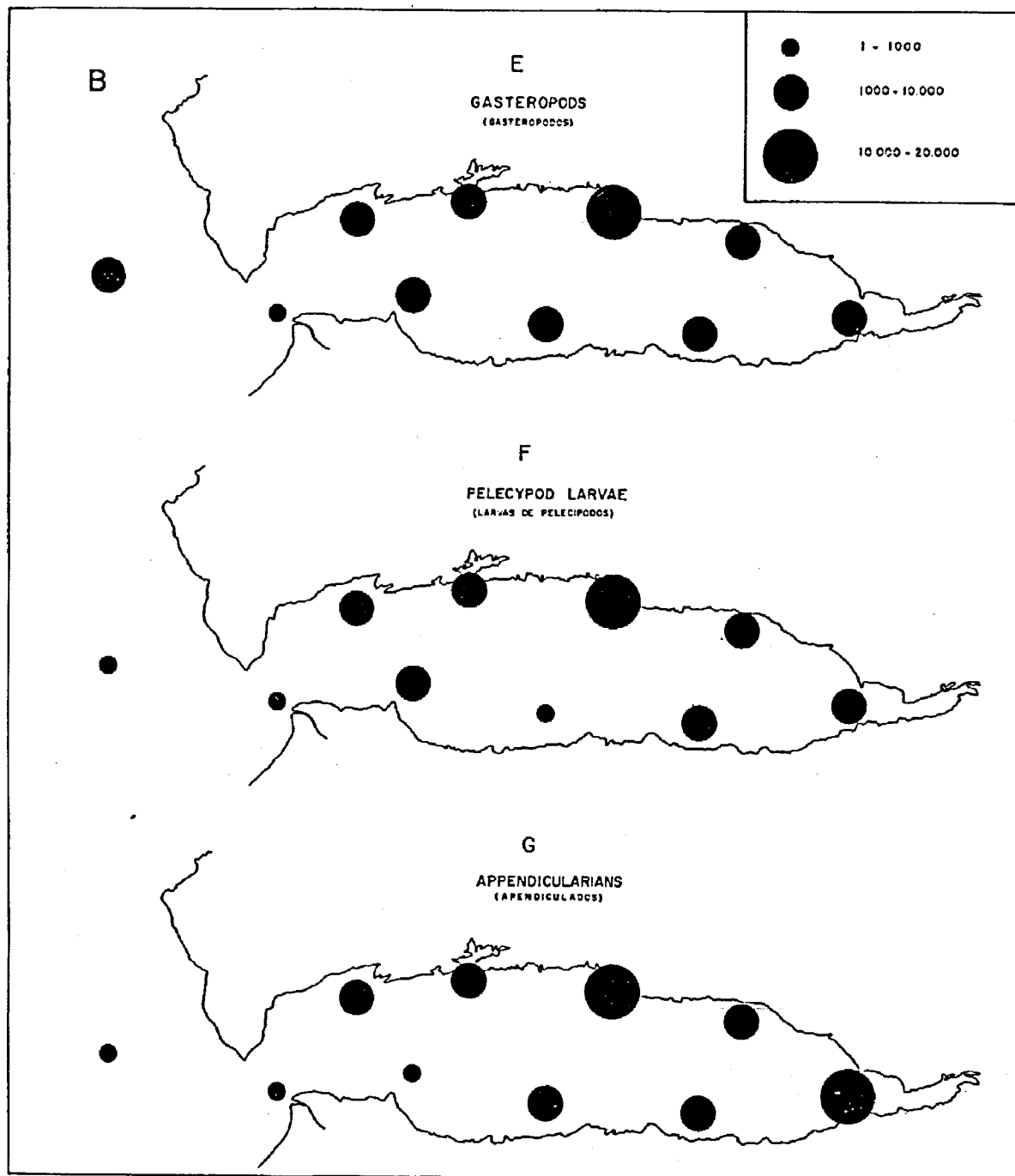


Fig. 6. B).

The distribution of groups 1, 2, and 3 is more homogeneous in the Cariaco region than that of groups 4 and 5. The latter groups have either a "cloudy" or "patchy" distribution or again sampling has been insufficient. Although the distribution of groups 1, 2, and 3 appears to be homogeneous when all stations are combined there still exists great differences between density from one station to another. In Fig. 6 (A and B) such differences are apparent when showing density of the 6 types of zooplankters belonging to group 1. There is a tendency for the zooplankters to aggregate inside the Gulf and to be less numerous at the "Fosa". Such a tendency has also been found during analyses on zooplankton volumes. There also seems to be greater numbers of animals inside the Gulf than at the entrance to the Gulf but there is no appreciable differences in density between one side of the Gulf (Araya side) and the other Cumana side).

NOTES ON THE COMPOSITION OF THE ZOOPLANKTON

In the analyses of zooplankton samples from May an effort was made to identify as many species as possible to gain a picture of the dominant and secondary forms of this region, their frequency, density, distribution, and stage of development. It is hoped that when the inventory of the zooplankton is complete, indicator species will be used to study the dynamic conditions of the waters.

The nanoplankton was not sampled adequately and therefore little has been found on such groups as Tintinnids and Coccolitophores except to note presence or absence. Some individuals of each group were observed at all stations.

Cyanophyceae were not included in the survey. However, large concentrations of *Trichodesmium thiebauti* (Det. Prof. F. Gessner) were observed at the surface, particularly at station A. Dinoflagellates were not included in this study either. However it can be stated here that millions of *Pyrophacus horologium* var. *Steinii* (Det. R. Margalef) were observed in surface tows. *Ceratium* were also very common. The dominant species observed were *Ceratium candelabrum*, *C. massiliense*, *C. fusus*, *C. gibberum*, *C. gravidum* and *C. Karstenii* (Det. R. Margalef). Diatoms and Radiolarians were also observed in the tows.

Foraminifers

Foraminifers had a high frequency and medium density in the region. Largest numbers were found inside the Gulf. Two genera were very common: *Globigerina* and *Orbulina*. Other genera identified were *Globigerinella*, *Globorotalia*, *Hastigerina*, *Pseudogloborotalia*, *Globigerinoides*, and *Globigerinita*.

Medusae, Siphonophores and Ctenophores

Large medusae were observed swimming at the surface but our sampling methods did not catch them. Those taken were of a small size. The common species caught were *Liriope tetraphylla*, *Aglaura hemistoma*, *Rhopalonema velatum* and *Obelia* spp. Many other forms, rare in the tows, are described in a separate paper (Zoppi, 1961). Hydroid fragments were seen in abundance in samples from stations A, H, and I.

Data on siphonophores are given in Table III. Seventeen species were identified in the region. *Muggiaea kochi* was the most common form encountered in the Gulf. *Diphyes dispar* was also common at most stations. Polygastric were far less common than eudoxids. *Eudoxoides spiralis* was the third most common species. *E. spiralis* was heteromorph in the region. *Eudoxoides mitra* was taken in small numbers at stations A and D. *Diphyes bojani* was common at station A but never taken in large numbers anywhere else in the region. *Lensia campanella* (Det. A. K. Totton), *Abylopsis tetragona* and *Nanomia bijuga* appeared infrequently in the tows. *Abylopsis eschscholtzii*, *Agalma elegans*, *A. okeni* (Det. A. Alvario), *Rhizophysa filiformis* (Det. A. K. Totton), *Sulculeolaria monoica* (Det. A. K. Totton), *Ceratocymba sagittata* (?) and *Chelophyes contorta* (Det. A. Alvario) were each taken once.

Large schools of ctenophores were observed swimming in surface waters. When taken in buckets, they were too brittle to transfer and no specimen was preserved. The species observed was undetermined.

Worms

Small turbellarians were found at surface at stations A and H. Nematodes were common in one tow (Sta. A). Polychaetes were common but never in great abundance. No determinations were made.

Chaetognaths

Ten species have been identified: *Sagitta hispida*, *S. helenae*, *S. tenuis*, *S. enflata*, *S. bipunctata*, *S. serratodentata*, *S. hexaptera*, *S. decipiens*, *Krohnitta pacifica* and *Pterosagitta draco*. The most common forms in the Gulf were *S. hispida*, *S. helenae*, *S. tenuis*, *K. pacifica* and *S. enflata*. Chaetognaths were abundant and had a high frequency of occurrence in the tows. More details are given in a separate paper (Legaré and Zoppi, 1961).

Cladocerans and Ostracods

Cladocerans were the second most numerous group of zooplankters in the region. At stations B and C they were the most abundant zooplankters. Two genera were extremely common in the Gulf: *Evadne*, and *Penilia*. *Evadne* was represented by four species the most common of which was *Evadne spinifera*. The accumulated data on the cladocerans are shown in Table IV. Specimens of *Evadne* were taken in abundance in all surface tows. Greatest numbers were taken at stations G and E. *Penilia* was very abundant at station E and common at all other stations. Smallest catches were made at the "Fosa".

Species of *Conchoecia* were taken in medium density at stations A, B, I and K. Adults were found at the "Fosa", adults and juveniles near the entrance to the Gulf, and juveniles inside the Gulf. Largest numbers were taken at the "Fosa".

Copepods

As expected, copepods were the most important constituents of the local zooplankton. Some 64 species of copepods of four sub-orders were taken: Calanoida, Cyclopoida, Harpacticoida, and Caligoida (Table V).

Sub-order Calanoida. *Acartia clausii*, *A. danae*, *A. lilljeborgii*, *Acrocalanus longicornis*, *Calanus minor*, *Calocalanus pavo*, *Candacia curta*, *C. pachydactyla*, *C. varicans*, *Centropages furcatus*, *Clausocalanus arcuicornis*, *C. furcatus*, *Euaetideus giesbrechti*, *Eucalanus attenuatus*, *E. monachus*, *Euchaeta marina*, *Haloptilus acutifrons*, *H. longicornis*, *Labidocera acutifrons*, *L. Scotti*, *Lucicutia clausi*, *L. flavicornis*, *Neocalanus gracilis*, *Paracalanus aculeatus*, *P. parvus*, *Pleuromamma gracilis*, *Pontellopsis brevis*, *Rhincalanus cornutus*, *Scolecithrix danae*, *Temora stylifera*, *T. turbinata*.

Sub-order Cyclopoida. *Copilia mirabilis*, *Corycaeus flaccus*, *C. giesbrechti*, *C. gracilis*, *C. longistylis*, *C. speciosus*, *C. typicus*, *Lubbockia squillimana*, *Oithona atlantica* (?), *O. plumifera*, *Oncaea conifera*, *O. mediterranea*, *Sapphirina angusta*, *S. intestinata*, *S. nigromaculata*, *S. opalina*.

Sub-order Harpacticoida. *Clytemnestra rostrata*, *Euterpina acutifrons*, *Macrosetella gracilis*, *Macrosetella rosea*, *Miracia efferata*, Others (8 to 10 species undetermined).

Sub-order Caligoida. *Caligus* sp.

The main genera in order of abundance were *Temora*, *Oithona*, *Oncaea*, *Macrosetella* and *Eucalanus*. All were common throughout the Gulf (Table V).

Many copepods were only found at the "Fosa". Such were *Calocalanus pavo*, *Euaetideus giesbrechti*, *Euterpina acutifrons*, *Haloptilus acutifrons*, *H. longicornis*, *Lubbockia squillimana*, *Lucicutia clausi*, *L. flavicornis*, *Neocalanus gracilis*, *Pleuromamma gracilis* and *Pontellopsis brevis* (Table V).

Identification, correction and verification of many species of copepods were made by Dr. T. Bjornberg.

Isopods and Amphipods

Only eleven isopods were taken in all the tows examined. No determinations were made.

Amphipods were also rare in the tows. Most individuals caught were small hyperiids. Some adults were taken in a vertical haul from 300 meters to surface at the "Fosa". No determinations were made.

Euphausiids

Five species of 2 genera were taken in the Cariaco region: *Euphausia americana*, *E. gibboides*, *E. mutica*, *E. tenera* and *Nyctiphanes simplex*. The latter species has never before been reported from the Atlantic and adjacent seas. Larval stages of euphausiids were common at stations K and A and present in small numbers at stations B, H and I. Stations inside the Gulf showed a paucity of adults and larvae.

Decapods and Stomatopods

The decapod fauna of the Gulf was varied. Brachyuran zoeae of many forms made up a large percentage of the catch. Megalopae

of brachyurans were not taken in abundance. Next in abundance were the Alpheidae. They were distributed over the whole region. The Thalassinidae were also common and ubiquitous. Taken in smaller numbers were the Penaeidae, Caridae, Paguridae, Hippolytidae, Stenopidae, Pasiphaeidae, Galatheidæ, *Lucifer faxoni*, *Porcellana longicornis* and *Eretmocariss* spp. Data on each group of decapods are given in Table VI.

Stomatopods were found in small numbers at seven stations. No determinations were made.

Gasteropods

Pelagic molluscs were the third most abundant zooplankters in the region. Heteropods were represented by *Atlanta* sp. and *Pterotrachea* sp., Specimens of *Atlanta* were found in the Gulf but were more abundant at the "Fosa". Pteropods were very abundant. Among the thecosomatae, *Creseis* were abundant at all stations. The most common species of *Creseis* was not determined but identification of *Creseis chierchiae* and *C. acicula* was possible. The two species were taken at the "Fosa". *Cavolinia inflexa* and *C. longirostris* were taken in small numbers. A few specimens of *Hyalocyclis striata* and *Diacra trispinosa* were also taken at the "Fosa". Great numbers of other small pteropods resembling Turridae, Littorinae, etc. were caught but no determinations were made. Also not determined were the gymnosomatae which appeared frequently in the zooplankton.

Eggs and Larvae

An anthozoan larva was taken at station F in a vertical tow. Cyphonautes larvae were common at most stations; greatest numbers were found at station A. *Lingula* larvae were abundant at station A and present in small numbers at stations A, C and G. Nauplii and cyprid larvae of cirripeds were found in 65% of the tows. Greatest concentrations were taken at the head of the Gulf. Larvae of bivalve molluscs were very abundant in the zooplankton. The density of all forms combined was higher inside than outside the Gulf. They formed 1.7% of the total number of animals counted and occurred in 85% of the tows. Small numbers of echinoderm larvae were taken at most stations. Bipinnarian larvae of starfish, ophiopluteus larvae of ophiuroids and echinopluteus larvae of echinoids were observed in small numbers. In addition post-larval echi-

noderns were found in some samples. Two *Amphioxus* larvae were taken from stations A and B. No determinations were made. Fish eggs were taken at all stations in medium numbers. Greatest concentrations were found at station A located near the entrance to the Manzanares river. Many forms were very abundant, anchovy eggs being one of them. Fish larvae were common. Largest numbers were taken at stations A and I. The accumulated data on fish eggs and larvae are shown in Table VII. Few insect larvae were taken. A certain number of eggs and larvae were not determined.

Appendicularians

Data on appendicularians are shown in Table VIII. Three genera were found: *Oikopleura*, *Fritillaria* and *Stegosoma*. At surface *Oikopleura* was twice as abundant as *Fritillaria*. In vertical hauls, catches of both genera were comparable. *Oikopleura* was represented by *O. longicauda* and *O. cophocerca* (Det. T. Bjornberg). *Fritillaria* was represented by *F. borealis* forma *truncata*, *F. pellucida* and *F. haplostoma*. The latter species was very abundant. Only one individual of *Stegosoma magnum* (Det. T. Bjornberg) was taken in the tows. Catches of appendicularians were greater inside the Gulf than at the "Fosa".

Salps and Doliolids

Two individuals of *Thalia democratica* were taken at station B. At the "Fosa" 46 oozoids of *T. democratica* were taken in a tow from 300 meters to surface. Two aggregate forms of the same species were also taken in the tow.

Data on doliolids are shown in Table IX. *Doliolum nationalis* was very common in the region. Most individuals taken in May were phorozoids. Gonozoids of the same species were taken at stations A and K. Fifty phorozoids and one gonozoid of *Dolioletta gegenbauri* were taken at station D. One *Doliolina mulleri* was taken at station A. Fifty "Old nurses" and three undetermined doliolids were taken at the same station. Eight "Old nurses" were also taken at the "Fosa".

DISCUSSION ON QUALITATIVE RESULTS

Based on species abundance and distribution four types of communities can be detected:

1. The deep water community at the "Fosa" characterized by large concentrations of amphipods, salps, euphausiids, the copepods *Enaetideus*, *Haloptilus*, *Lucicutia*, *Rhincalanus*, *Scolecithrix*, etc., the chaetognaths *Sagitta serratodentata*, *S. bipunctata* and *Pterosagitta draco*. Presence of any of these forms of zooplankters inside the Gulf would seem to indicate penetration or inflow of deep "Fosa" water into the Gulf.

2. The surface water community at the "Fosa" with such typical groups as *Atlanta*, large *Liriope*, ctenophores and such copepods as *Macrosetella*, *Clytemnestra*, *Euterpina*, etc., in abundance. Again presence of these groups in large concentrations in the Gulf would probably indicate inflow of outside surface water into the Gulf.

3. The water community near the entrance to the Manzanares river characterized by large concentrations of *Trichodesmium thiebauti*, fish eggs, turbellarians, hydroid fragments, *Lingula* and Cyphonautes larvae and smaller concentrations of offshore groups of zooplankters common at the "Fosa".

4. The water community of the Gulf with great concentrations of *Muggiaea kochi*, *Evadne*, *Penilia*, *Acartia*, *Centropages*, *Labidocera*, *Temora*, *Oithona*, brachyuran zoeae, cirriped larvae, etc.

These communities are only tentative and more analyses are needed to gain a complete knowledge of indicator species within various water masses .

Another interesting point indicated by the qualitative analyses was the very large numbers that few species attained in the zooplankton. It is a known fact that tropical waters are usually made up of a great number of forms having small density and that boreal zooplankton is made up of very large numbers of few species. The abundance of such groups as *Temora*, *Oithona*, *Centropages*, *Labidocera* and *Evadne* would not allow classification of the fauna of the Gulf as truly tropical, but, as more similar in composition to boreal waters. The species however are tropical in nature.

S U M M A R Y

Investigations of the abundance, composition and distribution of the zooplankton of the Cariaco region were carried out.

From May to November 1960, 10 stations were occupied monthly. One vertical tow and one surface horizontal tows were made. Many types of plankton nets were used in the hope of sampling all zooplanktonic animals.

Concentrations of zooplankton volumes in the vertical tows declined steadily over the entire Gulf from July to November. This coincided with an inflow of waters from the outside into the Gulf.

Zooplankton volumes were smaller at the "Fosa" than inside the Gulf for the greater part of the survey.

Zooplankton volumes in surface waters showed that at the "Fosa" surface waters are generally zooplankton-poor, but can also be zooplankton-rich at times. Near the entrance to the Manzanares river surface waters are generally zooplankton-rich. Inside the Gulf, surface waters vary from zooplankton-rich to zooplankton-poor in no set trend. Volumes show a "cloudy" or "patchy" type of distribution of zooplankton at surface inside the Gulf.

Zooplankters have been divided into 5 groups according to density and frequency of occurrence. High density, high frequency; medium density, high frequency; low density, high frequency; high, medium and low density, medium frequency; medium and low density, low frequency. The distribution of zooplankters belonging to group one is discussed. It showed a tendency for those zooplankters to aggregate inside the Gulf and to be less numerous at the "Fosa". It also showed greater density of animals deep inside the Gulf than at the entrance to the Gulf, but no appreciable differences in density between the Araya and Cumaná sides of the Gulf.

Notes are given on the composition of each group of zooplankton and tables show the density of the species of groups such as siphonophores, cladocerans, copepods, decapods, fish eggs and larvae, appendicularians and doliolids.

An attempt is made to detect the types of zooplankton communities within the waters of the Cariaco region. Four communities are given tentatively: The deep water community at the "Fosa", the surface community at the "Fosa", the water community near the entrance to the Manzanares river and the water community within the Gulf of Cariaco.

The qualitative analyses have shown a type of zooplankton composition similar to that of boreal waters in so far as few species are made up of very large numbers of individuals. Such species however are tropical in nature.

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TABLE I. Volumes of zooplankton, May - November 1960. 1. Horizontal tows. 2. Vertical tows.

TABLA I. Volumen de zooplancton, mayo a noviembre 1960. 1. Muestras horizontales. 2. Muestras verticales.

1. Horizontal tows. Volumes in cc/15 min. tow. 1. Muestras horizontales. Volumen cc/15 min. de remolque.												
Cruise (Campaña)	STATIONS (ESTACIONES)										(Región total) Whole region	
	A	B	C	D	E	F	G	H	I	K	%	Average
May	8	6	8	9	14	5	7	5	5	3	4.0	7.0
June	16	44	20	16	28	17	54	12	14	6	12.4	22.7
July	39	44	17	13	3	13	19	32	104	12	16.2	29.6
August	—	—	5	29	15	24	24	41	—	—	12.5	23.0
September	58	20	51	17	44	36	15	25	68	6	18.6	34.0
October	19	5	4	9	12	32	2	3	12	14	6.1	11.2
November	160	90	6	40	10	7	4	73	37	125	30.2	55.2
Average	50	34	15	19	18	19	18	27	40	27		
%	18.7	12.7	5.6	7.1	6.7	7.1	6.7	10.1	15.2	10.1		
2. Vertical tows. Volumes in cc/m ³ x 1000. 2. Muestras verticales. Volumen en cc/m ³ x 1000.												
May	38.4	83.3	33.3	39.0	71.4	208.3	55.5	50.0	62.5	83.3	2.0	72.5
June	384.6	500.0	466.6	500.0	1833.3	1250.0	900.0	454.5	363.6	100.0	14.6	675.3
July	714.2	2833.3	1133.3	800.0	2333.3	1750.0	1600.0	818.1	1111.1	160.0	28.7	1325.3
August	—	—	600.0	888.8	1833.3	892.8	666.6	1333.3	—	—	22.4	1035.8
September	227.2	571.4	1083.3	1000.0	833.3	1166.6	1300.0	1666.6	444.4	70.0	18.1	836.3
October	400.0	285.7	416.6	400.0	1666.6	666.6	200.0	166.6	444.4	60.0	10.2	470.6
November	500.0	571.4	66.6	200.0	166.6	166.6	50.0	83.3	62.5	10.0	4.0	187.7
Average	377.4	807.5	542.8	546.8	1248.2	871.5	681.7	653.2	414.7	80.5		
%	6.0	12.9	8.7	8.7	20.0	14.0	10.9	10.4	6.6	1.8		

TABLE II. Density and frequency of the groups of zooplankton in May 1960. Values are total numbers of animals per station in vertical and horizontal tows combined.

TABLA II. Densidad y frecuencia de los grupos de zooplankton en mayo 1960. Los valores son el número total de animales por cada estación en los remolques verticales y horizontales combinados.

Groups (Grupos)	A	B	C	D	E	F	G	H	I	K	% Frequency (Frecuencia) %
Copepods (Copepodos)	56708	25574	18355	283110	244157	73476	151315	131271	35632	32458	64.7 100
Cladocerans (Cladóceros)	10533	39829	40288	4113	65422	35508	131982	28738	8333	29559	24.3 100
Gasteropods (Gasteropodos)	831	2409	5304	7358	1956	3000	12660	3901	6524	4441	2.9 90
Appendicularians (Apendiculados)	208	952	1052	1561	10460	4352	11111	1819	6264	356	2.3 100
Pelecypod L. (Larvas de Pelecip.)	100	1100	600	1551	6756	1501	12500	1702	3152	200	1.7 75
Chaetognaths (Quetognatos)	3134	626	602	9301	1751	411	1670	816	612	430	1.1 95
Cirriped larvae (L. de cirrip.)		51	—	350	8801	500	2500	4706	351	2	1.0 65
Doliolids (Doliolidos)	2274	1983	782	25	28	—	3	261	2835	35	0.5 85
Fish eggs (Huevos de peces)	1296	420	602	366	462	206	56	631	457	582	0.3 100
Decapod L. (Larvas de decapodos)	751	143	3	714	1432	210	524	126	86	240	0.2 90
Foraminifers (Foraminiferos)	58	254	151	102	10	10	100	202	710	99	0.1 80
Polychaetes (Poliquetos)	101	259	—	304	400	52	24	15	155	62	0.08 85
Siphonophores (Sifonoforos)	33	236	202	58	365	17	27	59	29	72	0.06 95
Cyphonautes L. (L. de Cyphonautes)	454	150	101	—	50	—	—	50	200	—	0.06 40
Euphausiids (Eufausiáceos)	256	15	—	—	—	—	—	5	1	287	0.03 40
Ostracods (Ostracodos)	355	52	—	—	—	—	—	—	14	118	0.03 40
Fish larvae (Larvas de peces)	104	54	—	—	50	2	15	20	250	25	0.03 55
Hydroids (Hydroides)	100	10	—	—	—	—	—	51	100	—	0.01 25
Echinoderm L. (L. de equinodermos)	63	79	51	—	1	—	1	2	20	14	0.01 55
Turbellarians (Turbelarios)	100	50	—	—	—	—	—	50	—	1	0.01 20
Eggs-general (Otros huevos)	—	—	9	2	—	2	150	—	—	—	0.01 20
Medusae (Medusas)	8	55	6	11	18	4	4	2	23	19	0.009 85
Unidentified L. (L. indeterminados)	—	—	—	—	—	1	1	—	—	102	0.006 20
Amphipods (Anfipodos)	3	2	—	—	—	—	—	—	1	46	0.003 20
Salps (Salpas)	—	2	—	—	—	—	—	—	—	48	0.003 10
Stomatopods (Estomatopodos)	20	1	—	—	1	—	10	1	2	2	0.002 35
Lingula larvae (L. de Lingula)	11	1	2	—	1	—	—	—	—	—	— 25
Isopods (Isopodos)	—	—	—	—	—	—	—	10	—	1	— 10
Nematodes (Nematodos)	10	—	—	—	—	—	—	—	—	—	— 5
Amphioxus (Amphioxus)	1	1	—	—	—	—	—	—	—	—	— 10
Anthozoa larvae (L. de Antozoos)	—	—	—	—	—	1	—	—	—	—	— 5

TABLE III. Density of siphonophores in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA III. Densidad de sifonoforos en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Species (Especies)	A	B	C	D	E	F	G	H	I	K	TOTAL
<i>Abylopsis eschscholtzii</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Abylopsis tetragona</i>	—	2	—	—	—	—	—	1	—	5	8
<i>Agalma elegans</i>	—	—	—	—	—	—	—	—	—	2	2
<i>Agalma okeni</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Ceratocymba sagittata</i> (?)	—	1	—	—	—	—	—	—	—	—	1
<i>Chelophyes contorte</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Diphyes bojani</i>	10	—	—	—	—	1	—	—	—	2	13
<i>Diphyes dispar</i>	—	105	—	—	250	—	—	14	—	27	396
<i>Diphyes chamissoni</i>	—	—	—	—	—	—	—	1	—	—	1
<i>Enneagonum hyalinum</i>	2	1	—	—	—	—	—	—	—	3	6
<i>Eudoxoides mitra</i>	9	—	—	10	—	—	—	—	—	2	21
<i>Eudoxoides spiralis</i>	2	31	—	11	—	—	1	—	12	24	81
<i>Lensia campanella</i>	1	—	—	—	—	—	1	1	1	1	5
<i>Muggiaea kochi</i>	9	97	202	37	115	16	25	42	11	—	554
<i>Nanomia bijuga</i>	—	—	—	—	—	—	—	—	5	2	7
<i>Rhizophysa filiformis</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Sulculeolaria monoica</i>	—	—	—	—	—	—	—	—	—	1	1
Total	33	237	202	58	365	17	27	59	29	73	1100

TABLE IV. Density of cladocerans, in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA IV. Densidad de cladoceros en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Genera Genero	Type of tow Tipo de remolque	A	B	C	D	E	F	G	H	I	K
Evadne	Vertical	17	6	80	11	1	—	3	6	4	4
	Horizontal	10000	39500	40000	4000	50000	34150	129400	27450	7650	29550
Penilia	Vertical	16	23	8	52	171	8	29	32	29	5
	Horizontal	500	300	200	50	15250	1350	2550	1250	650	—
Total		10533	39829	40288	4113	65422	35508	131982	28738	8333	29559

TABLE V. Density of copepods in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA V. Densidad de copepodos en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Species (Especies)	A	B	C	D	E	F	G	H	I	K	TOTAL
<i>Acartia</i> (<i>clausii</i> , <i>danae</i> , <i>lilljeborgii</i>)	152	100	—	3051	23454	4750	1202	2350	—	34	35093
<i>Acrocalanus longicornis</i>	7	1	—	—	—	—	—	—	—	2	10
<i>Calanus minor</i>	155	10	—	—	—	—	—	1	2	152	320
<i>Calocalanus styliremis</i>	—	—	—	—	—	—	1	—	—	—	1
<i>Candacia</i> (<i>curta</i> , <i>pachydactyla</i> , <i>varicans</i>)	3	—	—	—	—	—	—	—	—	31	34
<i>Centropages furcatus</i>	2527	101	410	4861	19214	4672	19700	4916	1292	80	57773
<i>Clausocalanus</i> (<i>arcuicornis</i> , <i>furcatus</i>); <i>Paracalanus</i> (<i>aculeatus</i> , <i>parvus</i>); Juvenile calanoids	14504	5951	3400	9001	23500	5300	12800	5300	3602	10014	93372
<i>Euaetideus giesbrechti</i>	—	—	—	—	—	—	—	—	—	73	73
<i>Eucalanus attenuatus</i> , <i>monachus</i>)	763	263	19	62	370	1	150	439	100	1750	3917
<i>Euchaeta marina</i>	150	62	4	3	3	—	—	19	10	410	661
<i>Haloptilus</i> (<i>acutifrons</i> , <i>longicornis</i>)	—	—	—	—	—	—	—	—	—	152	152
<i>Labidocera</i> (<i>acutifrons</i> , spp.)	366	313	253	27375	2	1350	2460	1114	162	43	33438
<i>Lucicutia</i> (<i>clausi</i> , <i>flavicornis</i>)	—	—	—	—	—	—	1	—	—	49	50
<i>Neocalanus gracilis</i>	—	—	—	—	—	—	—	—	2	—	2
<i>Pleuromamma gracilis</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Pontellopsis brevis</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Rhincalanus cornutus</i>	—	1	—	—	—	—	—	—	—	22	23
<i>Scolecithrix danae</i>	—	1	—	—	—	—	—	—	—	33	34
<i>Temora</i> (<i>stylifera</i> , <i>turbinata</i>)	15185	3309	2758	228901	113610	51300	95350	98022	9432	3956	621823
<i>Copilia mirabilis</i>	50	—	1	—	2	—	—	50	51	7	161
<i>Corycaeus</i> (<i>flaccus</i> , <i>giesbrechti</i> , <i>gracilis</i> , <i>longistylis</i> , <i>speciosus</i> , <i>typicus</i>)	4209	1505	3852	2901	19200	2550	10400	5254	3506	13267	66644
<i>Lubbockia squillimana</i>	—	—	—	—	—	—	—	—	—	1	1
<i>Oithona</i> (<i>atlantica</i> ?, <i>plumifera</i>)	7504	8905	3453	4953	37351	2951	7650	7254	12622	730	93373
<i>Oncaea</i> (<i>conifera</i> , <i>mediterranea</i>)	5651	1850	1650	500	750	100	900	2700	1901	702	16704
<i>Sapphirina</i> (<i>angusta</i> , <i>intestinata</i> , <i>nigromaculata</i> , <i>opalina</i>)	30	50	—	1	—	—	51	1	1	20	154
<i>Clytemnestra rostrata</i>	200	100	—	—	—	—	—	—	—	100	400
<i>Euterpina</i> sp.	—	—	—	—	—	—	—	—	—	150	150
<i>Macrosetella gracilis</i>	—	—	—	—	—	1	—	—	—	25	26
<i>Microsetella rosea</i>	2101	1250	300	50	1151	—	150	2251	2300	202	9755
<i>Miracia efferata</i>	—	—	—	—	—	—	—	—	1	—	1
Other harpacticoids undetermined (Otros harpacticoides indeterminados)	650	2	250	600	1850	—	350	50	48	—	3800
<i>Caligus</i> sp.	—	—	—	—	—	—	—	—	—	1	1
Nauplii and metanauplii	2501	1800	2005	851	3700	501	150	1550	600	450	14108
Total	56708	25574	18355	283110	244157	73476	151315	131271	35632	32458	1052056

TABLE VI. Density of decapods in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA VI. Densidad de decapodos en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Group (Grupo)	A	B	C	D	E	F	G	H	I	K	TOTAL
Caridea	27	—	2	1	—	5	—	—	3	1	39
Paguridea	10	3	1	—	—	—	—	1	1	1	17
Lucifer faxoni	10	1	—	3	—	—	3	—	—	14	31
Alpheidea	268	11	—	5	20	4	9	16	20	1	354
Brachyuran zoea	160	109	—	704	1405	200	504	50	54	209	3395
Brachyuran megalopa	1	—	—	—	—	—	—	1	—	2	4
Thalassinidea	58	4	—	—	1	—	—	2	1	4	70
Porcellana longicornis	—	1	—	—	5	—	1	2	—	—	9
Penaeidea	10	—	—	—	1	1	—	50	2	—	64
Hippolytidae	1	3	—	—	—	—	—	—	—	—	4
Stenopidea	10	1	—	—	—	—	—	—	—	—	11
Eretmocarid	—	1	—	—	—	—	—	—	—	—	1
Pasiphaeidea	—	1	—	—	—	—	—	—	—	—	1
Sergestes	—	—	—	—	—	—	—	—	—	1	1
Galatheaidea	—	—	—	—	—	—	—	—	—	4	4
Others (Otros)	196	8	—	1	—	—	7	4	5	3	224
Total	751	143	3	714	1432	210	524	126	86	240	4229

TABLE VII. Density of fish eggs and larvae, in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA VII. Densidad de huevos y larvas de peces en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Group Grupo	A	B	C	D	E	F	G	H	I	K	TOTAL
Fish eggs Huevos de peces	545	117	2	356	362	206	53	281	257	562	2741
Anchovy eggs Huevos de anchovías	751	303	600	10	100	—	3	350	200	20	2337
Fish larvae Larvas de peces	104	54	—	—	50	2	15	20	250	25	520

TABLE VIII. Density of appendicularians in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA VIII. Densidad de apendiculados en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Genera Genero	Type of tow Tipo de remolque	A	B	C	D	E	F	G	H	I	K	TOTAL
Oikopleura	Vertical	5	1	1	5	5	2	2	6	6	6	39
	Horizontal	50	350	700	850	8550	1200	6250	900	5550	250	24650
Fritillaria	Vertical	3	1	1	6	5	—	9	13	7	—	45
	Horizontal	150	600	350	700	1900	3150	4850	900	700	100	13400
Stegosoma	Vertical	—	—	—	—	—	—	—	—	1	—	1
Total		208	952	1052	1561	10460	4352	11111	1819	6264	356	38135

TABLE IX. Density of doliolids in the combined vertical and horizontal tows, stations A - K, May 1960.

TABLA IX. Densidad de doliólidos en los remolques verticales y horizontales combinados, estaciones A a K, mayo 1960.

Species Especies	A	B	C	D	E	F	G	H	I	K	TOTAL
<i>Doliolum nationalis</i> (G)	50	—	—	—	—	—	—	—	—	9	59
<i>Doliolum nationalis</i> (Ph)	2119	1982	782	24	28	—	3	261	2835	18	8052
<i>Dolioletta gegenbauri</i> (G)	1	—	—	—	—	—	—	—	—	—	1
<i>Dolioletta gegenbauri</i> (Ph)	50	—	—	1	—	—	—	—	—	—	51
<i>Doliolina mulleri</i> (?)	1	—	—	—	—	—	—	—	—	—	1
"Old nurses"	50	1	—	—	—	—	—	—	—	8	59
Unidentified (Indeterminado)	3	—	—	—	—	—	—	—	—	—	3
Total	2274	1983	782	25	28	—	3	261	2835	35	8226

(G) = gonozoid; (Ph) = phorezoid.