Technical Papers

Eocene Foraminifera from Guam, and their Implications[1]

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Well-preserved and abundant upper Eocene Foraminifera from the matrix of water-laid tuffaceous rocks on Guam have a significant bearing on the geologic history of that island and of the Mariana island-arc as a whole (Fig. 1).

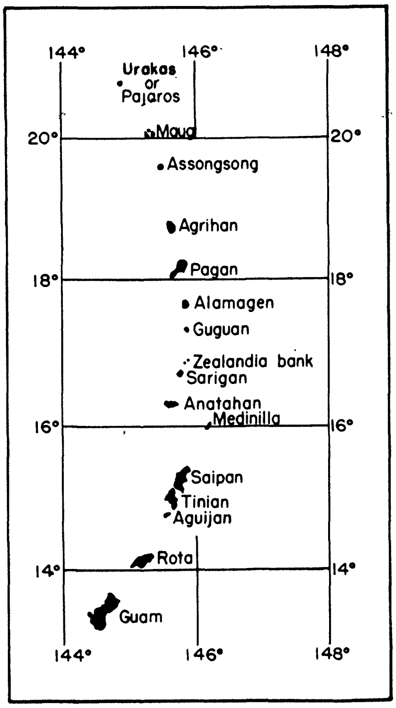

FIG. 1. Mariana Islands.

Stearns (*1*) divided the volcanic rocks of Guam into a lower effusive phase and an upper pyroclastic phase and stated that Miocene Foraminifera were associated with the pyroclastics. Cloud (*2*) suggested that the volcanic succession might be in part as old as Eocene, but accepted as a fact the report that Miocene Foraminifera were associated with some part of the volcanic succession. Results of additional field work by Cloud, after his report was submitted in late 1948, indicate that the lower Miocene rocks from which Cole (*3*) described Tertiary *e* Foraminifera are locally, and perhaps at all places, younger than known rocks of primary volcanic origin on Guam. Doubt is now felt as to the likelihood that any Miocene Foraminifera are actually associated with primary volcanic rocks on the island. Reworking of older volcanic sediments, in combination with recent leaching of interstitial calcium carbonate, accounts for the resemblance to primary pyroclastic rocks of many of the Miocene strata on Guam and other Mariana islands.

Recent studies by Cole have established the late Eocene age of Foraminifera collected by Cloud and R. G. Schmidt in 1948 from tuffaceous beds in west-central Guam. The fossils occur as free specimens in the matrix of soft, deeply weathered granule breccia and conglomerate that contain many rounded limestone pebbles and dip about 5° south. The locality, MGC-5, is a road cut on a ridge crest between Mount Tenjo and Mount Alifan. Similar Foraminifera, as yet not carefully studied, were collected from a second locality (MGC-4) 750 ft farther north along the same road, in pebble beds that contain both limestone and volcanic fragments, dip about 50°–70° south, and are associated with calcareous tuff and tuffaceous limestone.

Only the Foraminifera from locality MGC-5 are here considered, and some of the species from this locality have not yet been identified. However, the late Eocene age of this fauna, and its regional correlation with zone *b* of the Indonesian Tertiary, are established by the presence of *Pellatispira glabra* Umbgrove, *Biplanispira mirabilis* Umbgrove, and *B. absurda* Umbgrove, in association with two or more species of *Asterocylina* and two species of *Camerina.* In addition to the species listed, numerous specimens of an Operculina are tentatively identified as *O. pacifica* Whipple, and other specimens are referred to *Heterostegina* sp. It is of interest that one of the species of *Camerina* is a reticulate form closely related to *C. fichteli* (Michelotti), a marker for zone *c*, or lower Oligocene, in Indonesia. Although reticulate camerinids are not known to occur below zone *c* in the Indonesian Tertiary (*4*), this type of camerinid does occur in the Eocene of Europe (*5*). Its association with *Pellatispira, Biplanispira,* and *Asterocyclina* indicates a late Eocene age for the reticulate camerinid on Guam.

The observed sedimentary features of the strata at the outcrops described could be attributed either to the initial settling of primary pyroclastic debris in a marine environment, or to its reworking. However, the abundance of excellently preserved free specimens of Foraminifera several millimeters in diameter is conclusive evidence against the secondary derivation of these fossils. Thus, the time of final settling of the sediments to the beds in which they are now found is established as late Eocene. The volcanic fragments therefore can be no younger than late Eocene, and no pre-Eocene deposits have yet been recognized on other Mariana islands (*6*).

[1] Publication authorized by the Director, U. S. Geological Survey.

Evidence of an Eocene age for volcanism on Guam is consistent with evidence on age of volcanism from other Mariana islands south of 16° north latitude (Fig. 1). Conclusive evidence of post-Eocene volcanism in the Marianas has not yet been found on islands to the south of the young volcanic chain that ranges northward from Anatahan. Rocks of Oligocene age are as yet unrecognized in these islands, volcanic materials of known Miocene age can be interpreted as reworked from Eocene deposits, and younger rocks and sediments in no way suggest volcanic affinities. If, however, volcanic rocks younger than Eocene, or any rocks of Oligocene age, are to be found in the Marianas, Guam is a good place to look for them. The reticulate camerinid of the fauna here noted has an "Oligocene flavor," and succeeding rocks in a normal sequence might grade to the Oligocene.

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Manuscript received August 19, 1952.

Audiogenic Seizure and the Adrenal Cortex

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This study was designed to test the hypothesis that ACTH injections sufficient to increase adrenal cortical size modify the susceptibility of rats to audiogenic seizure (hereafter designated AGS). The rationale of the use of ACTH in relation to AGS susceptibility is that both endogenous and exogenous ACTH and adrenal cortical hormones have been shown to be important in the adjustment and adaptation of mammals to stress of physical, physiological, and psychological origin. The behavioral relevance of adrenal cortical function in stress adaptation has been discussed by Hoagland (*1*). The AGS situation can be conceived as stressful from two points of view: first, the environmental conditions used to produce it—exposure to intense sound while closely confined; and second, from the standpoint of the behavior of the rat displaying a complete audiogenic seizure. Such an animal releases tremendous amounts of energy in a severe bout of running and a subsequent tonic-clonic convulsion. Furthermore, the catatonic state which sometimes terminates the abnormal behavior probably overlies a state of increased energy mobilization.

In the experiment described here, 80 male and female hooded rats, approximately 40 days old, and obtained from a colony maintained at the Louisiana State University psychology laboratory, were used.

The seizure box was 48 in. high by 26 in. wide and was constructed of double layers of plywood insulated in the middle with asbestos. A double glass window in the top permitted observation of the subjects at all times. Within the box was the actual seizure chamber, a metal cylinder 28 in. high, with a diameter of 14 in. The sound source, consisting of two 3-in. electric bells operating off a 6-v transformer, was placed under the perforated floor of the cylinder 6 in. from the rats. The entire apparatus was constructed in such a fashion as to reduce extraneous stimuli to a minimum. Light was supplied by a 6-v bulb in the top of the box, so arranged as to maintain a constant visual field overhead; hence, distractions from the observation window were reduced to a minimum. All electric controls for the seizure box were located on an instrument panel on top of the box.

The adrenocorticotrophic hormone used in this study was equal to the Armour Standard.[1]

PHASE A

1. *Test for AGS susceptibility.* Seizure susceptibility was determined by one diagnostic exposure to sound stimulation. Preliminary experience with the particular strain of animals used indicated that the level of AGS susceptibility within the strain was approximately 50% with respect to the stimulus used. A 50% incidence of AGS was desirable, since it presented an equal opportunity for the detection of increasing or decreasing AGS frequency in the experimental animals. The diagnostic exposure was given 4 days before ACTH injection and was the animal's first experimental exposure to intense sound stimulation. The time interval was chosen to rule out as far as possible any spacing effects of seizures. There is evidence of refractoriness to seizures following massed seizures, but any such effect should dissipate in 4 days (*2*).

2. *Injection of ACTH.* Susceptible and nonsusceptible animals were equated with respect to weight and sex and assigned to one of four experimental groups. Group I consisted of susceptible animals that received injections of ACTH, Group II of susceptible animals that received injections of water, Group III of nonsusceptible animals that received injections of ACTH, and Group IV of nonsusceptible animals that received injections of water. Ten animals were assigned to each group. The animals receiving ACTH were given 2 mg standard ACTH subcutaneously, and the control animals were given an equal volume of water subcutaneously. The procedure was repeated at 4-hr intervals until three doses totaling 6 mg of standard ACTH had been given.

3. *Seizure test.* Two hr after the last injection of ACTH or water the animals in Phase A were subjected to 2 min of sound stimulation. If a seizure oc-

[1] We are indebted to Irby Bunding, of the Armour Laboratories, for providing the ACTH used in this study.