

The life of the tropics, so far as the fishes are concerned, offers analogies to the life of cities, viewed from the standpoint of human development. In the same way, the other regions under consideration are, if we may so speak, a sort of ichthyological backwoods. In the cities, in general, the conditions of individual existence are most easy, but the competition is most severe. The struggle for existence is not a struggle with the forces and conditions of nature. It is not a struggle with wild beasts, unbroken forests, or a stubborn soil, but a competition between man and man for the opportunity of living.

It is in the cities where the influences which tend to the modernization and concentration of the characters of the species, the intensification of human powers and their adaptation to the various special conditions, go on most rapidly. That this intensification is not necessarily progress, either physically or morally, is aside from our present purpose.

It is in the cities where those characters and qualities not directly useful in the struggle for existence are first lost or atrophied. Conversely it is in the "backwoods," the region most distinct from human conflicts, where primitive customs, antiquated peculiarities, and useless traits are longest and most persistently retained. The life of the backwoods will be not less active and vigorous, but it will lack specialization.

It is not well to push this analogy too far, but we may perhaps find in it a suggestion as to the development of the eels. In every city there is a class which partakes in no degree of the general line of development. Its members are specialized in a wholly different way, thereby taking to themselves a field which the others have abandoned, and making up in low cunning what they lack in strength and intelligence. Thus among the fishes we have in the regions of closest competition a degenerate and non-ichthyized form, lurking in holes among rocks and creeping in the sand, thieves and scavengers among fishes. The eels fill a place which would otherwise be left unfilled. In their way, they are perfectly adapted to the lives they lead. A multiplicity of vertebral joints is useless to the typical fish, but to the eel strength and suppleness are everything, and no armature of fin or scale or bone so desirable as its power of escaping through the smallest opening.

It may be too that, as rovers in the open sea, the strong swift members of the mackerel family find a positive advantage in the possession of many vertebræ, and that to some adaptation to their mode of life we must attribute their lack of ichthyization of the skeleton. But this is wholly hypothetical, and we may leave the subject with the general conclusion that with the typical fish advance in structure has specialized the vertebræ, increased their size and the complexity of their appendages, while decreasing their numbers; and that, with some exceptions and modifications, this reduction is characteristic of fishes in the tropics, and that it is so because in the tropics the processes of evolution are most active, so far as the fishes are concerned.

#### LETTERS TO THE EDITOR.

\* \* \* Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

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The editor will be glad to publish any queries consonant with the character of the journal.

#### Fair-Weather Echoes.

MY dog, a deep-voiced Newfoundlander, has one plague in life — an echo. It comes from a cottage some three hundred yards off, and there that "other dog" will always have the last word.

This is exasperating, and "Graph" — he is named after another sound-producer, the graphophone — gives vent to his anger in a series of short, sharp, threatening yelps, which are of course more distinctly reproduced than the long bow-wows and howls. Last night Graph was very noisy, but the echo was silent. I tried to rouse it, and excited Graph to do his utmost, but with no effect. A moderate, even-down rain was falling, and the fair-weather echo would not venture out. There is, of course, a reason for this, but I had never noticed the fact before. Is the explanation that the lines of rain cut through the aerial sound-waves and stop them? Are echoes among the hills interfered with by rain?

When the shower was over I tested the echo again, and there it was, a little fainter than usual, but persistent as ever.

A. M. B.

Colonial Beach, Va., Aug. 13.

#### Number of Words in an Ordinary Vocabulary.

IN examining the vocabularies of children, my interest in the size and nature of the vocabulary of an ordinary person, previously aroused by the varying statements and estimates I have seen, was excited sufficiently to induce me to spend a portion of my vacation in making some investigations, the results of which may be of interest to the readers of *Science*.

I first turned to Webster's Unabridged Dictionary (edition of 1870), and counted the words on every twenty-fifth page, and found the percentage of them whose meaning was known to me. Then by calculation I found that if the same percentage holds for the other pages I must know the meaning of nearly seventy thousand of the words given in that edition of the dictionary. Since in the dictionary a word as a transitive verb, as an intransitive verb, as a noun, as an adjective, as an adverb, is separately defined, as well as when used with a prefix, a suffix, or in a compound; and since the irregular plurals, adjectives irregularly compared, and the parts of irregular verbs are also given, this number is perhaps twice that of the really different words. The meaning of some of these words was readily divined from their form, although they had never been seen. On the other hand, one word not unfrequently has a dozen different shades of meaning, several of which often require as different and definite associations as entirely distinct words. Hence the effort required to learn all of these words, with their different shades of meaning, but similar form, is probably as great as it would be to have seventy thousand different words, each having but one meaning. I did not understand the meaning of all of the words well enough to define and use them with accuracy, but merely well enough to grasp their meaning in any sentences in which they might be used, and I probably have never actually used a fourth of them. But, besides the words in the dictionary and some new words given in later editions, and a number of words and phrases from other languages in common use, there are probably several thousand proper names, such as are found in history, geography, fiction, and among acquaintances, each with its distinct associations, familiar to every intelligent person. These words will more than make up for any error in counting that I could have made.

Professor E. S. Holden (Trans. Philol. Soc., 1877), found his own vocabulary to be between thirty-three and thirty-four thousand words, and estimated that of an ordinarily intelligent person at twenty-five thousand. I do not know what he called a word, nor whether he counted as known words that he could not or did not use. He estimates that the vocabulary of technical terms possessed by a specialist may reach ten thousand or more. In "Gray's Structural Botany" there is a glossary of between two and three thousand technical terms, the vast number used in cryptogamic botany not being included in the list, and of course none of the special names of plants, so it is not improbable that a well-read botanist may have a technical vocabulary of ten thousand words, and a zoologist a greater number.

The words in common use by the ordinary individual has been estimated at from one to three thousand, and it is claimed that when one has learned the meaning of that many words he can carry on any ordinary conversation or understand common, gen-

eral reading. It is also frequently stated that the vocabulary of certain miners consisted of but one hundred words. Whether this was an actual count or merely an estimate I do not know, but should think that it must be the latter. In order to determine the size of an ordinary vocabulary I could think of no better means than to find out the number of words used in some standard work that is easily read and understood by everybody. Nor could I think of any book better suited for the purpose in view than that great English classic, "Robinson Crusoe." The copy of that work in my possession contains 460 pages, and I first noted down all of the different words found on every tenth page (counting as a separate word what is given as such in the dictionary). This probably gave more different words than forty-six consecutive pages would have done, because a greater number of subjects and incidents are discussed and described. I then noted the new words on the remaining nine of a section of ten pages in the front part of the book, and then of a section in the latter part, in order to get a basis for estimating the new words in the rest of the book. The number of words on the sixty-four pages counted was thirty-one hundred, and if the percentage of decrease for each section of nine pages from the section counted just before it should be the same as for the two sections counted, there would be on the remaining 396 pages about three thousand words. It may be, as would seem probable, that the percentage of decrease would increase after awhile, but so far as counted there was no sign of an increased rate of falling off. The falling off was very rapid for the first five pages, less rapid for the next twenty, and after that not enough to be evident unless the average of a number of pages was taken. It seems quite certain, then, that De Foe, in writing his account of the adventures of Robinson Crusoe, used not less than five or six thousand words. Children of ten or twelve years read the book with pleasure, and probably have a pretty clear idea of the meaning of nine out of ten of the words they find in it. The work probably contains most of the verbs and a large proportion of the adjectives and adverbs in common use, but there is a large number of nouns, both common and proper, familiar to every child, which De Foe had no occasion to use in this work. It is probable then that to read ordinary general reading in English understandingly one needs to be familiar with from six to ten thousand words. The same must be true for other languages equally rich in synonymes. Grimm's "Märchen" contains a vocabulary of between four and five thousand words, yet any one who can readily read those stories needs a dictionary constantly by his side when reading ordinary German.

From the data at hand I should estimate the vocabulary of a citizen of the United States with a common-school education and of ordinary intelligence and reading at about ten thousand words, and that of a well-read college graduate, and of those who have pursued a university course, at from twenty thousand upwards to perhaps one hundred thousand. One's vocabulary is usually nearly complete at thirty years of age. If but two words are learned each day the vocabulary at that age would be only twenty thousand. My records show that young children acquire new words more rapidly than that.

As to the composition of a vocabulary, I find that in the dictionary about 60 per cent of the words are nouns, a little over 22 per cent adjectives, and a half that per cent verbs, and a fourth adverbs. Pronouns, prepositions, and conjunctions, though used in every sentence, constitute a very small part of a general vocabulary — none were found in examining fifteen pages, or one in every hundred, in the dictionary. Of the thirty-one hundred words obtained from "Robinson Crusoe," a little over 45 per cent were nouns, 24 per cent verbs, a little over 17 per cent adjectives, and 7 per cent adverbs. Probably nearly every one is familiar with a larger proportion of the verbs than of the nouns in the dictionary, but "Robinson Crusoe" is particularly rich in verbs. Many of them are used only as participles, the form in many cases being the same as for the adjectives, but they only counted as verbs unless distinctively used as adjectives. As already suggested, the ordinary vocabulary contains a larger proportion of nouns than are found in "Robinson Crusoe," and many that are not found in the dictionary, although the proportion is probably not greatly different from what it is in the latter. In small vocabularies the

proportion for the different parts of speech is quite different. Of the 215 words on the first page of "Crusoe" that I counted, 5 per cent were prepositions, 10 per cent adverbs, 10 per cent pronouns, 6 per cent conjunctions, and but 24 per cent nouns. This must be borne in mind in considering small vocabularies like those of children.

As a matter of some general interest, and a point of considerable importance, in considering the question of the pronouncing vocabulary of children, it is worth while to notice with what letters of the alphabet the greatest number of words begins. The letters s, p, and c begin nearly one-third of the words in the English language. The following is the order for the letters most frequently used in the dictionary: s, p, c, a, t, b, r, m, d, f, e, h, l, g, w, o, v, n, u; in "Robinson Crusoe," s, c, p, a, f, b, r, m, e, t, w, h, l, i, g, o, n, u, v.

Further data are needed in order to confirm or correct the estimates given in this article. E. A. KIRKPATRICK.

Rhodes, Iowa, Aug. 14.

#### Climatic Changes in the Southern Hemisphere.

HAVING had occasion to cruise a considerable time over the Southern Ocean, I have had my attention directed to its prevailing winds and currents, and the way in which they affect its temperature, and also to the ice-worn appearance of its isolated lands.

It is now generally conceded that the lands situated in the high latitudes of the southern hemisphere have in the remote past been covered with ice sheets, similar to the lands which lie within the antarctic circle. The shores of southern Chili, from latitude 40° to Cape Horn, show convincing evidence of having been overrun by heavy glaciers, which scoured out the numerous deep channels that separate the Patagonian coast from its islands. The Falkland Islands and South Georgia abound with deep friths; New Zealand and Kerguelen Land also exhibit the same evidence of having been ice-laden regions; and it is said that the southern lands of Africa and Australia show that ice accumulated at one time to a considerable extent on their shores. At this date we find the southern ice-sheets mostly confined to regions within the antarctic circle; still the lands of Chili, South Georgia, and New Zealand possess glaciers reaching the low lands, which are probably growing in bulk; for it appears that the antarctic cold is slowly on the increase, and the reasons for its increase are the same as the causes which brought about the frigid period which overran with ice all lands situated in the high southern latitudes.

Why there should be a slow increase of cold on this portion of the globe is because of the independent circulation of the waters of the Southern Ocean. The strong westerly winds of the southern latitudes are constantly blowing the surface waters of the sea from west to east around the globe. This causes an effectual barrier, which the warm tropical currents cannot penetrate to any great extent. For instance, the tropical waters of the high ocean levels, which lie abreast Brazil in the Atlantic and the east coast of Africa in the Indian Ocean, are not attracted far into the southern sea, because the surface waters of the latter sea are blown by the westerly winds from west to east around the globe. Consequently the tropical waters moving southward are turned away by the prevailing winds and currents from entering the Southern Ocean. Thus the ice is accumulating on its lands, and the temperature of its waters slowly falling through their contact with the increasing ice; and such conditions will continue until the lands of the high southern latitudes are again covered with glaciers, and a southern ice period perfected. But while this gathering of ice is being brought about, the antarctic continent, now nearly covered with an ice-sheet, will, through the extension of glaciers out into its shallow waters, cover a larger area than now; for where the waters are shoal the growing glaciers, resting on a firm bottom, will advance into the sea, and this advancement will continue wherever the shallow waters extend. Especially will this be the case where the snowfall is great.

Under such conditions, it appears that the only extensive body of shallow water extending from the ice-clad southern continent