THE LOCATION OF EARTHQUAKE EPICENTERS

ACCURATE determination of earthquake epicenters is important, for they are of much assistance in locating active faults. In a recent article on the fall of columns during the Long Beach earthquake, March 10, 1933, Professor Thomas Clements reaches the conclusion that the major shock had its origin in or near Compton instead of on the sea floor a short distance off Newport Beach, as had been indicated by seismograph records. In addition to evidence from overturned monuments in cemeteries, Professor Clements mentions the absence "of a so-called tidal wave, which might have been expected with violent earthquake waves emerging on the sea floor, and this regardless of whether the movement along the fault was vertical or horizontal."[1]

This erroneous conception of the cause of seismic sea waves is common, and has even found its way into a recent text-book of geology. A seismic sea wave is caused by a sudden vertical displacement of the sea floor. The time interval between the arrival of the earthquake vibrations and the arrival of the wave gives an accurate determination of the distance of the displacement from the point of observation, and is, therefore, useful in fixing the position of the origin. Many severe earthquakes have originated under the ocean without being accompanied by sea waves.

In spite of the fact that the San Andreas fault extends under the ocean for several miles, there was no sea wave at the time of the San Francisco earthquake of 1906, because the displacement was horizontal. Earthquakes due to vertical displacements along submarine faults may not always be accompanied by sea waves, for many of the smaller displacements do not extend to the surface. Vertical vibrations, indicative of a vertical displacement, seem to have been dominant near the epicenter of the Santiago-de-Cuba earthquake of February 3, 1932, which originated under the ocean, but there was no sea wave. Absence of a sea wave, therefore, can not be used as evidence that an earthquake did not originate under the ocean.

The evidence from overthrown columns must be used with great caution. If the base of a column is rectangular the direction of fall is usually limited to one of four directions. Some columns topple over, and some fall because they are displaced on their pedestals. If the earthquake is due to a horizontal displacement, columns close to the fault are usually overturned in directions parallel to it. During the San Francisco earthquake of 1906 objects close to the fault were commonly overturned or displaced parallel to it, while at a distance they were mostly displaced at right angles to it.

[1] SCIENCE, n. s., 78: 100–101, 1933.

In densely settled regions the epicenter can usually be located most accurately through a study of the distribution of intensity, but in comparing the relative intensity at different localities it is necessary to consider the character of the foundation material, for the apparent intensity is always much greater on made ground and unconsolidated alluvium, especially when saturated with water, than it is on rock or residual soil. At Long Beach and Compton, where damage as a result of the recent earthquake was great, the foundation conditions are poor.

From seismograph records it is possible to determine the distance to the point where the disturbance started. A displacement must begin in a rather limited area, and then extend rapidly over the fault surface and, sometimes, to adjacent faults. It is therefore possible for the area of maximum intensity to be a short distance away from the point of initial displacement.

When the position of an epicenter is determined from the records made on distant seismographs the error may be 50 km. or more; but in the southern California area, where the Carnegie Institution of Washington has established several stations equipped to study local earthquakes, it should be possible to determine the origin of the initial disturbance with an error of less than 5 km.

If the epicenter of the Long Beach earthquake was near the coast, as is now indicated, it was probably due to a displacement on the Inglewood fault, which was mapped and described as an active fault by me when I investigated the Inglewood earthquake in 1920.[2]

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WHY DO WE PERSIST IN TALKING ABOUT THE "EXPANSION" AND "CONTRACTION" OF CHROMATOPHORES?

ONE may well question the wisdom of adopting a mode of expression which the author himself commonly feels under obligation to repudiate. To those who are familiar with the voluminous literature relating to vertebrate chromatophores, and with the great importance of some of the biological problems which center in them, the following attempt to adjust our terminology to our accepted view-point will perhaps not appear futile. Such persons are well aware of the two chief divergent views which are held respecting the changes of form that these cells appear to undergo in response to stimuli. The first of these is the more obvious interpretation of the phenomena observed,

[2] "The Inglewood Earthquake in Southern California, June 21, 1920," Stephen Taber, *Bull. Seis. Soc. Amer.*, X, 1920, pp. 129–145.

namely, that we have to do with actual ameboid movements of the cells in their entirety. According to this conception, the outlines of the visible pigment masses are nearly or quite coextensive with the outlines of the chromatophores themselves. Not only the contained pigment masses, but the cells which contain them, are believed to actually contract and expand. This view, with various modifications, is still held by a minority of investigators, but little recent evidence appears to support it.

The alternative view asserts that the cell-outlines of the chromatophores are nearly or quite fixed, and that the space thus bounded is at all times occupied by the cell protoplasm or a certain portion of it. This protoplasm does not permit of differential staining, so that it is quite invisible in ordinary histological preparations, and commonly in living material as well. The familiar changes in the apparent form of the chromatophores are due to the movements of the pigment masses in the hyaline protoplasm of the cells. The streaming of these granules is one of the most fascinating as well as one of the most readily observed phenomena available to the microscopist. Successful moving pictures of this process have been obtained by Ballowitz.[1]

This second interpretation of the phenomena of chromatophore reaction is now accepted, with possible qualifications, by probably a large majority of investigators in this field, at least for animals beyond the larval stages. In spite of this fact, it is a curious circumstance that most of these investigators continue to employ the language of the earlier theory, even when they explicitly repudiate it. They speak freely of the "expansion" and "contraction" of the chromatophores, and then promptly proceed to explain, by footnote or otherwise, that they really mean nothing of the sort, but only employ this terminology for the sake of convenience. Any one familiar with recent literature in this field will recognize the truth of my statement.

My suggestion is that we continue to employ the terms "expansion" and "contraction," since something obviously does expand and contract, but that we credit these movements to the things that actually do expand and contract, namely, the pigment-masses within the cells.

For these pigment-masses I propose the following terms:

(1) A *chromatosome* is the aggregate pigment-content of any chromatophore, regardless of color.

(2) A *melanosome* is the pigment mass contained in a melanophore.

(3) A *xanthosome* is the pigment mass contained in a xanthophore.

[1] *Pflüger's Archiv,* Bd. 157: S. 165–210, 1914.

Corresponding terms may be employed for the pigmentary contents of erythrophores and guanophores.

The only objection to this terminology which I can think of is the fact that the term "iridosome" has been employed by Ballowitz[2] to designate the clusters of iridocytes (guanophores) which sometimes surround chromatophores of another type. I do not think that the term proposed by Ballowitz well characterizes these loose clusters of cells, particularly since they frequently form an open reticulum, passing from one melanophore to another. His use, in that connection, of the termination "—some" would hardly seem to render it unavailable for the appropriate, as well as more urgent, application suggested in the foregoing note. No one who has observed the pigment mass of a melanophore, particularly in its contracted phase, would hesitate to call it a "body."

It may be that my suggestions, here offered, are not new. Or it may be that there are serious objections to the proposed terminology which I have overlooked. If so, I shall be glad to be further enlightened.

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A RECORD OF YOUNG TARPON AT SANIBEL ISLAND, LEE COUNTY, FLORIDA

AVAILABLE records of the spawning habits of *Tarpon atlanticus* contain no reference to observations made north of Puerto Rico and Cuba other than those reported by L. L. Babcock,[1] and but three notes of the taking of young tarpon along the coast of the United States.

Evermann and Marsh[2] state that "*Tarpon atlanticus* is common about Porto Rico, where it evidently breeds." They record four specimens from 7.5 to 11.5 inches long taken at Hucares. At Fajardo very young fish from 2.5 to 3.5 inches were collected. Beebe and Tee-Van[3] give measurements of 78 to 1,060 mm of five arbitrarily chosen specimens collected in Haiti. Eigenmann[4] records tarpon of 20, 119, 182 and 192 mm at Pinar del Rio, Cuba.

Gill,[5] in 1905, wrote that the tarpon "does not appear to breed at any place along the continental

[2] *Arch. für mikr. Anat.,* Bd. 93: S. 404–413, 1920.

[1] L. L. Babcock. "The Tarpon." 3rd ed., 135 pp., 9 text-figs. Privately printed, 1930.

[2] B. W. Evermann and M. C. Marsh. "The Fishes of Porto Rico." *Bull. U. S. Fish. Comm. for 1900,* 20: p. 80, 1902.

[3] Wm. Beebe and John Tee-Van. "The Fishes of Port-au-Prince, Haiti." *Zoologica,* Sci. Contribs. N. Y. Zool. Soc., 10: 33–36, 1928.

[4] C. H. Eigenmann. "The Fresh-water Fishes of Western Cuba." *Bull. U. S. Fish Comm. for 1902,* 22: p. 222, 1903.

[5] Theodore Gill. "The Tarpon and Lady Fishes and Their Relatives." *Smithson. Misc. Colls.,* 48: 31–46, 5 pls., 7 text-figs. 1905.