ticle irradiation appears to be greater than one, the effect of the irradiation from Ra^{226}, Ra^{228}, and Pb^{210} may be greater than that from the other internal emitters. However, the same RBE factor must be used for the normal individual as for the one having an osteogenic sarcoma so that the difference in dose is still relatively small.

In addition, no great significance can be attached to the slightly higher dose rates calculated for the osteogenic sarcoma cases because the hospital from which the osteogenic sarcoma samples were obtained is located within the geographical area having high concentrations of radium in municipal waters. Consequently, one expects a higher concentration of Ra^{226} and Ra^{228} in the skeletons of these individuals than in those from other areas.

In conclusion, this study has demonstrated that for an individual with an osteogenic sarcoma, the internal dose rate, radium metabolism and possibly the metabolism of Pb^{210}, stable lead, and fluorine, do not differ significantly from those of the average human being. Thus, in future studies, the metabolism of these substances by individuals with osteogenic sarcomas may be assumed to be identical to those of the unaffected population, so that measurements on the former group are unnecessary.

While it is conceivable that the variation in environmental radiation may have a direct effect on the spontaneous incidence of osteogenic sarcoma in man, this study is not suitable for this purpose. Estimation of the osteogenic sarcoma incidence requires knowledge of the population at risk for each of the dose levels. Although these data are available for a limited geographical area, they are not available for the region in which these individuals lived. This estimate must await completion of an epidemiological study such as is in progress in the Midwest.

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Sterols in Recent Aquatic Sediments

Abstract. *The presence of sterols in recent fresh-water sediments was confirmed and, for the first time, sterols were found to be widely distributed throughout recent marine sediments. Quantities ranged from 60 to 300 parts of cholesterol carbon per million parts of organic carbon in the sediments. No correlation of sterol content with environment or depth of burial in the sediment was apparent.*

The suggestion that sterols might be a source material for some of the compounds in petroleum was first advanced by Walden (*1*) and numerous references have been made to this possibility during the intervening years; the literature on the subject has been reviewed by Bergmann (*2*). Unequivocal demonstration that such is the case should include evidence not only that sterol degradation products are present in crude oils, but also that sterols themselves are present in those recent sediments which are thought to represent future source beds of petroleum. The first evidence for the presence of sterol degradation products in crude oil was the recent isolation of Diels' hydrocarbon from Ponca City crude oil by Mair and Martinéz-Picó (*3*). However, convincing evidence for the occurrence of sterols in recent sediments is lacking since statements in the literature on this point are contradictory.

Although sterols have generally been found in recent terrestrial and fresh-water sediments by Turfitt (*4*) and others (*2*), Trask and Wu (*5*) were able to detect them in only one recent marine sediment. Fox and Oppenheimer (*6*) specifically stated that sterols could not be found in recent marine sediments; this is especially surprising in light of the work of Turfitt (*7*), who showed that lack of aeration and high water content were factors which inhibit the growth of organisms responsible for the decomposition of sterols in soils. Since the evidence at hand suggests no

Table 1. Concentration of sterols in recent sediments expressed as parts of cholesterol carbon per million parts of organic carbon of each sediment.

Location	Depth within sediment (cm)						
	0–15	15–30	105–120	110–125	115–130	120–135	125–140
	Tamarack Bog						
3	128						
	Okefenokee Swamp: savannah						
3	60			86			
	Okefenokee Swamp: cypress						
4	118*			60†			
	Bellefontaine Marsh						
3	261			237			
	Mississippi Sound						
1	174						102
4	160						
	Gulf of Mexico						
1	107	91	157			144	
2	147						
3A	304					209	
4	250						
	Santa Barbara Basin						
1	172			104			
	San Nicolas Basin						
2	99						

* Duplicate determinations gave values of 113 and 122. † Duplicate determinations gave values of 53 and 66.

good reason why sterols should not be found in all aquatic deposits, a survey was made of the sterol content of a series of recent sediments varying in type from fresh-water to deep marine.

Recent sediment samples were collected over a number of years (*8*).

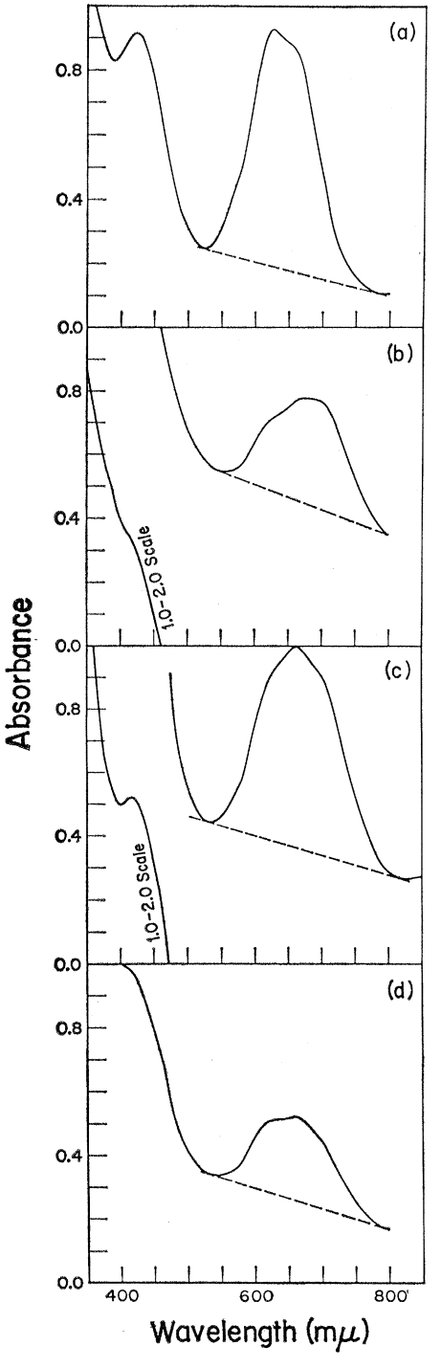

Fig. 1. Spectra of the color produced in the Liebermann-Burchard reaction of (*a*) cholesterol standard; (*b*) extract from Okefenokee Swamp, location 3, 0 to 15 cm; (*c*) extract from Bellefontaine Marsh, location 3, 110 to 125 cm; (*d*) extract from Gulf of Mexico, location 4, 0 to 15 cm.

Tamarack Bog in northwestern Pennsylvania represents a northern fresh-water swamp; Okefenokee in Georgia is a subtropical fresh-water swamp with both cypress and savannah vegetation. The samples from Bellefontaine Marsh, Mississippi Sound, and the Gulf of Mexico represent a traverse on the Gulf Coast from a brackish marsh through a salt-water lagoon to a shallow continental shelf. Santa Barbara Basin and San Nicolas Basin are from the Pacific continental borderland off the coast of California. In order to permit the determination of variation in composition within each environmental area, sets of samples were taken from at least several scattered locations (Table 1).

Samples were frozen in dry ice immediately upon collection in the field and were kept in a freezer. Frozen cores were thawed, ground in a blender where necessary, and lyophilized. The dry material was passed through a No. 40 sieve in a glove box under nitrogen and kept in the cold until used. A weighed amount of each dried sediment was extracted with acetone for 24 hours in a Soxhlet apparatus, a paper thimble being used. The solution was concentrated in a Rinco Rotovap, the temperature not exceeding 40°C. Sterols were separated from the crude acetone extract by saponification, extraction, and digitonide precipitation according to the procedure of Turfitt (*4*). After decomposition of the digitonide, the sterol content was measured by the Liebermann-Burchard reaction.

The sterol concentrate was taken up in 5.0 ml of chloroform; 1.0 ml of acetic anhydride and 0.1 ml of concentrated sulfuric acid were added. A Beckman DK-1 recording spectrophotometer was used to measure the color developed after 15.0 minutes. The quantity of sterols present, determined as cholesterol, was measured by integrating the area under the "red" peaks; background absorption was eliminated by the base-line method (Fig. 1).

A standard curve was made from data obtained with six different solutions of cholesterol, prepared over a period of 6 months. The regression line was calculated from 14 separate points and the concentration of sterols in the test samples was calculated from this equation.

The organic carbon content of the sediments was determined by our modification of the Van Slyke-Folch wet- and dry-combustion method. Values for the surface horizons, namely, 0 to 15 cm, were reported previously (*9*); the organic carbon content of the lower horizons was roughly similar to the surface horizons within each environment.

Typical Liebermann-Burchard color spectra for several extracts are compared with that for a cholesterol standard in Fig. 1. These three spectra show diagnostic maxima or shoulders at 420 and 600 to 700 mμ; family resemblance to the cholesterol standard spectrum is evident. It is apparent from these spectra that sterols other than cholesterol are also present in the sediments and that, qualitatively, the sterol contents differ with environment. These differences probably reflect the nature of the flora and fauna that contribute to the organic detritus within each sediment, although the possibility of different survival patterns for the individual sterols should also be considered. The spectra for the extracts from different locations within each environment were similar, as would be expected.

Quantitative data for the sterols expressed as parts of cholesterol carbon per million parts of organic carbon of each sediment sample are given in Table 1. All sediments examined, whether fresh-water or marine, contained sterols. From the data presented, no correlation of sterol content was apparent either with environment or depth of burial. Concentrations of 60 to 300 parts per million attest the importance of these substances in the total organic debris and hence their possibility as one of the source materials of petroleum.

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