sand movements is that a reversal of littoral currents is generally reflected in a consistent change in sea-level height without indicating the relation which probably exists between sea-level and currents.

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ZIPF'S "LAW OF URBAN CONCENTRATION"

IN the August 15th issue of SCIENCE, Alfred J. Lotka points out that the law of urban concentration described by G. K. Zipf in his recent book, "National Unity and Disunity," is not particularly striking and at least not novel, citing a number of cases where the type of frequency distribution utilized by Zipf has been found applicable but where such application has thrown little light upon the relevant functional relationships.

It should also be pointed out that Zipf has attempted to apply the harmonic series frequency law to the frequency distributions of words in English, German, and several other languages.[1] Here, too, Zipf's work was foreshadowed, *viz.*, by E. V. Condon's article, "Statistics of Vocabulary."[2] Though Condon was not able to utilize the empirical data available to Zipf, his mathematical formulation was as adequate as that of Zipf. It is well to note, however, that the harmonic series law has a semblance of good fit to linguistic data only in selected cases—generally where the samples of words are of moderate size (not over, say, 100,000 words) and are taken from written material such as newspapers, books, etc. I have tried without success to apply the law to distributions of words in telephone conversations,[3] in children's speech and in stories written for children.

Finally, I wish to draw attention to a certain mathematical limitation to the application of the harmonic series law. This limitation has been discussed by me previously[4] and can be shown to apply to Zipf's latest contribution. We may first regard the population of an area as analogous to the number of words in a sample (N) and the number of cities, towns and villages in an area as analogous to the number of different words in a sample (d). We may then write Zipf's law as $fr^x = \frac{N}{k}$, where f denotes frequency (analogously, population of a city, town or village), r denotes rank, and k and x are parameters. As shown in my article, the harmonic series law can not hold for a sample where $N > dk$, at least where $x = 1.00$.

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[1] "The Psycho-Biology of Language," Boston, 1935.
[2] SCIENCE, 67: 300, 1928.
[3] N. R. French, C. W. Carter, Jr., and W. Koenig, Jr., *Bell System Technical Journal*, 9: 290–324, 1930.
[4] J. B. Carroll, *Psychol. Record*, 2: 379–386, 1938.

"THE BREATHING MECHANISM OF TURTLES"

THE discussion of turtle breathing by Dr. Hansen in a recent issue of SCIENCE[1] expresses justifiable impatience with a perpetuation of error by modern text-books. My reaction to the conflicting statements from different sources about this subject led me in 1939 to start an investigation of turtle respiration using physiological technics. This work is progressing and a report should soon be possible.

It should be pointed out, however, that although the sources quoted by Dr. Hansen—especially the splendid morphological study and deductions of Mitchell and Morehouse, who *appeared* to have settled the question as early as 1863 with little recourse to experimental work—seem to make his own observations a reemphasis of fact from the last century, actually the case is not at rest. Those who talk of throat movements in turtles as breathing action can support their statements by contemporary experimental data. For example, Lüdicke[2] in 1936 appears to arrive at the compromise conclusion that the difference between land turtles (Testudo) and aquatic (Emys) is that aquatic types swallow air and land types can not. He made observations, like Dr. Hansen's, of cannulized tracheae and collapse of lungs upon opening the body cavity.

My results with an equally aquatic species (*Malaclemys centrata*—diamondback terrapin) do not agree with Lüdicke's. A presentation of experimental evidence and attempts to reconcile conflicting observations can not be done in this comment. I concur in the essential point (but not in his details) of Dr. Hansen's discussion. The primary breathing mechanism in turtles is the movement of muscular diaphragms located at each leg pocket in the shell and ventral to the viscera, together with the muscular closure of the opening in the glottis.

Present writers of text-books who discuss turtle respiration will need to deal with the striking, and misleading, hyoid movements. They appear from records now on hand to be definitely correlated with sensory rather than respiratory functions, and they are almost certainly olfactory.

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ON THE OCCURRENCE OF STEREOISOMERIC CAROTENOIDS IN NATURE

IT was reported recently[1] that the ripe fruits of the Tangerine tomato (a variety of *Lycopersicum*

[1] Ira B. Hansen, SCIENCE, 94: 64, 1941.
[2] M. Lüdicke, *Zool. Jahrb. Abt. Allg. Zool. u. Physiol.*, 56: 83–106, 1936.
[1] L. Zechmeister, A. L. LeRosen, F. W. Went and L. Pauling, *Proc. Nat. Acad. Sciences*, 27: 468, 1941.