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ABUNDANCE OF THE LOW SALINITY CLAM, *RANGIA CUNEATA* IN SOUTHWESTERN LOUISIANA

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ABSTRACT

The low salinity clam Rangia cuneata, *was found to be very common in oligohaline waters of southwestern Louisiana, discontinuously distributed across a band over 100 miles long and 10 miles wide, occurring in tidal creeks, lakes and bays from the shoreline to at least 4 m in depth. It was replaced in the intertidal zone by* Polymesoda caroliniana, *in saltier, deeper waters by* Tagelus plebius *and* Macoma mitchelli, *and in fresh water by unionids. It was inexplicably absent or rare in many areas, showing no correlation with total sediment carbon, except for being very rare in very highly organic sediments rich in plant detritus.*

Populations were usually composed of uniformly sized animals ranging from means of 28 mm in Grand Lake to 57 mm in one tidal creek in Vermilion Bay. Large populations of juveniles were rare although recently metamorphosed juveniles were sometimes taken. It is estimated that southwestern Louisiana has a minimum standing crop of between 24 and 48 billion clams based in part on an average of 11.1 clams/m^2 found over the whole study area.

INTRODUCTION

Although perhaps as common in their habitat as oysters are in their's, the moderate sized Louisiana road clam or rangia, *Rangia cuneata* Gray, long utilized by prehistoric man for food (McIntire, 1958), has received little interest until very recently. Indian mounds composed largely of rangia provide part of the basis of an extensive mudshell industry, which in 1966-67 (2 years) removed nearly 9½ million cubic yards of shell. Louisiana is the only state with large enough fossil populations to support such an industry, although rangia is now being considered in much of its range as a possible source of food. However, suspected slow growth rates (Fairbanks, 1963; Wolfe and Petteway, 1968; Gooch, 1971[1]) may render this clam less amenable to harvest than oysters, which reach market size very rapidly in Louisiana (Hopkins, Mackin and Menzel, 1953).

Nevertheless, southwestern Louisiana probably contains more *R. cuneata* than any other comparable area of the world, except perhaps Lake Ponchartrain, and the animal is undoubtedly of enormous significance to the ecology of the area. To this end, this study was devoted to determining the distribution and abundance of *R. cuneata* and associated mollusks from about the Atchafalaya River mouth to near but not including Sabine Lake (Fig. 1).

METHODS

Clams were collected in deep water with an angle iron frame dredge 85 x 20 x 93 cm long, pulled behind either a 40 ft or 18 ft boat at about 3 kn for 3 min at each station. The bag was constructed out of 1 in stretched mesh which retained clams as small as 25 mm, with a few down to 15 mm. Shallow waters (less than 2 m) were sampled with two random square meter frames thrown from a small boat. Clams were then removed from the quadrat by diving. Juvenile

[1] Gooch, D. M. A study of *Rangia cuneata* Gray in Vermilion Bay, Louisiana. M. S. thesis, USL: 50 pp.

FIG. 1. *Map of study area showing estimated concentrations of clams. 1 = 0 clams, 2 = less than 10/m², 3 - over 10/m². For more details, see Figure 2. White areas not sampled.*

clams were collected with a 2 or 5 m long cylinder of fiberglass or plexiglass with diameters of 56 or 63 mm. Two cores were taken at each station, sieved and examined for small mollusks, but large amounts of plant fiber at some stations undoubtedly obscured some of the clams. At each station salinity was measured by a Beckman RS5-3 conductivity meter, ph by meter or Hach color kit, oxygen with YSI model 54 m and temperature by thermistor.

Ninety-three shallow water stations were spaced three nautical miles apart around major water bodies, with some sampling elsewhere. Thirty-nine deep water stations were laid out in a grid separated by three nautical miles. Some areas could not be sampled due to shallow water and other problems.

Sediment samples were collected along with juvenile clams. Organic matter was measured by loss on ignition and is expressed in percent total carbon, including a small amount of carbonate carbon.

DESCRIPTION OF AREA

The area of study includes a very old reworked delta of the Mississippi, now known as the chenier plain region (Russell and Howe, 1935; Van Lopik, 1955). Cheniers are low, sandy intrusions above an otherwise flat marshland composed of several species of fresh and brackish water plants, with true salt marsh plants rare (O'Neil, 1949; Chabreck, 1970[2]). Degradation of these plants with other allochthonous sources results in high concentrations of plant detritus or peat mixed in with clays and silts. In addition mud is being added continually from the rivers and is reworked with the detritus (Coleman, 1966).

From Sabine Lake to Vermilion Bay (Fig. 1) the marsh is nearly continuous except for numerous tidal creeks and ponds and the estuaries of two rivers, the Calcasieu and the Mermentau. Grand Lake, associated with the latter and White Lake, with no apparent river system, are oblong ovate "lakes" roughly parallel with the shoreline. These lakes are isolated on all three sides from salt water by control structures completed in 1951. From Vermilion Bay to the Atchafalaya River mouth there is a system of shallow bays (2-3 m) separated from the Gulf of Mexico by marsh on the western end (Marsh Island) and dead oyster reefs on the eastern end (Point au Fer). These reefs have been killed by the increasing flow of the Atchafalaya, which has been capturing much of the Mississippi River flow (Gunter, 1952; Thompson, 1955) and now is building its own delta in Atchafalaya Bay (Shlemon, 1971).

HYDROGRAPHY

Except for Vermilion Bay there is relatively little hydrographic data on the area, although the mouth of the Atchafalaya River has attracted some interest due to the increased flow. Salinities there have been very low, usually within the range of fresh water through Atchafalaya Bay into West Cote Blanche Bay. Salinities increased to an aver-

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[2]Chabreck, R. H. 1970. Marsh zones and vegetative types in the Louisiana coastal marshes. Ph.D dissertation, LSU. 113 pp.

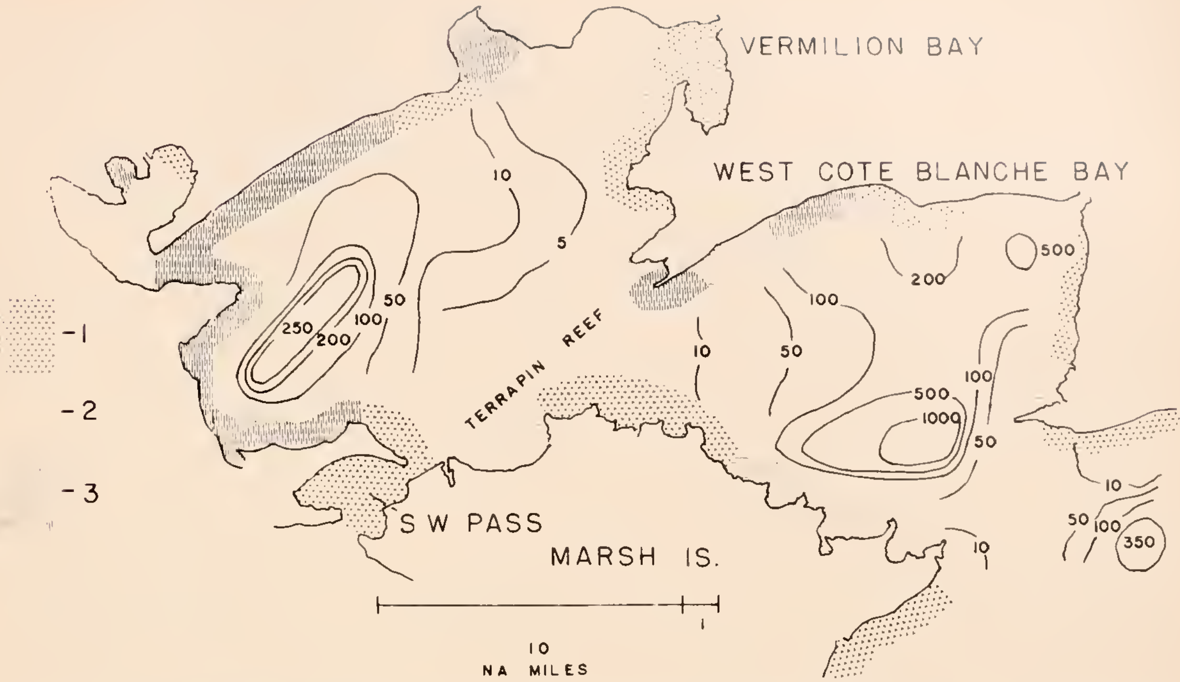

FIG. 2. *Area of highest concentrations. Shoreline concentrations in nos./m². 1 = less than 1. 2 = 1 -10. 3 = more than 10. Offshore are lines of equal density. Numbers are clams caught per 3 minute dredge haul. (To estimate numbers/m² divide by 6)*

age of 3.7 ‰ in Vermilion Bay. Although this is about the same as reported by Dugas (1970)[3] for 1969, it is 2-3 ‰ lower than that observed in 1963-64 (Fontenot, 1967[4]).

Westward through the marsh salinities decrease to near fresh water in Grand and White Lakes. Data given by Gunter and Shell (1958) showed similar salinities for this area although they noted some as high as 2.7 ‰ . Calcasieu Lake has been reported to be somewhat saltier (Kellogg, 1905) and the highest salinities (15.5-26.0 ‰) in the study were found there. Probably the Lake Charles Ship Channel has caused an increase in the average salinity of the Lake.

DISTRIBUTION AND ABUNDANCE

Rangia was not continuously distributed across southwestern Louisiana. It was absent in much of the shallow water of Atchafalaya Bay, at Terrapin Reef between Vermilion and West Cote Blanche Bays, White Lake, Calcasieu Lake and most of the northern marsh area between Calcasieu and Sabine Lakes. Its center of abundance lies in western Vermilion Bay (the area studied by Gooch, 1971[1]), central and eastern West Cote Blanche Bay, with lesser concentrations in parts of Grand Lake, central East Cote Blanche Bay and western Atchafalaya Bay (Fig. 2, Tables 1 and 2). In Vermilion Bay clams appeared equally abundant along the shoreline and in deep water. However, in West and East Cote Blanche Bays clams were scarce along much of the shoreline while reaching high densities in deeper water.

The highest density of clams found in shallow water in a single sample was 238/m² in Vermilion Bay. Doubtlessly higher densities could be found by further searching since Gooch (1971)[1] reported concentrations up to 756/m². Nevertheless, our data indicates an average concentration in shallow water of 11.1/m² with highest numbers in Vermilion Bay to none found in White and Calcasieu Lakes (Table 1). In core samples covering 1.5 m², an average of 14/m² was taken for clams over 10

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[3] Dugas, R. J. 1970. An ecological study of Vermilion Bay. 1968-69. M. S. thesis, USL:107 pp.

[4] Fontenot, B. J. 1967. Seasonal relative abundance and distribution of postlarval white and brown shrimp in Vermilion and Cote Blanche Bay. M.S. thesis, USL: 77 pp.

TABLE 1. *Average numbers/m² at shallow water stations in several Louisiana bays.*

	Highest concentration	No. Stations	Avg. Abundance[a]
Atchafalaya Bay	69	8	6.1
East Cote Blanche Bay	34	6	7.0
West Cote Blanche Bay	130	11	8.5
Vermilion Bay	238	18	26.6
White Lake	0	11	0
Grand Lake	116	13	16.9
Calcasieu Lake	0	13	0
Miscellaneous	97	12	11.8
Total (all stations)		92	11.1

[a]Lowest sample in all bays was 0.

mm while for clams under 10 mm the rate was $28/m^2$. The number of clams taken by core in shallow and deep water were exactly the same (0.08/core). While this does not constitute proof that deep and shallow water samples are comparable there are no data refuting this hypothesis. Various estimates of abundance based on our data, based on weights given by Hopkins (1970) and based on the acreages given by Chabreck (1971)[5] and Perret, et al. (1971) are shown on Table 3.

Accepting the slow growth rate of rangia as suggested by previous workers (Fairbanks, 1963; Wolfe and Petteway, 1968; Gooch, 1971[1]), it might be prudent to harvest no more than 5% of the population annually until more information is gathered about the actual deep water concentrations, the effect of harvesting, recruitment, possible culture methods and the importance of the clam to the ecology of the bays. This should still give a potential annual harvest of about 2 billion clams, at a wet meat weight of 22 million pounds (45.5 million kg.).

Regardless of the precise figure, rangia populations between Sabine Lake and Atchafalaya Bay must number in the tens of billions, with total weights in the billions of pounds (85% is shell weight). Based on our recommendations a few billion rangia could be harvested each year. However, current harvest is about 8-9 billion pounds of shell a year, which exceeds the replacement amount by a factor greater than 18, assuming the whole Louisiana coast is producing the same amount of rangia as the western part.

[5]Chabreck, R. H. 1971. Ponds and lakes of the Louisiana coastal marshes and their value to fish and wildlife. 25th Ann. Conf. S. E. Assoc. Game and Fish Comm. (mimeo. 19 pp.).

TABLE 2. *Average numbers/3 min haul at deep water stations by dredge.*

	Highest concentration	Lowest	No. Stations	Avg.
Atchafalaya	233	4	3	143.7
East Cote Blanche	352	6	5	83.4
West Cote Blanche	1458	22	10	37.8
Vermilion	273	0	15	53.5
White Lake	0	0	2	0
Grand Lake	190	0	2	95.0
Total (all stations)			37	60.0

TABLE 3. *Total amounts of* Rangia cuneata *in southwest Louisiana study area based on various means of estimation.*

	Total Study Area (Chabreck, 1971[5])		
Total from	Number (in millions)	Shell Weight (lbs. in millions)	Wet Meat Weight (lbs. in millions)
Shallow water avg. ($11.1/m^2$)	38,457	1,864	390
Tube samples ($14.0/m^2$)	48,504	2,350	491

By Bay System (Perret et al., 1971)	
Bay	Number (in millions)
Atchafalaya	3,325
East Cote Blanche	2,332
West Cote Blanche	3,092
Vermilion	13,091
Grand	2,170
Total of above	24,011
Total based on total acreage	32,332

Most of the clams lie in the area from Vermilion to western Atchafalaya Bay (Fig. 2). Within this area, which covers about 330 thousand acres (133.5 thousand hectares), there is an estimated standing crop of 23 billion clams.

Several workers have suggested that rangia abundance might be correlated with sediment type or amount of organic matter. Figure 3 shows organic matter concentrations versus rangia abundance. Except for the scarcity of rangia in very highly organic sediments (over 10%) there seem to be no correlations. These highly organic sediments are predominately broken down plant detritus. In these areas rangia may have difficulty in becoming stabilized. Rangia does occur in sediments high in plant detritus where small pockets of detritus collect in swales in hard packed clay. In this clay the clam burrows with difficulty. Therefore, the correlation may only represent problems of maintaining stability where loose plant detritus exceeds the normal burying depth of the clam.

SIZE

The majority of clams collected exceeded 34 mm. At only 19 of 55 shallow water stations were smaller clams found and at 6 of these no clam was under 30 mm. Only at Grand Lake was there an abundance of small clams, over $10/m^2$ (Fig. 4), and the majority of these were between 20 and 30 mm. However, numerous clams over 35 mm were also present at some stations in the Lake and at one station in the northeastern part they averaged 48 mm, or about as large as that found anywhere in the study area.

At deep stations the majority of clams were within the 30-42 mm range although some smaller clams were often found. The mean size for clams at the deep water stations ranged from 30-52 mm which was closely comparable to those found in shallow water. The majority of clams over 50 mm were taken in numbers under $10/m^2$, the only exceptions being at one station in Grand Lake and two in Atchafalaya Bay. The largest clam taken was in a tidal creek off Vermilion Bay; it measured 75 mm. Gooch (1971)[1] reported a record 86 mm clam from the area and the average size of some populations was over 75 mm. While large rangia seem most common in tidal creeks where the water remains practically fresh, there is no obvious correlation of size with environmental factors.

An example of the most common length-frequencies are shown in Figure 4. Means of rangia populations in excess of $10/m^2$ (outside of Grand Lake) ranged from 38-52 mm. Only 14% of the clams were over 48 mm and 40% of them were

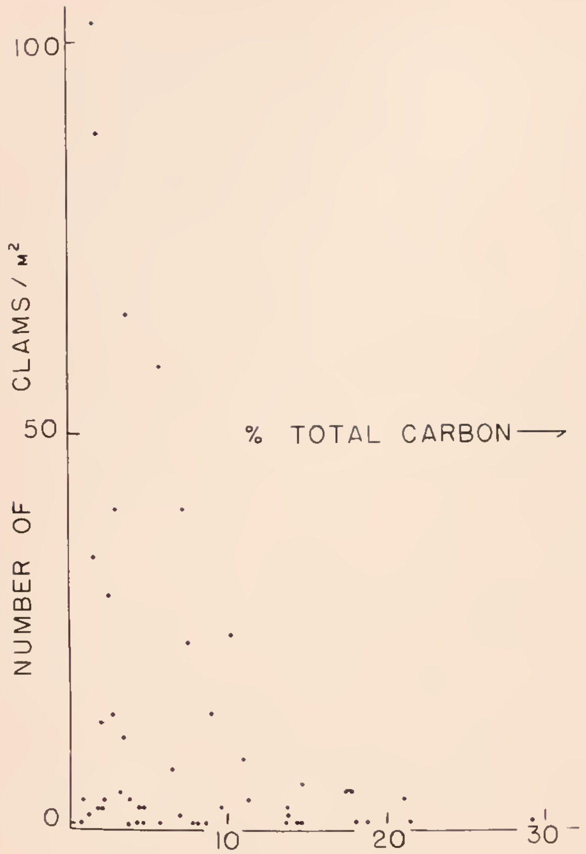

FIG. 3. *Comparison of number of clams/m^2 in shallow water with amount of sediment carbon.*

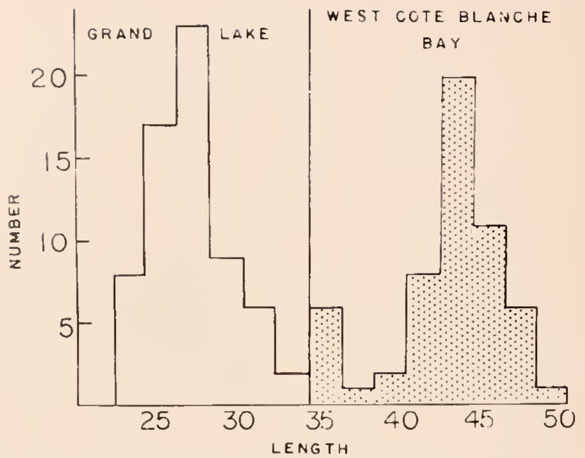

FIG. 4. *Comparison of size distribution (in 2 mm intervals) of rangia from one station on north shore of Grand Lake and one on north shore of West Cote Blanche Bay.*

between 40 and 44 mm. In contrast, at Grand Lake only 2 populations were above 37 mm (both at 48 mm) and 84% of the clams were between 22 and 31 mm.

Samples containing juveniles below 10 mm were rare. Collections were made at all times of the year, and occasionally coincided with the time that veligers were metamorphosing. For example, collections made between 24 March and 21 April 1970 in Vermilion and West Cote Blanche Bays coincide with the t'me of setting previously reported by Fairbanks (1963). A total of 27 small juveniles was taken, mostly from areas where less than 5 adults were taken per drag. While this may suggest that rangia larvae only settle in areas where clams are scarce, large populations of small clams are often found very close to, although not intermixed, with adults.

One accidental capture of very small clams may provide some insight into settlement of larvae. A large uncounted group of young less than 1 mm in length was accidently snagged with a small hydroid colony caught on the end of the oxygen probe in West Cote Blanche Bay. The clams had apparently clamped onto the colony by the shell margins.

ASSOCIATED SPECIES

Rangia apparently has no infaunal competitors in southwestern Louisiana estuaries. Occasionally we found the marsh clam, *Polymesoda caroliniana*, the small low salinity tellinid, *Macoma mitchelli* and unidentified unionids among the rangia populations.

P. caroliniana lives in the intertidal zone buried in mud in *Spartina patens-Sagittaria lancifolia* type marshes and sometimes reaches fair abundance there. Young clams (1-4 mm) were also found intertidally on Mud Point above mean sea level. Live *P. caroliniana* were common in intertidal burrows and loose clams were found scattered all the way to adjacent subtidal areas, where they are undoubtedly inadvertently transported. In an adjacent tidal creek rangia were abundant; however, none were found above mean low water. It appears, therefore, that these two species do not mix. Harry (1942) reported *P. caroliniana* among roots of marsh grasses in Barataria Bay, Louisiana, and Andrews and Cook (1951) describe their range and habitat in Virginia.

Macoma mitchelli was found only at the saltier and deep water stations in southern Vermilion Bay close to southwest Pass. Here they barely overlap rangia populations in the western part of the bay.

Closely associated forms seem largely limited to the two tiny gastropods, *Littordina sphinctostoma* and *Vioscalba louisianae* (Gooch, 1971)[1]. These two species live among the rangia, but their mode of life is unknown.

Oysters, *Crassostrea virginica*, and hooked mussels, *Brachidontes recurvus*, occur predominately seaward of rangia, although both occasionally set and survive for a short period of time in areas where rangia are found. Other than these animals and several demersal fishes and crustaceans (Norden, 1966; Perret, 1967) only two other mollusks were found. The gastropod *Nereitina reclivata*, is common in the lower intertidal zone and on some of the higher oyster reefs. They feed on green and blue-green algae, and occasionally overlap with rangia. The mussel, *Modiolus demissus*, occurs rarely in the marshes; only two records are known. Other than a rare chironomid larva or polychaete, there was no other macroscopic animal associated infaunally with rangia.

Only *R. cuneata* (Gray) was found; living specimens of *R. flexuosa* (Conrad) seem to be very rare, and have been reported in Louisiana by Harry (1942), Behre (1950), and Gooch (1971)[1]. Although recent *R. flexuosa* seem rare, many shells were found in old assemblages.

DISCUSSION

The distribution of rangia in Louisiana clearly follows the lower salinity waters that range from 0.5 - 9.0 ‰ . This zone is perhaps best called oligohaline, although the term does not fit the salinity limits given by other authors. However, rangia clearly occupies this lower zone where there is some salt water intrusions. Other infaunal pelecypods, both fresh-water and marine, are absent. The absence of rangia along the eastern Atchafalaya Bay shoreline may be explained by the possible lack of salt water intrusion. This came about in the past two decades with increasing river flow. However, we were unable to sample the open waters of the Bay because of recent shoaling in the central and eastern part (Shlemon, 1971). It is possible that rangia would be in these waters.

The same may be true of White Lake which, like Grand Lake, has been isolated since 1951 by control structures to prevent seasonal salt water intrusion. Rangia were abundant in White Lake in 1952 (Gunter and Shell, 1958), but very few were taken there by Gooch (1970) as late as 1969. Howe, Russel and McGuirt (1935) reported that in 1934 Grand Lake was too saline for rangia. Today Grand Lake has considerable numbers of rangia including populations of small individuals (below 30mm). These must have set after the control structure was built. Penaeid shrimp are still found in White Lake indicating that there may be some salt water intrusion, especially since the opening of Freshwater Bayou to the Gulf of Mexico. However, no rangia were found in this lake.

The lack of rangia in Calcasieu Lake can be explained by the higher salinities, probably increased by the ship channel. Instead, *Tagelus plebius* is a common infaunal mollusk. Large numbers of recent rangia shells on the bay bottom attest to its presence within historic times. Rangia was reported to be extremely common in upper Calcasieu Lake by Kellogg (1905). We failed to find any although no samples were taken in the center of the bay, in the river above the bay or in Lake Charles.

Although rangia does not penetrate the moderate salinity area of estuaries, it is not clear what factors are limiting. It tolerates moderate salinities (O'Heeron, 1966)[6] and occurs in small numbers off Marsh Island in the Gulf of Mexico where salinities often reach 20‰. O'Heeron (1966)[6] suggested predation by *Thais*, but this is an epifaunal feeder. Two drilled rangia were found in lower Vermilion Bay, but based on the bevel of the hole they were apparently drilled by *Polynices*. *Polynices* is a common predator of infaunal pelecypods. Other possible predators discussed by Gooch (1971)[1] do not seem to be segregated by salinity. There is no evidence of competition with other pelecypods at the seaward edge or no changes in bottom types which might explain the lack of rangia.

One of the most intriguing findings made during this study was the uniform size of populations and the apparent slow growth (Gooch, 1971)[1]. Another interesting observation was the lack of clams, young or old, in many apparently suitable areas suggesting that recruitment is rare. One explanation is the possible need for degrading plant detritus on which rangia might first attach to before burying into the sediments. The lack of plant detritus or other suitable materials at time of setting may contribute to setting failure. However, other hypotheses need to be investigated and studies on spawning, larval abundance, settlement and recruitment should be done.

The great abundance of rangia in southwestern

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[6] O'Heeron, M. K., Jr. 1966. Some ecological aspects of the distribution of *Rangia cuneata* Gray. M.S. thesis, Texas A & M Univ. 55 pp.

Louisiana is undoubtedly related to the great width of the upper part of the estuarine zone. Its width in the Vermilion-Cote Blanche area is about 12 miles and the length exceeds 100 miles. Rangia appears well adapted to the very organic, turbid waters and reduced sediments that typify this area. The importance of the clam to the area seems to be as follows:

(1) Important converter of detritus to animal matter and reservoir for many nutrients, especially $CaCO_3$;

(2) Fills a niche in a habitat (infaunal, oligohaline) that no other similar animal tolerates;

(3) Provides shell for storm built marsh beaches;

(4) Provides a hard substrate in bay bottoms for attachment of epifaunal species; and

(5) Probably has many unknown effects on sedimentation and survival of burrowing species of other groups.

Rangia have commercial applications both potential and realized. While some of the more obvious applications, such as mudshell, receive the most attention, some unstudied aspects may be more important. Rangia maintains a productive, stable area, which produces one of the largest commercial catches of other animals in the world. Hopefully future utilization of this clam will be considered over a long term view since the data gathered in our studies suggests that rangia may be very susceptible to rapid depletion.

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