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ABSTRACT

Foraminiferal populations in Laguna Madre are large, indicating high organic productivity. The fauna is dominated by Miliolidae, believed to be due to general abundance of sand in the substrate. It is a modified lower lagoon fauna with abundant *Elphidium* and *Streblus beccarii* variants. Live-total population ratios indicate the lagoon barrier as a source of most of the sediment.

INTRODUCTION

Laguna Madre is on the south coast of Texas between approximately 26°00' and 27°40'N. Lat. and 79°10' and 97°40'W. Long. It is a coastal lagoon separated from the Gulf of Mexico by Padre "Island", a lagoon barrier 110 mi. long. The northern end is at Aransas Pass and the southern at Brazos Santiago.

The purpose of this report is to record foraminiferal distributions within Laguna Madre and to interpret their possible sedimentary significance. Locations of stations are on Figure 1. The samples are composed of surface sediment approximately 10 sq. cm. in area and 1 cm. thick. Living populations (fig. 2) were determined using rose Bengal stain (Walton, 1952) and total populations also were recorded (fig. 3). The samples were collected by Gene A. Rusnak and were analyzed by C.R. Haller.

DESCRIPTION OF THE AREA

The oceanography and sedimentology of Laguna Madre have been discussed by Rusnak (1960) and the sedimentology of Padre Isalnd and the Laguna Madre flats by Fisk (1959). The lagoon is separated into northern and southern basins by a land bridge of low sand and mud flat extending from Padre Island to the mainland. The average width of the basins, which trend parallel to the coast, is $2\frac{1}{2}$–5 mi. and each basin is approximately 50 mi. long. The basins have an average depth of about $2\frac{1}{2}$ ft. Baffin Bay extends inland from the northern basin for 15 mi. and has an average depth of 5 ft. The sediments range from sand to clay and are described by Rusnak (1960).

The climate is semi-arid with an average rainfall of 27 in. and a reported 21 in. of evaporation in excess of rainfall. The water in the lagoon is generally hypersaline, with salinities in the northern basin ranging from 22–45 ‰ Cl and in Baffin Bay from 1–45 ‰

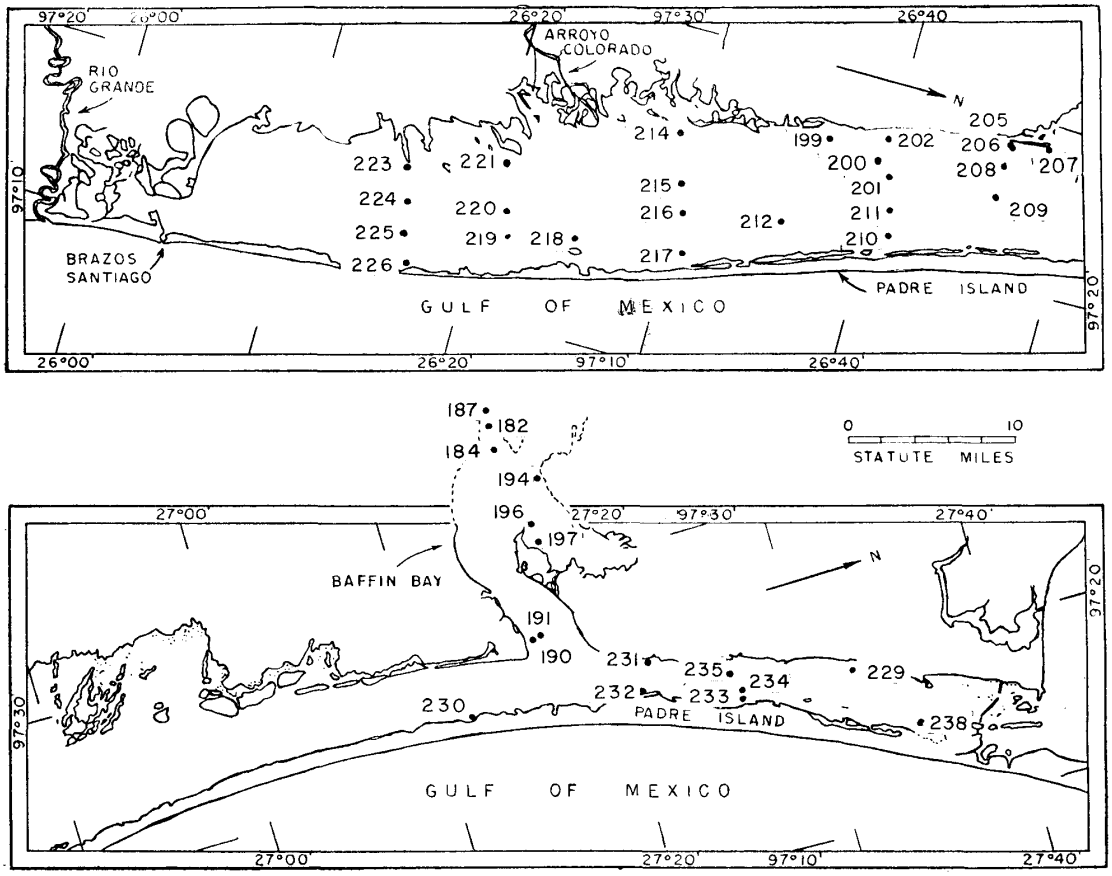

Fig. 1. Locations of stations.

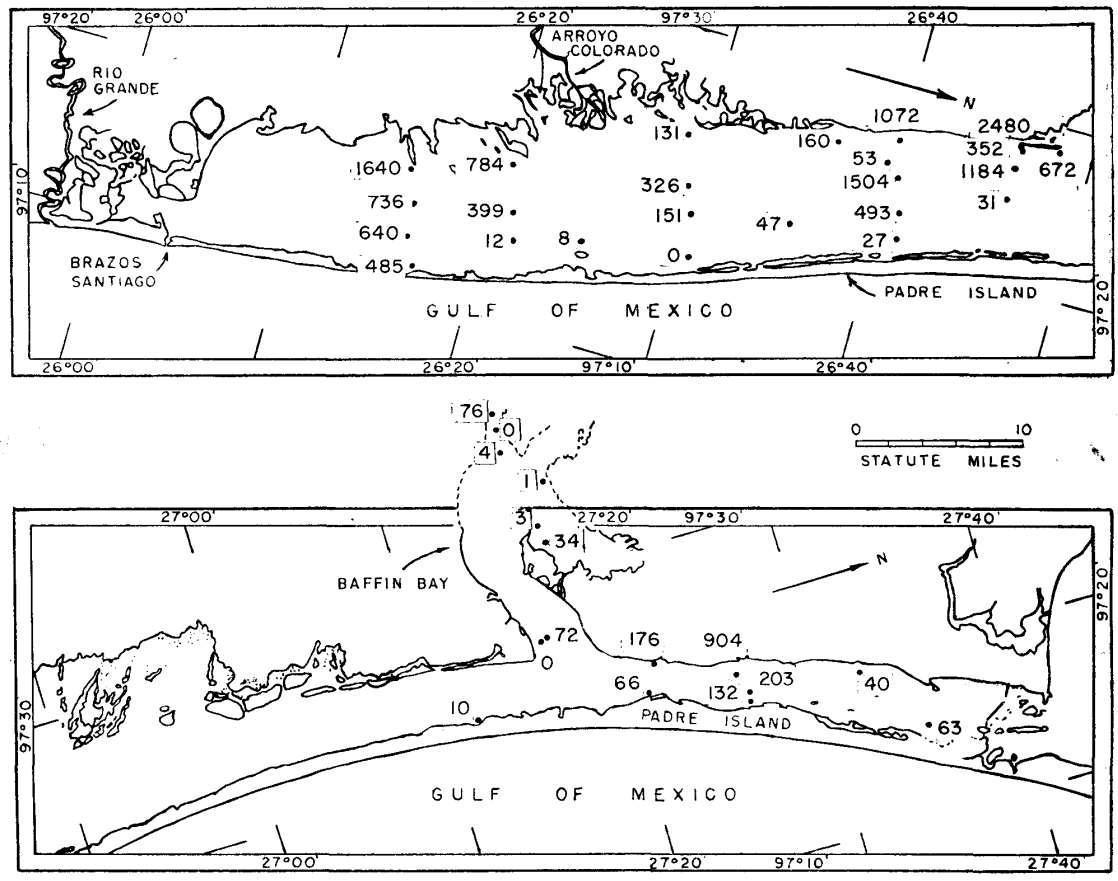

Fig. 2. Living populations of Foraminifera.

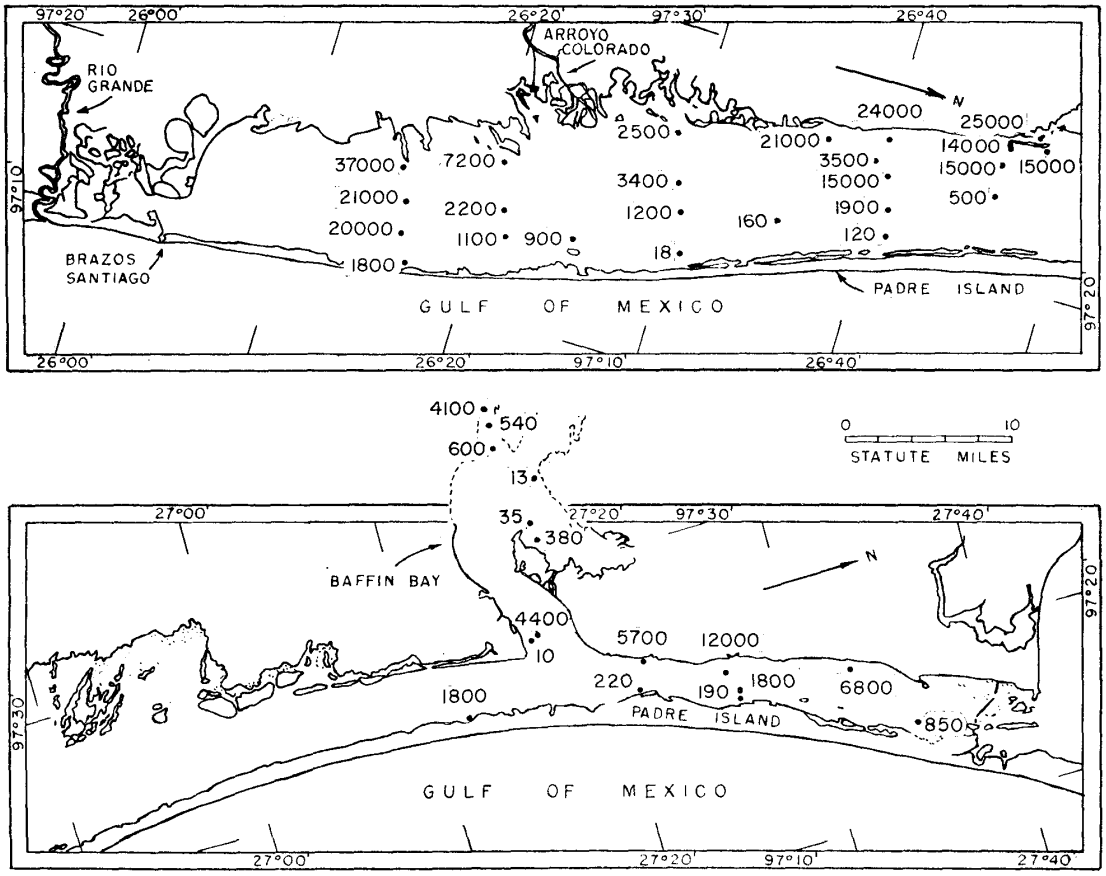

Fig. 3. Total populations of Foraminifera.

Cl. The southern basin has lower salinities, but up to 35 ‰ Cl has been observed. Water temperatures reflect the air temperatures and yearly ranges average approximately 10–35°C with occasional extremes higher and lower than these values. The northern basin is reported by E. Simmons (personal communication) to be an area of very high organic production.

FORAMINIFERAL POPULATIONS

Occurrences of Foraminifera are listed in Table 1. Most identifications are referred to those reported by Parker, *et al.* (1953). Samples and additional data are on file at the Marine Foraminifera Laboratory.

Total populations (fig. 3) are generally high in Laguna Madre except at the marginal stations near the lagoon barrier and at some stations in Baffin Bay. The largest populations occur in the southern basin where they range up to 37,000 specimens/10 ml. of wet sediment. Near the barrier populations range from 18 to 1800/sample. In Baffin Bay there were no Foraminifera found at one station, but most of the stations have an appreciable number of specimens and 4,100 are reported from one.

Fisk (1959, p. 108) found that in the Laguna Madre waters "the invertebrate fauna is impoverished and includes only a few foraminifers, ostracodes, and dwarfed molluscs."

Table 1. Distribution of Foraminifera in per cent of living and total population.

STATION	182	184	187	190	191	194	196	197	199	200	201	202	205	206	207	208	209	210	211	214	215	216	217	218	219	220	221	223	224	225	226	227	229	230	231	232	233	234	235	238
L/T		0.6	2		2	8	9	9	0.9	10	10	4	10	2	4	8	6	22	26	29	5	10	13		0.9	1	18	11	4	3	3	27	0.6	0.6	3	31	68	11	8	7
LIVING POPULATION	0	4	76	0	72	1	3	34	160	53	1504	1072	2480	352	672	1184	31	27	493	47	1331	326	1511	0	8	12	399	7841	1640	736	640	485	40	10	176	66	132	203	904	63
Ammotium salsum							33		4	23	X					1																					2		X	
Bolivina cf. striatula																					X						1	1	X	2										
Elphidium galvestonense								6		2	4	2			2	4			1		X	2						3	1		3	6			9	8	7	1	3	
gunteri									4	4		10	10			4	3				3						X	4	X								X	2	1	
koeboeense										4	1								X		2	X					X	1	2		X							—		
matagordanum												3									2							41	X									1		
poeyanum								3	8	15	2	31	8	11	12	11			1			2					2	10	3		X		10		28	12	3	6	2
Palmerinella palmerae										4		9									X																		
Quinqueloculina funafutiensis																					2									3									
poeyanum											3		X		7	5			X		2						1		3		2	1					X	3	2
rhodiensis											11		4	2	5	16			2		2	5				12		X		2		3	X				3	6	7	
wiesneri									4		20			18	2	7	3		X		13	17					6		4	7	8	1			18				1	2
spp.			11						4	2	18		10	28	2	11	10	70	16	4	8	16	X		38	8	22		10	15	2	1		10	4	6	10	17	6	14
Rosalina spp.																					3						1													3
Streblus beccarii vars.		75			100	100	67	91	54	30	4	46	23	16	41	23	3		X		18	6			13	25	4	37	4	22	20	X	70	70	64	24	39	60	51	
Triloculina oblonga			5						13	4	9	2	13	14	2	4	3	4	4	4	5	12	1		25	17	4	1	21	6	15	61	20			3	9	3	8	24
Triloculinella obliquinoda		25	84						8	4	26		19	11	27	12	39	26	75	92	31	38	98			42	54	2	35	48	42	27	10			31	17	2	14	53
miscellaneous spp.										8	1		10			2	39				9	1			12	8	4		14		2	1		10	5			3		
TOTAL POPULATION	540	600	4100	10	4400	13	35	3800	21000	35000	15000	24000	25000	14000	15000	15000	500	120	1900	160	25000	34000	12000	18	900	1100	22000	72000	37000	21000	20000	18000	6800	18000	5700	220	19000	12000	850
Ammotium salsum	X						3	1	1	3	X	2	X	X		X												1		X			X				6	X	X	X
Bolivina cf. striatula			X						X	X		X		X							X					X	X	X	X	X									
Elphidium galvestonense	X		2		1			3	1	1	4	2	6	1	3	6	3	3	2	2	X	4	X	11	2	2	X	6	1	8	1	6	2	2	10	2	6	6	2	6
gunteri	17	23	1	30	8	43	4	5	3	X	4	2	1	X	3	2					5	X			1	5	1	8	2	4	X	X	X	4	1		X	3	X	X
koeboeense		X	X		6				2	5	X	X	X	X	1	1	4	X	2	X	7	1	1		1	X	X	6	3	5	2	X	2	X	X			1	X	X
matagordanum	X		X		1				1	X			1	X	1	X		2			2				X			14	X	1		X	1	X	X			1	X	X
poeyanum	20	12	3	10	23			6	2	50	3	36	6	5	5	8	4	10	1	6		4	3	5	1	8	1	6	4	8	2	X	6	17	X	18	11	9	3	4
Palmerinella palmerae		X						1	X	1		2		X		X					1	X	X					1	X	X			X				X		3
Quinqueloculina funafutiensis															1						1									2					4	4			1
poeyanum			6						1	X	7		X	X	15	7	1	2	2	3	1	2	2		3	4	4	2	2	2	5	3	9	4	16	4		1	6	4
rhodiensis	X	X	8				3	1	8	2	11	3	11	20	10	17	X	3	8	3	6	7	X	28	3	5	2	4	7	8	2	X	25	16	16	7	4	8	21	8
wiesneri			2					X	1	X	18	X		13	12	9	11	7	4	2	14	25	8		7	3	10	X	8	10	18	7	12	3	9	1		X	8	5
spp.			14		X			X	7	X	12	X	15	17	2	8	11	39	25	12	4	7	9	17	8	6	32	1	12	13	22	2	16	23	4	16	11	8	21	8
Rosalina spp.							3			X											X					X	X	X		X		X							2
Streblus beccarii vars.	55	64	2	40	59	92	34	80	52	29	4	48	12	13	8	13	5	2	2	3	7	6	2	16	6	12	4	28	4	19	4	1	14	14	11	21	36	56	17	25
Triloculina oblonga			11		X				4	X	7	X	4	5	2	6	5	6	5	5	2	6	6		43	15	3	2	5	2	2	46	6	7	5	4	8	2	4	8
Triloculinella obliquinoda	7	X	46	20			14	3	14	2	33	2	36	22	39	21	45	25	48	63	44	34	67	17	24	37	34	20	40	18	34	31	6		22	21	14	3	17	24
miscellaneous spp.	X		4		1				X	3		X	6	1		X	8		X	X	4	3	1	6	X	2	8	X	11	1	5	3	X	10	3	2		1	X	X

Based on the present samples, the foraminiferal fauna is not at all "impoverished" but is relatively abundant in numbers of species and specimens. The contrasting results may be due to differences in methods of sampling or locations of stations.

The living foraminiferal populations in the present samples are very large, especially in the southern basin where they range up to 1640 specimens per sample (fig. 2). Most of the samples from near the barrier in the southern basin have very small living populations. However, the majority of the living populations in the southern basin are much larger than those reported from any comparable area. In Breton Sound in the Mississippi Delta area, for example, there are generally about 100 specimens per sample or less (Phleger, 1955). In Aransas, Mesquite, and lower San Antonio bays most living populations range from less than 100 to 200 per sample. The populations on the continental shelf off central Texas also are much smaller than those in southern Laguna Madre. Living populations in the northern basin are large at some stations but at most are within the ranges of those found in Aransas, Mesquite, and lower San Antonio bays and Breton Sound.

Populations comparable in size to the large ones in the southern Laguna Madre

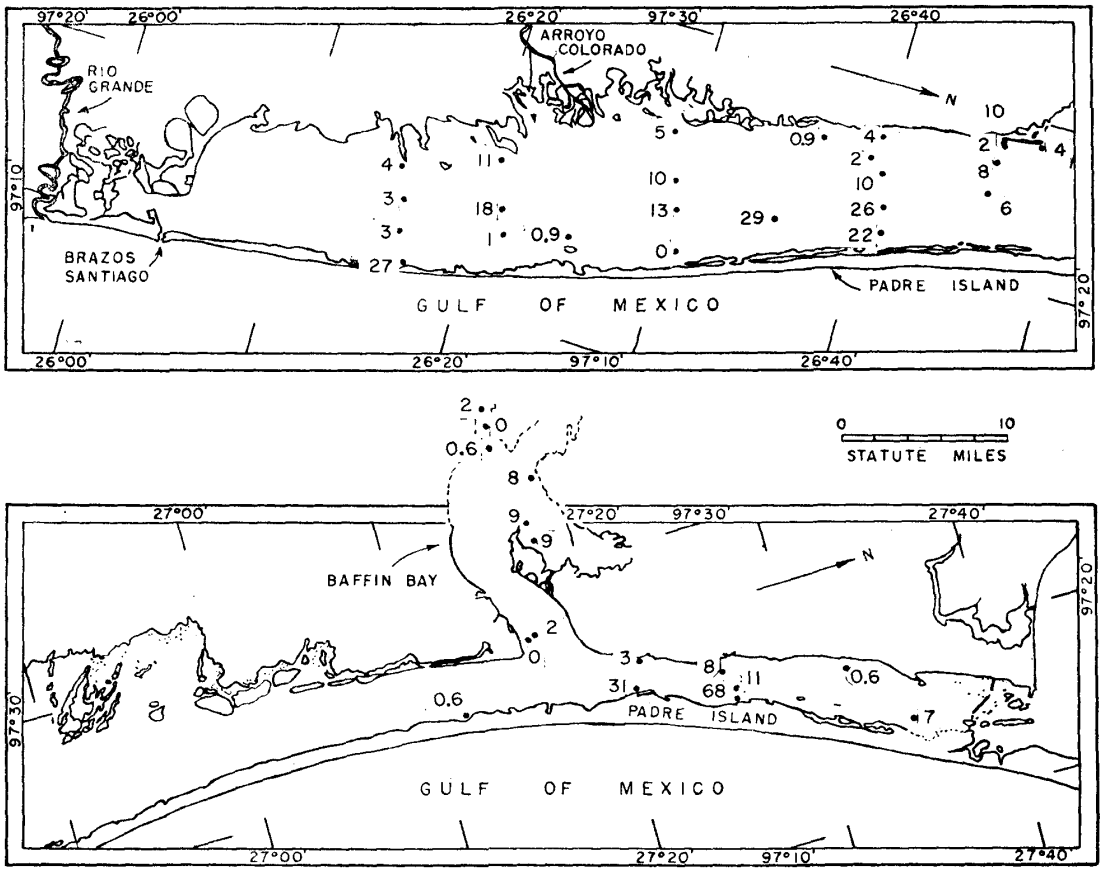

Fig. 4. Living-total population ratios $\times 100$.

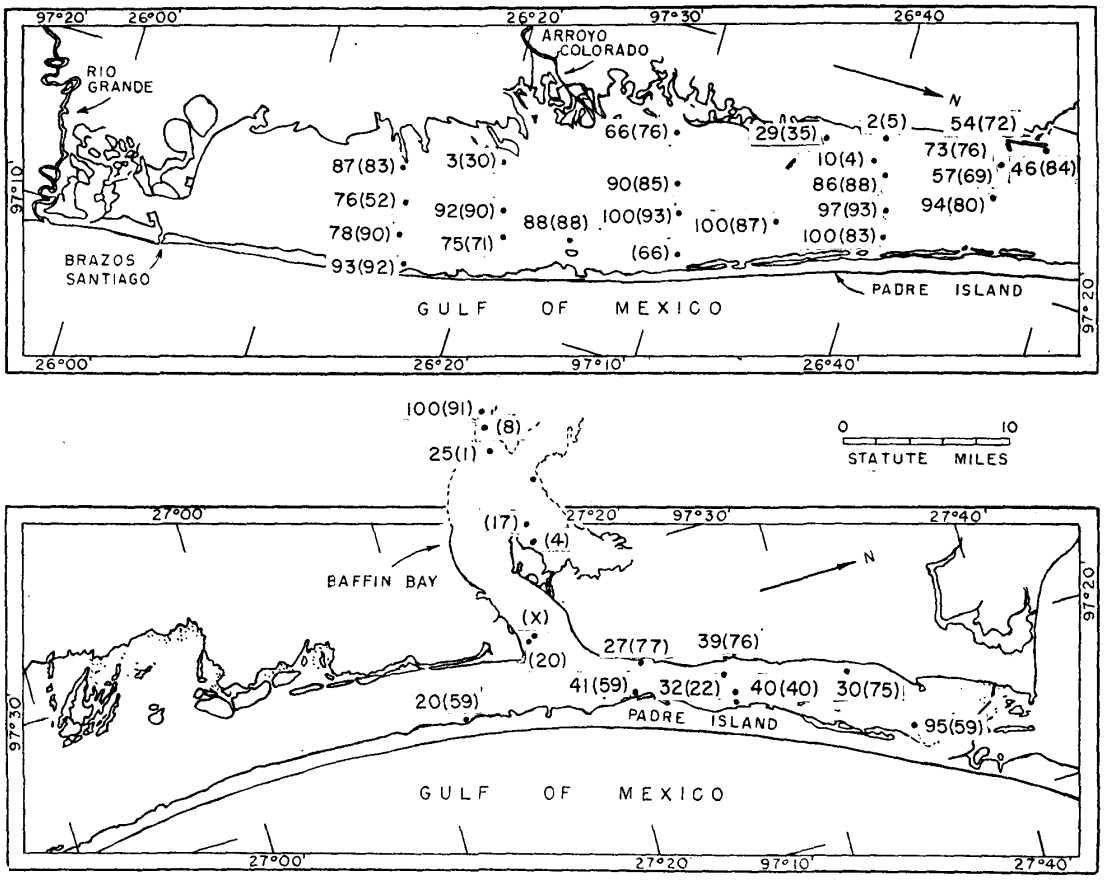

Fig. 5. Miliolidae in **per cent** of living population (not in parentheses) and total population (in parentheses).

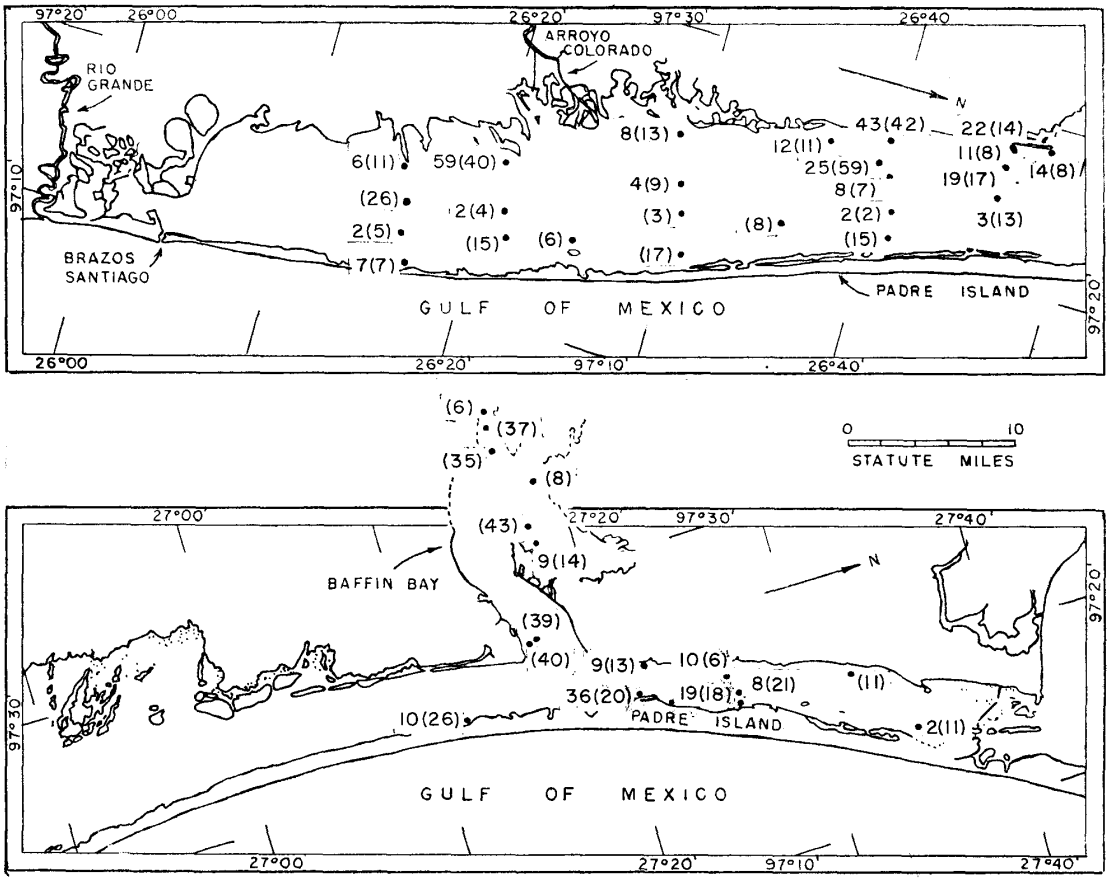

Fig. 6. *Elphidium* in per cent of living population (not in parentheses) and total population (in parentheses).

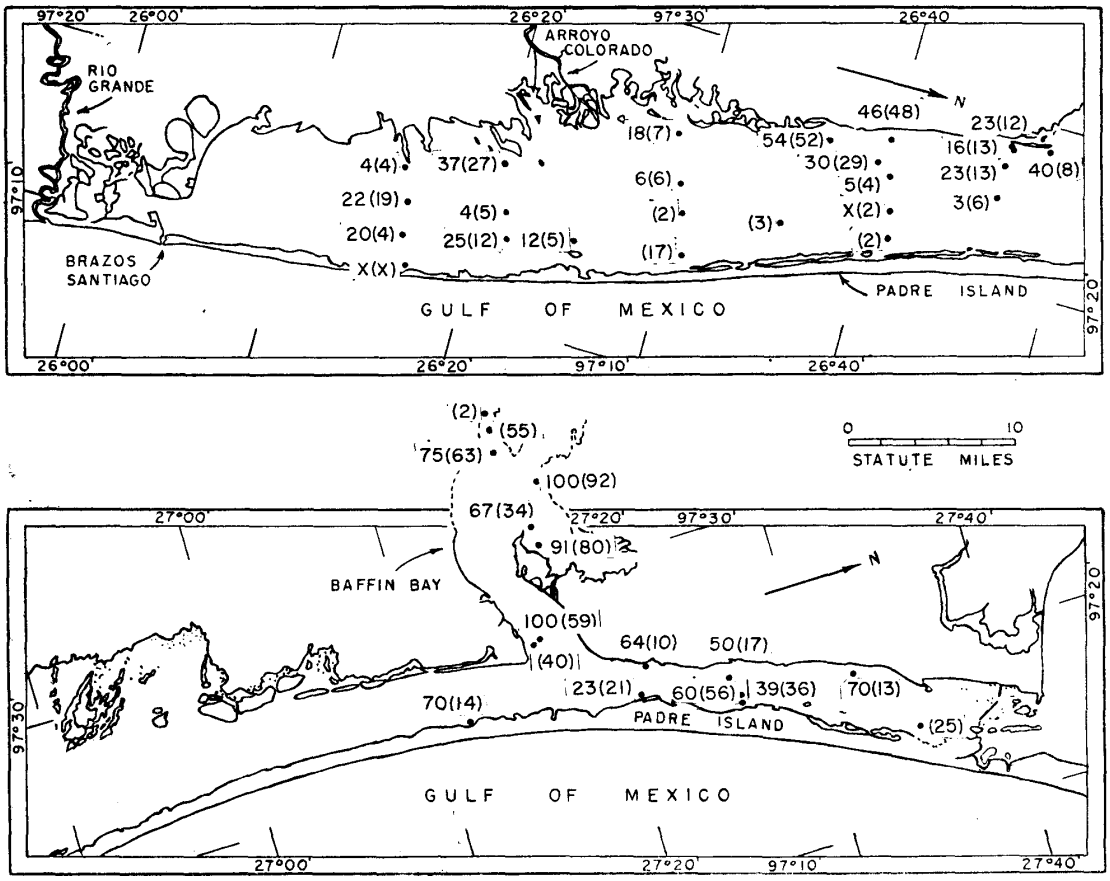

Fig. 7. *Streblus beccarii* (Linne) variants in per cent of living population (not in parentheses) and total population (in parentheses).

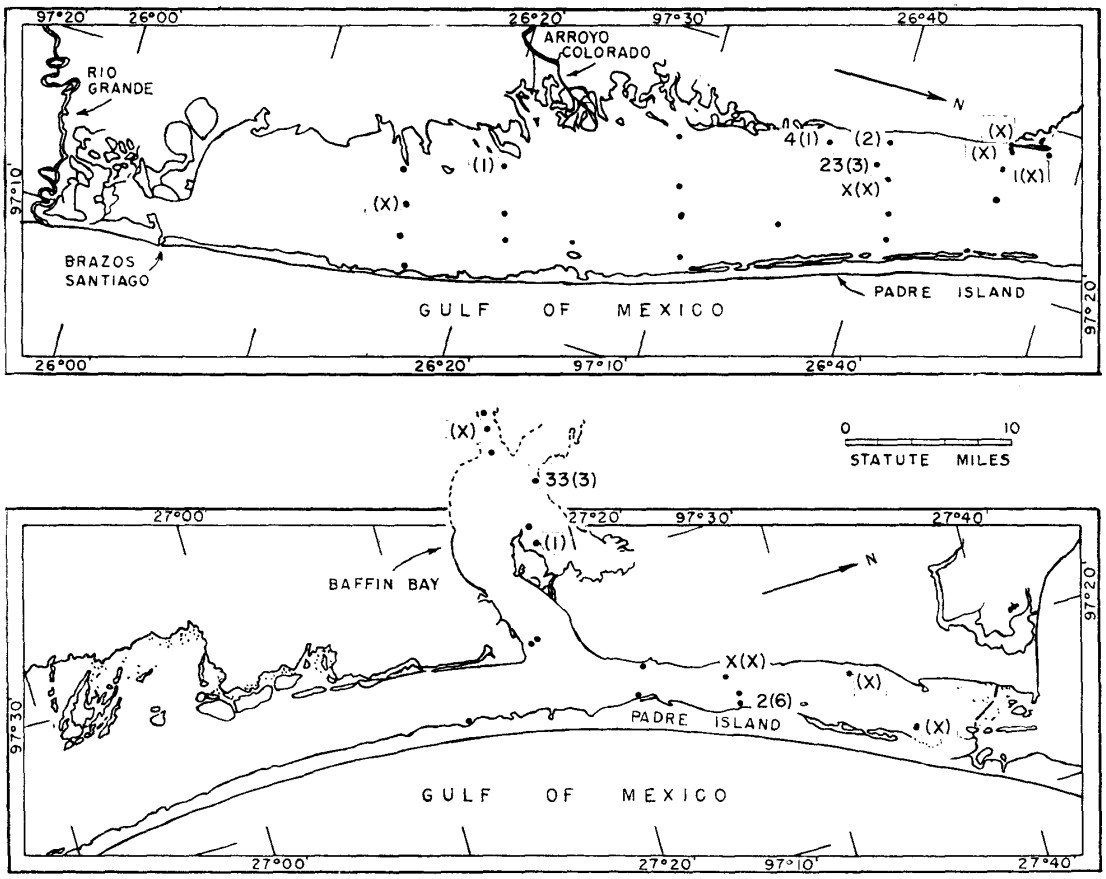

Fig. 8. *Ammotium* in per cent of living population (not in parentheses) and total population (in parentheses).

have been found only in the deltaic marine or deltaic lagoon environment (Lankford, 1959). These populations occur near the mouths of rivers where they enter a lagoon or the open ocean and where sedimentation is rapid. It seems obvious that largest standing crops of Foraminifera reflect abundance of food and thus very high organic productivity in these environments. The small standing crops in the barrier margin samples in the southern basin appear to correlate with distribution of high salinity in the shallow water at these stations (Rusnak, 1960), although high salinity in itself may not be a critical factor.

The foraminiferal fauna is dominated by the Miliolidae which average 40–90% of the total and living populations at most stations (fig. 5). *Elphidium* (fig. 6) and *Streblus beccarrii* variants (fig. 7) are the other abundant elements of the fauna and are dominant at stations having low frequencies of miliolids such as at most stations in Baffin Bay. *Ammotium* (fig. 8) occurs at lower frequencies in Laguna Madre than in adjacent Aransas, Mesquite and San Antonio bays, but does constitute a small part of the total population at approximately one-half the stations. Another group of species which are considered to be typical of the nearshore, open ocean but which also occur in lower lagoons are :

Bolivina cf. *B. striatula* Cushman
Buliminella elegantissima (d'Orbigny)
Rosalina spp.

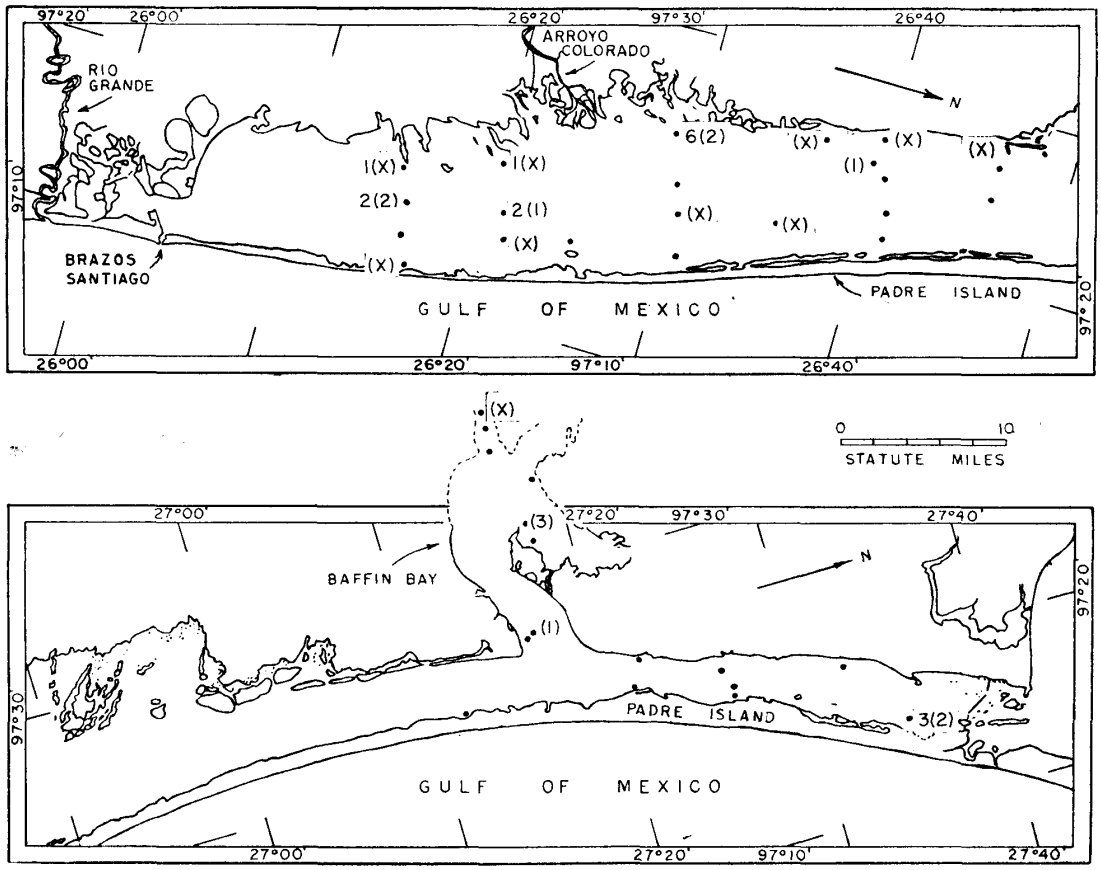

Fig. 9. "Open-ocean" benthonic Foraminifera in per cent of living population (not in parentheses) and total population (in parentheses).

Textularia earlandi Parker

These occur in very low frequencies and most are from the southern basin which may have more widespread invasion of gulf water than the northern basin (fig. 9).

The Laguna Madre foraminiferal fauna may be characterized generally as a lower lagoon, or bay, fauna which is dominated by the Miliolidae. The general dominance of the Miliolidae in the Laguna Madre distinguishes it from any other area of comparable size which has been studied in the northern Gulf of Mexico. Post (1951) reports abundant miliolids at three stations in Redfish Bay and they are abundant at four stations in adjacent lower Aransas Bay (Phleger and Lankford, 1957). The latter authors interpreted abundant miliolids as being related to substrate: "They appear to prefer a sand or shell bottom, and numerous instances of living forms with their pseudopods attached to sand grains have been observed in the preserved samples" (*op. cit.*, p. 96). Rusnak's (1960) data show that sand is an important constituent of the sediment at most stations in Laguna Madre. Where the sediment is silt and clay the fauna is dominated by *Elphidium* and *Streblus beccarii* variants and the miliolids are less abundant.

LIVE-TOTAL RATIOS OF FORAMINIFERA

It has been shown that live-total ratios of foraminiferal populations suggest relative rates of deposition of sediment. These ratios (fig. 4) in Laguna Madre are generally much

larger than in nearby Aransas, Mesquite and San Antonio bays (Phleger, 1956) and not as large as in the Mississippi Delta area (Phleger, 1955). The implication is that relative sedimentation rates are somewhat faster here than in Aransas, Mesquite and San Antonio bays and considerably slower than in the Mississippi Delta area. There is no certainty that the differences in values between Laguna Madre and the other Texas bays are significant, and it is always possible that the standing crop was unusually large at the time of sampling although this is not likely.

Fisk (1959) has suggested that sedimentation rates are high on the flats and that the rate is approximately 1 ft. in 50 yrs. Rusnak (1960) believes that the rates are much slower on the basis of the thickness of "Recent" deposits. The total thickness of sediment deposited during the Recent cycle, however, does not necessarily indicate present rates of deposition.

The live-total population ratios are higher in most places near the lagoon barrier than elsewhere in the lagoon. This suggests that the source of sediment is from the barrier. This is in agreement with Fisk (1959) and Rusnak (1960) who point out that most or all of the sediment is being introduced into the lagoon from the barrier by wind action and storm wash-over.

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