the reticuloendothelial system without participation of the other potentialities of the system, yielding a unique monocytic cell. Both extramedullary and medullary proliferation concerns exclusively this type of cell. The experimental condition produced by me corresponds to the form known in human pathology as Schilling's monocytic leukemia. This germinative line of leucocytes has therefore in pathology its meaning and importance, as Virchow claimed.

These experimental results may be considered in the light of what we know with respect to the origin of certain neoplasms, so-called "conditioned" that are best known in the field of endocrinology. Leukemogenesis is a type of carcinogenesis (Furth) and therefore the concepts referred to the growth of conditioned neoplasms can be extended to experimentally ascertained events that move in the direction of leukemia.

FRANCESCO PENTIMALLI
Istituto Regina Elena per lo Studio e la Cura dei Tumori, Rome, Italy

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Copper Fluorides

A recent paper of Crabtree, Lees, and Little (*1*) reports in part on an x-ray study of the fluorides of copper. Reference is made to an earlier paper by Ebert and Woitinek (*2*), the conclusions of which are questioned. In attempting to explain the original error, the recent authors have confused the situation by further error and misinterpretation.

The complete explanation had previously been published (*3*). In brief, the original "CuF," $a = 4.26$ A, ZnS structure, was apparently Cu_2O, $a = 4.25$ A, Cu_2O structure. "CuF_2," $a = 5.41$ A, CaF_2 structure, was apparently CuCl, $a = 5.41$ A, ZnS structure. The comparison becomes obvious when the interplanar spacings are calculated, taking into account the extinctions characteristic of the different structural types. Direct comparison of lattice constants is not advisable since the structure types being compared are not the same, contrary to the statement by Crabtree *et al.* (*1*). The general extinctions of space groups $F\bar{4}3m$ (CuCl) and $Fm3m$ ("CuF_2") are the same, but those of $F\bar{4}3m$ ("CuF") and $Pn3m$ (Cu_2O) are not.

To complicate matters further, reference is made to cupric chloride, $CuCl_2$, with lattice dimension 5.4075 kx, where CuCl, $a = 5.4057$ A (*4*) is meant. Cupric chloride has the monoclinic $CuBr_2$ structure.

The structure of cupric fluoride, CuF_2, has been determined here by Claudine Billy. It is monoclinic, $a = 3.325 \pm 0.005$ A, $b = 4.544 \pm 0.005$ A, $c = 4.578 \pm 0.005$ A, $\beta = 83°17'$. Details will be submitted elsewhere for publication.

HELMUT M. HAENDLER
Department of Chemistry, University of New Hampshire, Durham

References

1. J. M. Crabtree, C. S. Lees, K. Little, *J. Inorg. Nuclear Chem.* 1, 213 (1955).
2. F. Ebert and H. Woitinek, *Z. anorg. u. allgem. Chem.* 210, 269 (1933).
3. H. M. Haendler *et al.*, *J. Am. Chem. Soc.* 76, 2178 (1954).
4. R. W. G. Wyckoff, *Crystal Structures* (Interscience, New York, 1948), Chap. 3.

19 September 1955

Paleotemperatures of Pacific Bottom Waters and Multiple Hypotheses

Cesare Emiliani's recent article on the temperature decrease of Pacific bottom waters during the Tertiary (*1*) is not only a very interesting and important contribution but one that stimulates many lines of thought. Using the method of oxygen isotope analysis, he has analyzed the benthonic Foraminifera of three cores from the eastern Pacific, which he reports as Oligocene, Miocene, and late Pliocene, indicating a temperature decrease of about 8°C from the middle of the Oligocene to the end of the Pliocene. Emiliani's conclusions are predicated on at least two critical assumptions that permit additional postulates. He assumed, in the first case, that one or two species dated the entire fauna in *Albatross* cores 53 and 57 and, in the second case, that the entire fauna analyzed lived in the same abyssal depths as the one or two key species.

Concerning the first assumption regarding age data, Emiliani states that the Middle Oligocene age of core number 53 is well established because of the presence of typical specimens of *Cassidulina spinifera* Cushman and Jarvis in all of the samples of the core. He reports that Oligocene and Miocene sediments were available for coring in cores 53 and 57 because submarine erosion or slumping had previously eliminated the younger sediments. It should be pointed out that *Cassidulina spinifera* or one almost identical with it occurs in association with modern species in the Marshall Islands at depths of 710 and 680 fathoms (*2*). There are many typical specimens of this species in the collections of the Allan Hancock Foundation, all from Recent assemblages collected in the Marshall Islands. Other reports indicate that this species is no older than Pliocene in the Pacific area (*3*). Cushman and Stainforth also recognize discrepancies in the correlations between Trinidad and the Pacific area. In a report on *Cassidulina spinifera* and the associated microfauna of the type locality for this species (Oligocene, Cipero formation, Trinidad), they speak of the striking similarities between the Cipero species and those of the late Tertiary of the Indo-Pacific region. They also mention T. W. Vaughan's comments regarding the affinities between the Oligocene corals of Trinidad and the living species of the Indo-Pacific area (*4*).

Next, Emiliani states that the age of core 57 is established as lower-middle Miocene because of the presence of *Gyroidina zelandica* Finlay, together with *Laticarinina bullbrooki* Cushman and Todd. This species of *Gyroidina* is very similar to variations of *G. soldanii* that range from well back in the Tertiary to Recent. As for *Laticarinina bullbrooki,* the very authors of this species state, "A very similar, perhaps identical, species occurs in some numbers at *Albatross* D 2144 at 896 fathoms in the Caribbean Sea off Panama" (*5*).

Arrhenius (*6*) analyzed core 58 by the titanium method of age determination, and the Pliocene sample in Emiliani's report was taken from just below the probable Pleistocene core segment thereof.

Turning to the second assumption, that the faunas are abyssal, again raises a question. One might postulate that the same results might be achieved with displacement of shallow water faunas instead of decreasing bottom temperatures. If the faunas were displaced from depths of about 500 m or less, the temperatures there are mostly above 7°C, and so isotopic analyses would produce results that would be within the range reported by Emiliani for the Oligocene and Miocene cores. True, the key species include two that are most likely abyssal in habit (*Laticarinina bullbrooki* and *Gyroidina zelandica*); however, the remaining faunas in the two cores may include shallow benthonic species, and these would in turn affect the results. *Cassidulina spinifera* occurs in the Oligocene of Trinidad with an upper bathyal fauna, and it also occurs in modern sediments on the flanks of some of the seamounts of the Pacific along with modern species. Whether or not this species is fossil and/or displaced, it is inconclusive evidence that the associated species in the isotope analyses are Oligocene or abyssal.

On the basis of the published report, there is a reasonable doubt concerning the ages of samples 53 and 57 and there is similarly little reason for indicating ages of faunas based on one or two species of faunas that are taken from the surface sediments of the sea bottom. An excellent example of possible pitfalls of this kind is demonstrated by Hamilton in his paper on the mid-Pacific seamounts (*7*). He reports mixtures of Cretaceous to Recent species in a sample taken at 2050 fathoms at latitude 19°34′N, longitude 171°54′W near the base of Guyot 20171. His faunal list and figured specimens leave no doubt concerning the validity of his results. His data suggest that the guyot was near sea level in the early Tertiary and Cretaceous. It is interesting to note that Arrhenius reports that core 57 was collected from a seamount (*6,* p. 154), and this may have been much shallower in the Tertiary than it is now. Until a faunal analysis is made of the cores in question, it would seem questionable to accept the isotope data of Emiliani as demonstrating paleotemperatures of abyssal waters.

ORVILLE L. BANDY
Department of Geology, University of Southern California, Los Angeles

References and Notes

1. C. Emiliani, *Science* 119, 853 (1954).
2. J. A. Cushman, R. Todd, R. J. Post, *U.S. Geol. Survey Profess. Paper 260-H* (1954).
3. Oral communication from R. B. Hutcheson, Superior Oil Co., Bakersfield, Calif.
4. J. A. Cushman and R. M. Stainforth, *Cushman Lab. Foraminiferal Research Spec. Publ. 14* (1945), p. 7.
5. J. A. Cushman and R. Todd, *Cushman Lab. Foraminiferal Research Contrib. 18* (1942), p. 19.
6. G. Arrhenius, *Repts. Swedish Deep-Sea Expedition 1947–48* 5, fasc. 1 (1952).
7. E. L. Hamilton, *J. Paleontol.* 27, 207 (1953).

2 September 1955

On Paleotemperatures of Pacific Bottom Waters

A detailed faunal analysis of the samples of cores 53 and 57 was not published in my previous paper (*1*) because the micropaleontological study of these two cores was assigned by H. Pettersson to F. Brotzen, who will presumably report in the near future.

However, in view of O. L. Bandy's justified criticism of micropaleontological dating based on one or two key species only, and with Brotzen's permission, I present a schematic analysis of the two cores in question in Table 1.

The samples analyzed were core 53, 2 to 10 cm, 282 to 290 cm, and 339 to 346 cm below the top; core 57, 412 to 420 cm and 478 to 483 cm below the top. These samples are the same as those on which isotopic analyses were performed.

A Middle Oligocene age for core 53 and a lower-middle Miocene age for core 57 are clearly indicated by the table. No shallow water benthonic species have been observed.

Certain similarities between Paleogene marine invertebrate faunas of Central America and Europe, on the one hand, and Neogene ones of the Indo-Pacific, on the other hand, have been observed by several authors, including me (*2,* p. 84, Table 18). These similarities are produced by the survival in the Indo-Pacific of types that evolved faster and disappeared earlier in the western Tethys, following the isolation of this area from the Indo-Pacific in mid-Tertiary time (*3*). Thus, certain genera and species that occur exclusively during the Paleogene in Central America and Europe occur in association with Neogene faunas in the Indo-Pacific. This, however, is not the case of the short-range species of the table, including *Cassidulina spinifera,* none of which has been found, so far, in association with Neogene faunas of the Indo-Pacific. Hutcheson's unpublished opinion that *Cassidulina spinifera* is not older than Pliocene in the Pacific area needs substantiating evidence.

The occurrence of typical specimens of *Cassidulina spinifera* in association with modern faunas in bottom samples from the Marshall Islands is neither surprising nor a demonstration that this species is extant in the Pacific. These samples, including those in the collections of the Allan Hancock Foundation, come from the top and sides of a guyot (*4*) and are likely to contain reworked fossils, as Hamilton has shown for a different area (*5*) and as Bandy himself mentions. Similarly, the probable occurrence of *Laticarinina bullbrooki* at a single *Albatross* station in the Caribbean off Panama may be due to reworking. Increasing knowledge of deep-sea sedimentation is continuously reducing the areas where sedimentation is found to be continuous or undisturbed—a condition that once was thought to prevail along most of the ocean bottom. Current views on deep-sea sedimentation are discussed in recent papers by Ericson, Ewing, Heezen, and Wollin (*6*) and by Revelle, Bramlette, Arrhenius, and Goldberg (*7*), covering the Atlantic and Pacific oceans, respectively. From these important papers, it appears evident that conclusions concerning age and ecology of fossils from the deep sea must be based on selected samples from selected areas.

As far as is known at present, the eastern Pacific eupelagic area is one of the least disturbed of the ocean bottom, and its hummocky bottom topography is a safeguard against influx of material from turbidity currents and displaced faunas. Core 57 was taken from the top of a shield-shaped elevation about 180 m high (*8*)—one of the great many that apparently occur in that area. These structures may be original features of the earth's crust or, as is suggested by Arrhenius (*8*), shallow laccoliths. They are not volcanic extrusions. Therefore, it is unlikely that the ocean floor at the location of core 57 stood in Miocene time more than 4000 m higher than it does at present, as is required by Bandy's hypothesis.

In summary, cores 53 and 57 appear to be of Middle Oligocene and lower-middle Miocene age, respectively. Bottom morphology and regional submarine geology indicate that the microfossils on which the oxygen isotopic analyses were made (*1*) grew in place and at approximately the present depth. The probable conclusion is that the isotopic temperatures published previously (*1*) represent the bottom temperatures of the ocean water at the given times, localities, and depths.

CESARE EMILIANI
Enrico Fermi Institute for Nuclear Studies, University of Chicago, Chicago, Illinois

Table 1. Schematic analysis of cores 53 and 57. The Lower, Middle, and Upper divisions of the Tertiary epochs are indicated by the abbreviations L, M, and U.

Species	Upper Cretaceous	Eocene			Oligocene			Miocene			Pliocene			Pleistocene
		L	M	U	L	M	U	L	M	U	L	M	U	
Core 53														
Anomalina almendarensis			—	—	—	—								
Cassidulina spinifera						—	—							
Cassidulina subglobosa					—	—	—	—	—	—	—	—	—	—
Globigerina venezuelana						—	—	- -	- -					
Gyroidina planulata							—	—						•
Nodogenerina challengeriana						—	—	—	—	—	—	—	—	—
Pleurostomella elliptica							—	—						
Pullenia quinqueloba					—	—	—	—	—	—	—	—	—	—
Spiroplectammina grzybowskii	—	—	—	—	—	—								
Core 57														
Eggerella bradyi								—	—	—	—	—	—	—
Globigerina quadripartita								—	—	—				
Globigerinoides sacculifera immatura						- -	- -	—	—	- -				
Gyroidina zelandica						- -	- -	—	—	—	- -			
Laticarinina bullbrooki					—	—	—	—	—					
Pulleniatina obliquiloculata										—	—	—	—	—
Sphaeroidinella rutschi							—	—	—					

References

1. C. Emiliani, *Science* 119, 853 (1954).
2. ———, *Palaeontographia Italica* 48, 77 (1954).
3. A. M. Davies, *Tertiary Faunas* (London, 1934), vol. 2.