

endyma. These defects were pointed out by me in 1899,¹⁸ but in the present paper they are of interest mainly as neither corrected nor even alluded to in any of the reproductions of the figure known to me.

The figure and description are given on p. 876 of the protocols of the committee (of the Anatomische Gesellschaft) on anatomic nomenclature in the fasciculus dated March 20, 1894; these protocols were edited by W. Krause.

But in the following year, in the final report,¹⁹ commonly known as the "B N A," supervised and explained by His himself, the same figure appears on p. 161 as "Median-durchschnitt durch ein fötales menschliches Gehirn aus dem dritten Monat." It may be conjectured that there had occurred an inadvertent repetition of the legend under the figure on the opposite page (where, however, the first word is "Medianschnitt"); but it is not easy to understand how so self-evident an error could escape the other members of the committee.

With the original correct designation of "adult" the figure was reproduced in 1897 by van Gehuchten (*Anatomie du système nerveux de l'homme*, second edition, Fig. 17), and in 1899 by L. F. Barker (*The Nervous System and its Constituent Neurones*, Fig. 92).

But in 1901 the identical figure, reduced about one third, was employed by Barker²⁰ and described as a "Median section through a human fetal brain of the third month, after His, 1892" [probably 1893 was meant].

¹⁸ Comments upon the mesal [median] aspect of a human brain as published by His and reproduced by him and others. *Asso. Amer. Anatomists, Proceedings*, 1899, pp. 23-24.

¹⁹ "Die anatomische Nomenclatur. Nomina anatomica, Verzeichniss der von der Anatomischen Gesellschaft auf ihrer IX. Versammlung in Basel angenommen Namen. Eingeleitet und im Einverständniss mit dem Redaktionsausschuss erläutert von Wilhelm His." *Archiv für Anatomie und Physiologie*. Anat. Abth., Supplement Band, 1895. O., pp. 180; 27 figs., 2 plates, 1895.

²⁰ Buck's "Reference Handbook of the Medical Sciences," second edition, Vol. 2, Fig. 939.

Students and lay readers might easily be confused or actually misled by the discrepancies indicated above. As yet no explanation or expression of regret has been encountered by me. Fitting opportunity would seem to have been provided for Professor His in his article on nomenclature in the *Anatomischer Anzeiger*, Vol. XII., October 30, 1896, and for Dr. Barker in his "Anatomical Terminology with special reference to the B N A," 1907.²¹

The injuriousness of an uncorrected error depends not alone upon its intrinsic extent but also upon certain extrinsic conditions, viz., (a) the number and status of those who are interested in the subject and therefore liable to be misled; (b) the publication in which it appeared; (c) the evidence of its unchallenged acceptance by others; (d) the number of repetitions; (e) the reputation of its originator. To these self-evident propositions should perhaps be added the reminder that one need not himself be inerrant in order to point out imperfections in another.

The desirability of the explicit correction of errors under some circumstances has now, I trust, been indicated by example as well as by precept.

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SPECIAL ARTICLES

THE SINGLE CYCLE DEVELOPMENT OF THE GRAND CANYON OF THE COLORADO

SEVERAL years ago Davis¹ called attention to a number of facts which lead him to conclude that the Grand Canyon of the Colorado has been developed in a single cycle of erosion as contrasted with the two cycles postulated

¹ So far as I know, the "Isthmus rhombencephali" was never withdrawn by Professor His or, explicitly, by any of the several who adopted it; see the papers by B. B. Stroud and the writer, *Association American Anatomists, Proceedings*, 1899, and *SCIENCE*, March 16, 1900.

² "An Excursion to the Grand Canyon of the Colorado," *Bull. Mus. Comp. Zoology*, Harvard College, XXXVIII., May, 1901.

by Dutton.² This conclusion does not appear to have received the attention that it merits, probably because Dutton's monograph has for so long been the accepted source of information concerning the region. But as more recent work has shown, Dutton's conclusions in regard to the history of the Grand Canyon District are subject, in general, to important modifications. The writer would like to emphasize, therefore, some of the data supporting Davis's conclusion as to a single cycle of development as they impressed themselves upon him during a recent revisiting of the canyon after a lapse of several years.

One of the most striking features in the development of the canyon is the perfect correlation that exists between the topography and the different rock formations. This is seen throughout the canyon, but is more easily comprehended in small areas. On a large scale two distinct canyon forms may be noted depending upon the character of the eroded strata. One is the comparatively wide-bottom type which is developed where the strata are soft, as in the Unkar and Chuar area in the vicinity of the mouth of the Little Colorado River. The other is the more common gorge type as developed, for example, in the Kaibab and Toroweap sections of the canyon where the river is cutting the more resistant granite, Tonto and Redwall formations. In any limited view of the canyon walls the relationship is even more impressive; the resistant formations always give rise to cliffs and the softer ones to graded slopes, so that the resulting topography is of wonderful constructive beauty and possesses an almost infinite variety of detail.

Attention may be called particularly to the resistant cliff-making formations and the part they have played in bench-making through the stripping of the overlying soft strata. It may help to visualize the facts here presented if the idea is kept in mind of the Colorado River cutting into the plateau and successively exposing the resistant formations on which benches have been developed by the

removal of overlying soft strata; the development and dissection of each bench progressing as the river has cut more deeply into the plateau.

In the Kaibab section of the canyon benches may be seen at several different horizons. There are traces of one at the summit of the upper Aubrey cross-bedded sandstone near the top of the canyon walls. It has probably never been of any extent, since the overlying upper Aubrey cherty limestone is in itself too nearly of the same resistance to be easily stripped off. There are numerous indications of a bench at the summit of a group of heavy sandstone members near the top of the lower Aubrey red sandstone. The upper one third of this formation is, on the whole, more uniformly soft than the lower two thirds and must have been eroded with comparative rapidity. The next bench, a very noticeable one, is situated at the summit of the Redwall formation, which is the most prominent cliff-maker found in the canyon walls. The lowest bench is the Tonto, located immediately above the granite gorge. This bench is the latest one that has been formed and is, therefore, the least dissected.

Throughout there is, then, a striking dependence of the benches upon the character of the strata; they are found at the summits of resistant beds which in all cases are overlain by soft ones. If, therefore, there is any good reason for considering the Tonto bench in the Kaibab section as indicating a base-level of erosion and a halt in the uplift of the region, as is necessary on the assumption of two cycles of development, there is equally good reason for supposing that base-levels of erosion also occurred at the summits of the other resistant formations. It is hardly reasonable, however, to expect such a nice adjustment of base-levels, three or four in number, to such definite structural horizons. It must be concluded, rather, that the benches are simply what they appear to be—the stripped surfaces of resistant formations which have been successively exposed in the progressive down-cutting of the Colorado River through the plateau. Consequently the uplift of the region,

² "The Tertiary History of the Grand Canyon District, Arizona," Monogr. II., U. S. G. S., 1882.

on the whole, has been continuous and the erosion of the canyon has been accomplished in a single cycle.

Another fact which eliminates the necessity of considering that the esplanade—Redwall bench—of the Toroweap and the Tonto bench of the Kaibab section represent a common base-level of erosion and a halt in the uplift of the region is that these two benches occur in the same locality one above the other in undisturbed condition and separated vertically by over 1,000 feet. Evidently they can not indicate one base-level of erosion and it is necessary to suppose, as in the previous case, that they represent two base-levels, each coinciding with the summit of a resistant formation, or that the benches are structural surfaces exposed by the removal of soft overlying beds. The latter explanation, taken in connection with other lines of evidence, is to be considered the correct one.

In the foregoing paragraphs it has been assumed that Dutton considered the Tonto bench as equivalent to the esplanade farther west and as indicating a base-level of erosion. It should be said that Dutton does not specifically make this correlation. He states that the esplanade represents a base-level of erosion (p. 121) and in speaking of the first stage of the canyon cutting says that "during this paroxysm of upheaval the outer chasm of the Grand Canyon was cut; the river corradng down to the level of the esplanade in the Kanab and Uinkaret divisions but *below that horizon in the Kaibab*" (p. 226). In speaking of the second stage he says that "the narrow inner gorge of the Toroweap was swiftly cut, and is in this respect *a type of the lower deeps of the entire canyon*" (p. 227). The only lower horizon in the Kaibab which has a development corresponding to the esplanade of the Kanab and Uinkaret sections is the Tonto bench. And the only part of the lower depths of the Kaibab which is comparable with the inner gorge of the Toroweap is the granite gorge. The Tonto bench lies immediately above the granite gorge in the Kaibab, as does the esplanade above the inner gorge of the Toroweap. It has seemed to the

writer that the logical interpretation of these statements permitted the correlation of the Tonto bench with the esplanade; but this may be taking too great a liberty with the written word.

A minor topographic detail, of definite import, however, which argues against the Tonto bench being a base-level of erosion and indicating a halt in the uplift of the region, is seen just west of the mouth of Bright Angel Creek. At this locality the Tonto formation has been faulted to the extent of about 400 feet, and the faulting is apparently of pre-Carboniferous date and in any case older than the cutting of the canyon. (The displacement here referred to is not the Bright Angel fault.) The point is that a bench has been perfectly developed at the same horizon in the sandstone, judging from the eroded remnants, on both sides of the fault, notwithstanding the difference in the elevation of the strata in the two blocks. It is evidently unduly complicating matters to suppose that the lower bench, for instance, represents a base-level of erosion and that the upper one originated in some other way, for this is calling in two processes to explain exactly similar things. The true explanation is clearly to be found in the single process of stripping and consequently the Tonto bench in general, like the older benches in the Carboniferous formations, does not indicate a pause in the uplift of the region, but is simply a stripped structural surface exposed by the removal of the softer overlying beds.

The writer has little doubt that when this problem is studied in more detail many other facts will come to light supporting the general conclusion of Davis "that while many partial cycles of erosion may have preceded the long pause during which the broad denudation of the plateaus was completed, only a single uplift and a single down-cutting are recorded in the canyon."

H. H. ROBINSON

THE H--MAN FACE

It seems surprising how little we are influenced by the scientific method in the ex-