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DISTRIBUTION DATA

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# FLOATING CORALS: A POSSIBLE SOURCE OF ERRONEOUS DISTRIBUTION DATA

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## ABSTRACT

Some reef corals are able to float after their cellular structure is filled with air. Experiments performed with corals collected on Texas' barrier islands show that when corals capable of floating are immersed in water they absorb water slowly and stay afloat for varying lengths of time; some float for more than 8 months. The possibility of floating corals being deposited far from where they originate is real and might lead to erroneous distribution data and wrong ecological interpretations.

## INTRODUCTION

The ability of corals to float after drying, although not of general knowledge, was recognized as long ago as 1775 by Muller, who gave the specific name *natans* to *Colpophyllia natans*, the "Schwimmenstein," in recognition of its buoyancy. Muller noted that to float, the corallum must first be dried so that its inner cells become air filled. Other references to flotation of *C. natans* include those of Esper (1789), Dana (1848), and Matthai (1928). Flotation of the Indo-Pacific species *Favia speciosa*, which has a characteristically light corallum, was noted by Guppy (1889), Wood-Jones (1912), and Vaughan (1918) who suggested long transportation of floating coral heads in some instances. Weigelt (1938) called upon flotation to account for the peculiar occurrence of a fossil specimen of *Colpophyllia* in the Oligocene of Central Europe.

The present paper identifies coral species capable of floating after the cells become air filled, considers the internal structure of floating corals, and presents data on the distribution of floating corals which indicate that the corals were transported considerable distances from where they lived.

## TRANSPORTATION RECORDS

Dry corals belonging to the species *Colpophyllia natans* (Muller), *Colpophyllia amaranthus* (Muller), *Solenastrea hyades*

(Dana), and *Solenastrea bournoni* (Milne-Edwards and Haime) are not uncommon on the beaches and among the sand dunes of Padre, Mustang, and St. Joseph islands, Texas.

All species named above are commonly found living among coral reefs of the West Indies and Florida. *Colpophyllia natans* has also been collected alive off the top of a bank called the "Flower Gardens," which is situated in the Gulf of Mexico about 120 miles south of Galveston, Texas (T. Pulley, *personal communication*). *Solenastrea bournoni* has been reported from Alacran Reef, which is situated in the Gulf of Mexico about 70 miles north of Progreso, Yucatan (Kornicker, *et al.* 1959).

About 35 dry coral specimens from Padre, Mustang, and St. Joseph islands, ranging in weight from 0.52 to 43.6 kg, were tested and found to float, and it is postulated that flotation is the principal mechanism by which these corals were transported to the coastal islands of Texas. It is possible, of course, that some specimens were torn off outcrops of fossils in the offshore waters of the Gulf of Mexico. However, these species have not been reported from the near-shore Gulf, and it is unlikely that if this were the source, the corals on the islands would consist mostly of specimens that are capable of floating when dry. Storms satisfactorily account for the presence on the beach of the small coral *Astrangia astreiformis* Milne-

Edwards and Haime, which lives offshore and does not float when dry. It is considered unlikely that corals in 11 or more fathoms of water on offshore banks, which are situated in water 45–65 fathoms deep, could be transported to the beach either by flotation or by bottom currents.

It is possible that some of the floating corals now found on the coastal islands of Texas became dry during a low stand of the sea and then floated to the Texas coast; however, several specimens collected from the water's edge of Padre Island contained dried polyp tissue showing that these corals were of recent origin. Many specimens of coral collected along the water's edge had attached to them goose-neck barnacles with stalks that had not yet decayed, indicating that they must have been stranded just prior to discovery.

Additional evidence, supporting the hypothesis that flotation is the principal mechanism in the distribution of these exotic corals, was supplied by Mr. John W. Ward, Corpus Christi, Texas, who observed a specimen of *Colpophyllia* floating off Padre Island in 1954 (*personal communication*). This specimen weighs 34.5 kg, and is a fragment of a coral estimated to have weighed in the vicinity of 900 kg. Also, a ship's captain reported seeing a large coral head floating in the Gulf of Mexico off Port Aransas, Texas, on 27 January 1960 (H. T. Odum, *personal communication*).

The largest specimen of floating coral observed by the authors was a complete coral head of *C. natans*, which was collected by Mr. Louis Rewalt on Padre Island. It weighed 43.6 kg.

Corals cast upon a beach, dried, and then taken again into the sea could be transported from the Caribbean area to the Texas coast through the mechanism of the Gulf of Mexico circulation. Water entering the Gulf of Mexico converges in the coastal bend area of Texas where these islands are located. The dominant wind pattern from the southeast would also facilitate drift towards these islands.

Because the distance traveled by a float-

TABLE 1. *Field tests of floating duration*

Species	Dry weight (g)	Maximum dimension (cm)	Initial specific gravity (approximate)		Period corals remained afloat (days)
<i>Colpophyllia natans</i>	366	15	0.81 <sup>a</sup>	0.73 <sup>b</sup>	17
	442	—	0.64 <sup>a</sup>	—	—
	477	17	—	0.65 <sup>b</sup>	58
	1,950	31	—	0.75 <sup>b</sup>	240 plus
	2,005	23	—	0.73 <sup>b</sup>	240 plus
<i>Solenastrea bourmoni</i>	51	9	0.69 <sup>a</sup>	0.64 <sup>b</sup>	11
	407	16	0.61 <sup>a</sup>	0.55 <sup>b</sup>	124
	420	16	0.86 <sup>a</sup>	0.83 <sup>b</sup>	5
<i>Solenastrea ? bourmoni</i>	103	—	0.61 <sup>a</sup>	—	124
<i>Pectinia paeonia</i> <sup>c</sup>	8	—	—	0.44 <sup>b</sup>	240 plus
	12	—	0.75 <sup>a</sup>	—	50

<sup>a</sup> Approximate specific gravities determined by dividing dry weight of specimens by wet weight at time specimens sank.

<sup>b</sup> Approximate specific gravity obtained by dividing dry weight of specimen by volume of water it displaced. Comparison of this method with that described in footnote "a" above, indicates that the specific gravities obtained in this method are about 0.055 points lower.

<sup>c</sup> These Pacific specimens were purchased from a supply house. Balance of specimens was collected on Padre Island, Texas.

ing corallum depends not only upon its initial buoyancy, but also upon the duration of the buoyant state, 9 specimens from Padre Island were placed in a tank of water and observed for 8 months. The results of this experiment are shown in Table 1.

Certainly the observed flotation period of 8 months for 4 of the specimens tested is permissive of transport across large bodies of water, and of introduction of coralla into habitats to which they are foreign. Larger specimens are quite capable of floating sufficiently long for completion of a journey from the Caribbean to Texas coastal islands, while those which sink below the surface may possibly be transported for considerable distances before they actually touch bottom. There is also the possibility of beach-to-beach transportation with periodic drying on the beach alternating with periods of transport in water currents.

COMPOSITION AND INTERNAL STRUCTURE  
OF FLOATING CORALS

From the evidence acquired during the course of this study, it is apparent that the factors causing lowered specific gravity in coral skeletons are variable within species. For example, field flotation experiments have demonstrated that specimens belonging to the same species float for differing periods of time (Table 1). Indeed, some specimens may float while others of the same species do not. As an example, only one of about a dozen specimens of *Diploria strigosa* (Dana) collected alive and *in situ* by Kornicker from the Alacran Reef, Campeche Bank, Mexico, floated after being dried. However, apparently among some species such as *Colpophyllia natans*, *C. amaranthus*, and *Favia speciosa*, specific gravities are usually well below that of water and flotation is the general rule.

Primary inspection of coralla from beach drift might suggest that large cavities caused by burrowing clams or snails might cause entrapment of air and enhance the buoyancy of the specimens. Such holes are not necessary nor are those caused by other chemical, physical, or biological means, for some floating specimens are apparently free from all such cavities. It is also known that the period of time elapsed between the tearing loose of the coral from its substrate by external forces and subsequent floating may be small; although the majority of specimens are bleached white and fragmentary, indicating a period of wear and tear on drying on beaches, some specimens have been observed floating with the dried tissues of the polyp still remaining on the corallum. It is probable, however, that the majority of floating specimens have spent some time in residence on a beach near where they lived, for the mechanism required to break the corallum loose would probably be storm waves and these are quite likely to cast the specimen upon the beach. Later, after the pore spaces of the corals have become air filled, high storm waters may remove the corals from the beach and start them on their journey.

Because of the possibility that residence

on the shore with exposure to air, fresh water, and sunlight might result in conversion of the original aragonite to calcite, resulting in a lower specific gravity (2.94 to 2.72), specimens were checked for mineralogical composition. X-ray spectrographic analysis made by Dr. Brian Mason, American Museum of Natural History, showed no differences in skeletal mineralogy between floating and nonfloating types.

The mechanism of flotation is obviously the result of reduction of specific gravity by the introduction of large volume of air-filled spaces. A coral skeleton composed of vertical elements, the walls and septa of the corallites, and horizontal elements such as dissepiments, aided by vesicular exothecal tissue, is remarkably well designed for such a feat. Specific gravities of 0.44 were obtained for specimens of *Pectinia paeonia* indicating that the volume of air entrapped is considerable in relation to the mass of the skeletal material. Other specific gravities of floating specimens are given in Table 1.

Superficial examination of the relative sizes of pore spaces in floating and nonfloating specimens of the same species does not yield informative data. Differences of a very small magnitude in the thickness of the walls of the cellular calcareous tissue can introduce a considerable difference in the specific gravity of the entire corallum. This aspect of the variation within species must receive continued attention.

As shown in Figure 1, corals immersed in water initially absorb water rapidly, but after about 30 days, water is absorbed more slowly. The specific gravity of the coralla, including those which sank soon after immersion, never reached that of aragonite (2.94). Corals should float for proportionately longer periods in water with high salinity and low temperature because of the resulting increase in water density. It is therefore considered possible that corals which become waterlogged and sink below the surface while in the open sea might remain suspended in denser subsurface water and be transported by deep currents.

As a check on field experiments of flotation duration, several specimens were

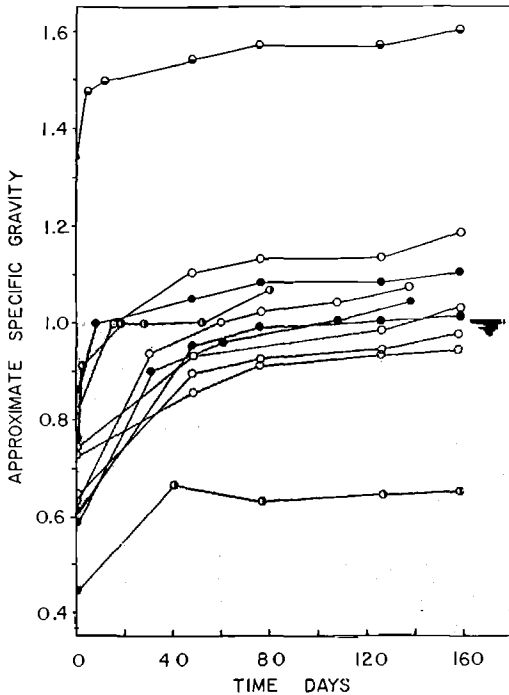


FIG. 1. Graphs showing the change in specific gravity of corals immersed in water. Open circles represent specimens of *Colpophyllia natans* collected on Padre Island. Closed circles represent specimens of *Solenastrea bourmoni* collected on Padre Island. Circles with bottom half filled represent an unidentified specimen collected on Padre Island. Circles with right half filled represent specimens of *Pectinia paeonia*, a Pacific coral, which was purchased from a supply store for use in this experiment. Corals floated when the specific gravity was below one (shaded area). The initial approximate specific gravity of corals that did not sink and of the unidentified coral that did not float was determined by dividing the weight of the dry specimen by the volume of water it displaced. The approximate specific gravity of corals that at first floated but then sank was determined by dividing the weight of the dry specimen by the weight of the specimen after it just sank. Interim specific gravities were obtained by dividing the dry weight of the specimen by the wet weight at the time measurements were made.

placed in water-filled jars and subjected to high vacuum. In some instances, the specimens remained under the high vacuum for as long as 72 hr, yet when specific gravities were determined at the end of this period, they were in the range of 1.8 to 1.96, which is far below that of aragonite. These low values of specific gravity are impressive

granting the assumption that all entrapped air was removed from the specimens. To ascertain the validity of this assumption, thin, flat fragments of septa several millimeters square which were free from all angular protuberances or re-entrants were floated in methylene-iodide acetone solutions together with standard density cubes. The following specific gravities were obtained:

Species	Specific gravity
<i>Colpophyllia</i> cf. <i>C. amaranthus</i> (Muller)	2.69 ± 0.01
<i>Solenastrea hyades</i> (Dana)	2.69 ± 0.01
<i>Pectinia paeonia</i> (Dana)	about 2.8

These data indicate that despite the high vacuum, entire specimens retain much air, suggesting that there must be large pore spaces which are closed or sealed. If this is so, it also is suggestive that these pore spaces are filled with gas during the life of the polyp. This line of speculation needs field study and careful laboratory corroboration.

Specific gravities of minute septal particles are also much lower than those expected for purely aragonitic skeletal elements. It is expected that the reduction is, in part, a reflection of the amount of substrate materials within the skeletal element, upon which the aragonite is deposited. This material, a mucopolysaccharide-like substance (Goreau 1959), is present in unknown quantities in these corals. Discrepancies between theoretical values of specific gravity and those observed for small fragments are due to imperfections in technique and in particular to buoyancy derived from the fundamentally fibrous structure (thus, perhaps, porous) of the coral skeleton.

In general, it is apparent that the flotation of the coral skeleton is dependent upon the entrapped gases within the cellular organization of the skeletal elements. This cellular construction, coupled with an apparent reduction of density resulting from compositional aspects, is probably variable to a very large extent not only from region to region, but locally with a given population. Whether local environmental differ-