SCIENCE

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CONTENTS:

*THE LANGUAGE OF HAWAII.**

I.

ENGAGED in the work of geodesy and astronomy, the author of this paper made several trips to the Hawaiian Islands. Although little attention could be given to ethnological or linguistic studies on account of professional duties, contact with the natives incidentally brought out points which seemed interesting.

Struck by the occurrence of peculiar grammatical forms, and finding unusual mental habits among the Kanakas induced by their ethical ideas, it was thought worth while to briefly note these facts. Parallels have been drawn between Polynesian and European constructions, and, as bearing on the formation of language, some incidents are related illustrating characteristic lines of thought.

Grateful acknowledgment is here made to Dr. Cyrus Adler of the Smithsonian Institution, for valuable suggestions as to the arrangement of the material.

I.—INTRODUCTION.

Geographical Limits of Languages considered.—The establishment of the Oceanic family of speech has been characterized by Max Müller as one of the most brilliant discoveries in the science of language. Both on account of the wide geographical limits involved and the scanty basis of com-

*Read before the Philosophical Society of Washington.

parison, a study of these groups is beset with difficulties. Think of the immense space and time separating the localities and occurrences. From New Zealand on the south to Formosa on the north; from Easter Island on the east to Madagascar on the west, covering a territory of 208° of longitude and 88° of latitude—nearly one-fourth the habitable surface of the globe—we find a root language governed by the same grammatical system and pervaded by the same modes of thought. We shall have occasion later to point out certain peculiarities which are common to all the Oceanic languages, but which are radically distinct from any branch of the Indo-European family, showing that Oceanic speech, in the great struggle of the race to acquire an instrument of analysis, has been developed from a fundamental, separate type, and in its origin had nothing in common with the stock to which European tongues are referred. Between some of the islands there has been no contact for thousands of years; yet their linguistic connection is unmistakable and everything points to derivation from a common source. They have the same customs and mythology; the laws of euphony regulating the change from one consonant to another are fixed and uniform; the mold into which sentences are cast, the co-ordination of phrases, the mutual dependence of ideas, all reflect the thought habits of an identical race.

Classification of Oceanic Languages.—The Hawaiian is one branch of the Polynesian group of the great Oceanic family. An analysis of the structure shows that six groups can be logically defined, namely, the Polynesian, Micronesian, Papuan, Australian, Malayan, and the Malagasy. Each one of these embraces distinct branches, having close affinities with one another. For example, the Polynesian includes the language of Hawaii, Fiji, Samoa, Marquesas, and Tahiti. The Micronesian comprises the Gilbert, Marshall, and Caroline Islands; and so on through all the members of the family, ending with Madagascar, which is the center and type of the Malagasy group. When we consider that this vast territory of speech, from America on the east to Africa on the west, with its families, groups, branches, and dialects almost numberless, has been reduced to a permanent and philosophical system of syntax, we do not wonder that one of the most profound students of comparative philology refers to the achievement as a discovery of the greatest importance.

Dispersion of Terms.—Before passing to an analysis of Hawaiian speech, one word on the theory of dispersion. It is admitted that all the Oceanic languages were derived from one very ancient tongue, now lost. The Malagasy has felt the influence of the Arabic, and the Malay shows unmistakable contact with the Sanskrit; yet the great tidal wave of emigration, which was ever from west to east in the Pacific, swept on and preserved intact the structural features of the original form. The theory that each dialect has an indigenous base, and that words common to all were introduced through commercial intercourse, is entirely inadequate. In the first place, the connection was far too slight to produce the effect mentioned, and in the next place the common words are not those ingrafted and absorbed by intercourse, but are such as are in every known language—the oldest and the commonest. When the Normans came to England they introduced many words; but they could not displace those simple names of natural objects as sun, moon, etc., nor those indicating intimate family relations, such as father, mother, brother, sister—terms always dear to the heart of humanity and jealously guarded against foreign intrusion and corruption. Just so in the Pacific. The words common to all branches of the group are those which from the very

nature of things must have been in use from time immemorial. This fact alone explodes the theory that the dispersion of terms was the result of intercourse. It is confidently believed by some philologists that the old Egyptian word *ra* (the sun) is still preserved in the *la* of Hawaii, as in Hale-a-ka-la, meaning the house of the sun; *l* and *r* are still interchangeable in Hawaii, and the word being not only one of the commonest, but also associated with certain forms of worship, has tenaciously held its place through all the varying influence of ages.

The original home of the Polynesian race was one of the Malay islands—probably Sumatra—and the modern Hawaiians exhibit the primitive state of civilization in those islands; but the dialects have diverged. The Philippine islands now offer the purest type of speech, since here may be found all the grammatical forms which appear more or less complete in the other groups. These islands, therefore, hold the same linguistic place, compared with sister groups, that we find exemplified by Tours in France, Valladolid in Spain, and Hanover in Germany. By some mysterious law of nature these sections have kept their speech nearer the standard, and may be fairly designated as the purest type of the common language.

Introduction of Spanish Words.—One of the most potent factors in the modification of language is commercial intercourse. Similarity has been noticed between certain Hawaiian words and those of identical meaning in Spanish. They furnish evidence of early contact between the two nationalities. Here are a few examples:

The words *mate* in Kanaka and *matar* in Spanish both mean *to kill; poko* in Kanaka means the same as *poco* in Spanish; *piko* means the same as *pico* in Spanish, as in *ka piko o ka mauna.*

Where do these native words come from? Does the following offer an explanation?

An old tradition relates that in the reign of Kealiiokaloa a foreign vessel was wrecked on the south shore of Hawaii. The only persons saved were the captain and his sister. They were kindly received by the natives, intermarried with them, and became the progenitors of well-known fam ilies of chiefs. Counting back through well-established genealogy and allowing thirty years to a generation, the wreck must have taken place between 1525 and 1530.

Three Spanish vessels left Mexico on October 31, 1527, bound for the Molucca islands, in the East Indies. Two of them were lost. No other white people were navigating the Pacific at that period, and it seems reasonably certain that the wrecked vessel was one of the three sent out by Cortez. Their westward course lay to the southward, and the violent *kona* storms of the Pacific would carry them toward Hawaii. On the return trip they went north to latitude 30°, to take the westerly winds, and thus passed far above the islands. This explains why Hawaii, although known to the Spaniards, was seldom visited by them. Old charts in the archives at Madrid show conclusively that the Hawaiian islands were known during the sixteenth century. This bit of history and tradition may possibly explain similar terms in Spanish and Kanaka, of which there are many. On the island of Hawaii may be found at the present day an apparently full-blooded Kanaka child, with pure South Sea features, yet possessing a white skin and a complexion similar to that sometimes seen in the Spanish-Moorish mixture. Will any one say that this may not be a recurrence and manifestation of certain influences in times past? Examples are not wanting in our own race where effects appear after having lain dormant for generations.

II.—PHONOLOGY.

Vowels and Consonants.—Let us now examine the language from the standpoint of

sound. The Kanaka ear is as delicate in detecting vowels as it is dull in the distinction of consonants. When Isaac Pitman invented phonography he used the straight line and parts of a circle to represent the English consonants. They were classified into labials, dentals, gutturals, liquids, etc., and the same signs, made heavy or light, were applied to different sounds of the same class. Now it happens that his classes are precisely those in which the Polynesian ear makes no distinction. For instance, with the labials *p* and *b*, we may say either *taburoa* or *kapuloa;* we may say *Honorourou* or *Honolulu.* As a matter of fact, the first form is invariably found in the earlier accounts of the islands. Ask a Kanaka which is right, *taburoa* or *kapuloa*, the reply will invariably be that his ear detects no difference. The term means *great taboo* and is used now as an injunction against trespass. This shows that the Hawaiians, in their inability to distinguish between *b* and *p*, *d* and *t*, *g* and *k*, *l* and *r*, and *v* and *w*, are following a natural law of human utterance, namely, that certain sounds similarly made readily coalesce, and without impairing the context may be used interchangeably. The fact also became evident when the problem of writing English phonographically was confronted. In phonographic characters, *p* and *b* have the same length and slope. They only differ in shading, a detail of minor importance, since the substitution of one sound for the other in the spoken word involves little uncertainty in the meaning.

Two invariable rules lie at the foundation of all Polynesian speech. Every word must end in a vowel, and no two consonants can be pronounced without at least one vowel intervening. Only one word has ever been printed in Hawaiian with two consonants together. That word is *Kristo* Christ. But any number of vowels may be pronounced consecutively, as in the word *hooiaioia* meaning certified, where we have eight continuous vowel sounds. Compare this with the English word 'strengths,' where we have nine letters and only one vowel. Before attempting the pronunciation of this word an Hawaiian would have to transform it by the introduction of at least eight vowels. No less would suffice to make it utterable by Polynesian organs of speech, and the probability is that many more would be interjected in the hopeless struggle to give birth to such an angular product of English speech. Take also the expression, *E i ae oe ia ia*, meaning *Speak thou to him there.* This is a complete sentence of six words in which not one consonant appears to mar euphonic beauty or to disturb the easy liquid flow of vowels so dear to the Hawaiian ear.

The importance of the vowels in the Polynesian languages is such that if we open a Hawaiian dictionary we find, not the order of letters given in English, but a totally different one. First come all words beginning with the vowels *a e i o u;* then those beginning with the consonants *h k l m n p w*. This completes the list of all pure Hawaiian sounds—twelve in number. Nine additional consonants, *b d f g r s t v z*, have been introduced from foreign tongues, because new words took root in the language. In passing, we may say that the Hawaiian consonants are probably the softest and most effeminate of the Oceanic group. In a dictionary of 502 pages, 111 were found devoted to the vowels, 387 to the native consonants, and 5 to the foreign ones, so that the words introduced are about one per cent. of the total number.

Cacophony.—There is a natural aversion in most languages to the consecutive repetition of the same sound, and especially so between words. An example is given on a following page, under 'syntax,' of affirmation by means of the article *he.* The phrase *he pono ole*, however, is never pronounced as

written, the *o* is elided, and we say *he pon ole*, just as the Spaniards in rapid speech use *boca bajo* instead of *boca abajo*. So strong is this sentiment that rules of gender are sometimes made to give way so that euphony may be preserved, and the method observed in Italian finds application in Hawaii. Instead of saying *na alii*, the chiefs, the Kanakas drop a letter and say *na' lii*. The Italians say *bel originale*, avoiding the repetition of *o*; the French use *mon amie* and the Spanish *el agua*, in order to eliminate the same disagreeable effect. In English the combination is equally distasteful and we say *an apple*; yet the Hawaiians do sometimes violate this rule in the middle of words. Notice the artifices employed in the different languages to avoid cacophony. The Kanakas prefer elision; the French and Spanish are willing to break another rule of speech in order to satisfy the ear, and couple words of opposite genders, while English avoids the difficulty by supplying a letter. The methods employed exemplify characteristic national traits. The Hawaiian accomplishes his purpose in any way that diminishes labor; he therefore cuts out rather than introduces. The energy of the Anglo-Saxon prompts him to interject something, and the Latins, true to their natural instinct, sacrifice symmetry of form to euphony of sound.

The Guttural Break.—Besides the Hawaiian sounds previously cited there is a guttural break which represents the elision of the *k* in other Polynesian dialects. It is indicated by a comma, just as the circumflex accent in French indicates the suppression of a letter or syllable in earlier forms. This break is an essential part of the word, and a disregard of it completely changes the meaning. For example, *ao* means light; *a'o* means to teach; *ia* means he; *i'a* means fish. There are many examples of this in the language.

As we pass from Sanskrit to Gothic, and on to high German, a regular mutation in the appearance of certain consonants is found. No less evident than this law of Grimm is the change of Polynesian sounds, and, although neither rule is infallible, both are useful in tracing certain paths of development.

The *l* in Samoan becomes *r* in New Zealand and returns to the original letter in Hawaii. The *p* in Samoan is *b* in Tongan, and is again *p* in Hawaii; *v* in Samoan is *w* in New Zealand, but remains *w* in Hawaii. The *k* in New Zealand is replaced by the guttural break in Tahiti and Hawaii. The vowels, however, undergo fewer changes than the consonants.

Meanings of aa.—The definition of words by context necessarily finds wide application in the stage of development now reached by the language of Hawaii. The sound indicated by the letter *a* is probably the most common in the entire range of articulation. Standing alone, it has, like many others, a variety of meanings; but doubled, it answers to nearly thirty significations, many of them of the most diverse nature. To begin with, *aa* may be either a verb, adjective, or noun, and some of its meanings are:

> *to burn, to tempt, to defy, to girdle, to make a noise, to send love.*

Then it may mean—

> *spiteful, silent, stony, mischievous.*

And finally it stands for—

> *fire, belt, dumbness, roots of trees, pocket, bag, dwarf, lava, covering for the eyes, bird of prey, caul of animals, sea breeze at Lahaina, husk of the cocoanut, chaff, outside of seeds or fruit, red fish.*

Add to these some adjectives that may be derived from verbal meanings and the number may be considerably increased. It is evident that a necessary condition for the successful employment of a word of such unlimited power is great flexibility of construction. The groundwork of the lan-

guage must be free from intricate forms of syntax.

Used alone *a* may be a noun, an adverb, a conjunction, a preposition, an interjection, a verb or an adjective. Under each part of speech it has several meanings. Here are a few when it is used as a noun: First, *the jawbone;* second, *an instrument made of smooth bone, used in piercing unborn infants;* third, *broken lava;* fourth, *white spots in poi;* fifth, *a sea bird;* sixth, *a small fish;* seventh, *the alphabet.*

III.—MORPHOLOGY.

General Characteristics.—We now proceed to develop the peculiar genius of the Polynesian languages, and of the Hawaiian in particular. They differ radically from the Indo-European family, which stands pre-eminent for the perfection of its organic structure, in three essential particulars:

1. They are completely devoid of inflections.

2. The vowel sounds largely predominate.

3. The construction has great flexibility.

Most writers on the subject fall into the naural habit of comparing the Oceanic with the European tongues, and analogies more or less real are indicated. These are often stretched beyond the limits warranted, perhaps with the laudable object of easing the student's path. The fact is the Oceanic family of languages is a distinct and separate creation, and must be followed on entirely different lines from those followed in Western speech. The inflections of our highly cultivated tongues add symmetry and elegance, but do not necessarily give flexibility. Even barbarous dialects can furnish in certain directions more varied locution for the conveyance of thought; for instance, in the Hawaiian language gender is denoted in two ways. There are five methods of distinguishing number. There are ten cases. There is almost endless variety in the arrangement of words, depending on the order of preference.

The Singular and Plural Distinctions.—The five ways of indicating number are:

1. By changing the article, as in most European languages, and saying *ka hale,* the house, or *na hale,* the houses.

2. By the use of the plural sign *mau,* which can be associated with any noun. Thus they have *he mau lio,* several horses; or,

3. One may employ a collective noun; as in

he poe haumana, a company of disciples;
keia pae moku, these islands;
he pu'u pohaku, a pile of stones;

Poe is applied to living things, *pae* to lands and islands, and *pu'u* to lifeless objects. These shades of meaning, invariably observed, impart a vividness to the language unknown to Western speech.

4. The plural may also be indicated by shifting the accent; as, *kanáka,* a man; *kánaka,* men. And, finally

5. The same idea may be expressed by using the work *ma,* which means literally a company.

Here then are five distinct ways of expressing an idea for which only two exist in our own language.

Tense and Case.—The distinctions of time are never so definite as in other languages, the chief attention being centered on the accidents of place. The word *ana* denotes continuance, and may be past, present, or future. Thus *e hana ana au* may mean, I *am* working, I *was* working, or I *will be* working, according to the connection.

Take the relations of case. There are ten. The six cases of Latin are well defined, and four of them—the genitive, accusative, vocative, and ablative—each have two shades of meaning, for which only one means of expression exist in English. Not only this, but one of the subgenitives, the *aui pili,* has two significations for which we

have only one. This difference is so distinct in the Hawaiian's mind that the distinguishing words are seldom, if ever, used interchangeably. In designating the cases, recourse is necessarily had to Hawaiian terms, since no European tongue provides sufficient names. The extreme development of the case relation is seen by comparison. The English has 4; the Latin, 6; the Sanskrit, 8, and the Polynesian, 10.

The formation of words is one of the interesting phases of the language. As in all uncultivated tongues, intensity of expression is accomplished by repetition. This may be done by doubling a letter, a syllable, or even two syllables, as

a means to burn, *aa* to burn hotly;
naki means to bind, *nakiki* to bind tightly;
pulu means wet, *pulupulu* very wet.

A noted distinction before referred to in speaking of case is made between active and passive relations, as indicated by the prepositions *a* and *o*. If we refer to the house a man built, we use *a*; if he simply lives in it, we use *o*—*e. g.*:

ka hale a Keawe means the house that Keawe built;
ka hale o Keawe means the house that Keawe lives in.

a is employed in speaking of a man's wife; *o* in speaking of his maid servant—*e. g.*:

ka wahine a Keawe means Keawe's wife;
ka wahine o Keawe means Keawe's maid servant.

The literal translation is the *woman of Keawe*, but whether she bears the relation of wife or servant is indicated by the choice of prepositions. By the mere change of one sound in the sentence a husband may imply volumes of meaning.

A refers to an oven for you to cook with; *o* to an oven for you to be cooked in. In New Zealand they say—

he hangi mau; to cook with; but
he hangi mou; to be cooked in.

This introduction of a particle to completely change the meaning is common in some of the Romance languages. Take the example in Spanish:

Mi hermano quiere una criada; and—
Mi hermano quiere á una criada.

The first means that my brother wants a maid servant; the second, that he loves one.

Forms Similar to the French.—A striking similarity to the French exists where the noun is inserted between the two parts of the pronoun—*e. g.*:

ua moku nei = ce navire-ci = this ship;
ua mokú la = ce navire-là = that ship;

ua-nei being here a strong demonstrative.

Note also the resemblance between

keia and *kela*—meaning this and that—and
ceci and *cela*.

The idea of *everything* would be expressed in Kanaka by that thing, this thing, *kela mea keia mea*.

In this phrase we see again the lack of generalizing power of the Polynesians.

The Hawaiian is one type of the agglutinated languages. The combination of the article with a proper name forms a new compound, in which, however, the original signification of the article is lost. The names of two of Hawaii's famous queens may be cited as examples.

Kapiolani means the heavenly prisoner; *Liliuokalani* is the lily of heaven.

IV.—SYNTAX.

Relative Pronouns.—When we come to compare the Polynesian languages with the Indo-European from the point of view of syntax, many interesting peculiarities are developed. The fact that all their mental action follows special lines involves a radical modification of our methods of expression. Some of our constructions apparently necessary and certainly logical cannot be employed.

No relative pronoun has ever been found in Hawaiian. This does not involve a lack of logical clearness. From their mode of

thinking they find little use for relatives; but the meaning is just as unequivocal as though the sentence were constructed after a Latin model.

For example,

O ka'u poe ke iki ka poe nana ka laau,

means literally,

My children are those for them the timber;

or, freely translated:

My children are those *who will own* the timber.

Absence of Verbs.—In this last sentence we see several peculiarities. In the first place, *o* is used simply for euphony. It cannot be translated into English. Then the word *poe* has no equivalent. In the next place, there is no verb. Some of the strongest and clearest affirmations are made in Hawaiian without any kind of a verb; there is no verb in the language to express the idea of existence. The structure of the idiom does not require it. Neither is there any verb to express having or possessing, nor to express duty or obligation, nor to affirm any quality as belonging to any substance; but these ideas are necessary in the communication of thought. How, then, do the Hawaiians express them? In various ways:

I. By particles of affirmation, as: *he akamai kona*, a skill his—*i. e.*, he has skill. A construction similar to this is found in Hebrew and other Semitic languages.

II. By *he*, a simple article, as: *he pono ole*, a good not—*i. e.*, good does not exist therein. In other words, it is unrighteous.

III. Affirmation is sometimes expressed by the pronouns *ia, eia, keia*, etc., as:

O ia ka poe i hele mai (the *o* is emphatic).
(Those were) the people who came.

In fact, verbs play a very subordinate part in the language and are seldom employed, since their place is supplied, as occasion arises, by other parts of speech. Take the sentence that appears on the Hawaiian coins:

ua mau ke ea o ka aina i ka pono; meaning
(is continued) the life of the land by righteousness. The affirmation seems to be made in the first word, *ua*, although this is sometimes a supernumerary word, or at least an auxiliary one.

Position of Nouns.—A peculiarity about nouns is that they may stand in almost any part of the sentence except at the beginning. The whole method of affirmation is unique. It may be done by several parts of speech. Here is an example where a noun contains the idea:

I ka po ka lakou hana; meaning
In the night was their work.

In the following case there is no verb in the sentence, and the pronoun contains the declaration within itself:

(*Oia*) *ka mea i loaa i ka waiwai;* meaning
(That is) the thing to obtain wealth.

Some phrases are difficult to understand. This was once found in good Hawaiian:

O makou hoi, o na elemakule kane, a me na elemakule wahine;

which literally means:

We, also, the old men males and the old men females.

Just what is implied therein has baffled more than one Hawaiian scholar. The idea may be akin to that contained in the Spanish phrase *Voy á dar un abrazo á mis padres*, where the word *padres* is employed when both father and mother are meant, the meaning, of course, being that he is going to embrace both of them.

French and German Constructions.—In certain constructions two negatives are necessary just as they are in French. *Nele* means to lack, and *ole* means not; yet they are both employed, and, taken together, have the force of one negative only, as:

Nele na Kanaka o Honolulu i ke kumu ole.

This *ole* in our idiom would be superfluous but the Hawaiian requires it. The French

ne-pas is precisely parallel, and the French equivalent of the Hawaiian phrase is:

Les gens de Honolulu n'ont pas d'instituteur.

The interjection of words between two parts of a verb as in the German is very common, as:

Na lawe malu ia ke dala.

The other form would be with *laweia* as one word; and the phrase translated into German, using a separable verb to show the correspondence, would be:

Man nahm das Geld heimlich weg.

Here is a case where the regular German separable verb construction is duplicated in Hawaiian.

Flexibility.—The Polynesians avoid inflection. But if their language is loose and cumbersome in this respect there are corresponding advantages. Indeed, from this very fact great flexibility becomes a necessity, and any sentence may be cast in a variety of ways, depending on the idea which is to take precedence or acquire emphasis. Take the phrase, 'I give this to you.' Here we have five words. The sentence may have as many different arrangements in Hawaiian, according to the shade of meaning sought. When it is desired to bring out the fact that an object is given and not loaned, the words *ke haawi* take precedence, as:

Ke haawi aku nei au i keia ia oe.

When prominence is given to the idea that it is I and not some one else who gives, the form is:

Owau ke haawi aku nei i keia ia oe

and so on through the five different arrangements, each laying stress on a different idea and all perfect models of pure Hawaiian syntax. It cannot be denied that this flexibility gives to the language a power and subtlety unknown in the inflected tongues.

We are all familiar with that inimitable scene in the *Bourgeois Gentilhomme*, of Molière, where a lover repeats in five different ways: "Fair Marquise, your beautiful eyes make me die of love." The actor succeeds in revealing an ardent passion, but his French is intolerable. An untutored Kanaka from the South seas would have been able to bring out in his native speech all these shades of meaning, impossible in the cultured language of France. But the French language, proud mistress that she is, will not tolerate these liberties of construction that the Polynesian tongues not only permit but even court. The higher the civilization, the more acute are the forms of thought. The more exacting the rules of syntax become, the more limited appears the capacity for flexibility.

It is a peculiar trait of the language that the same word may be used as a verb, noun, adjective, or adverb. As an example, let us take the common word *aloha*, and we have

As a verb: *ke aloha aku nei au i kuu hoalauna*—

I love my friend.

As a noun: *he aloha kona i kona hoalauna*—

he had love for his friend.

As an adjective: *he alii aloha no ia i kona hoalauna*—

he is indeed a loving chief to his friend.

As an adverb: *hana aloha ae la kela ia ia*—

that person treated him with friendship (love).

Even the pronoun I can be used as a verb. A native, relating his reply to the question as to who possessed a hat, said:

Owau aku la no hoi au owau,

which translated literally is:

I 'ied' to him, I

that is,

I said to him I had.

But then our language is sometimes given similar license. A schoolmaster once asked for an example of an interrogative pronoun used as a verb. No one was able to reply

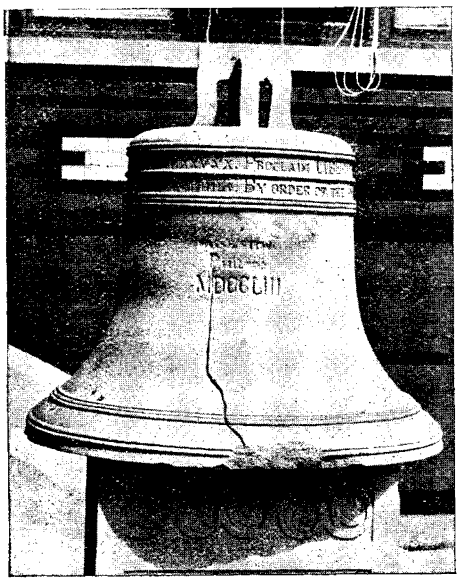
successfully except a mischievous urchin who had been thrashed for saying *what*, and his answer was, 'Give me that stick and I'll *what* you.'

ERASMUS DARWIN PRESTON.

(To be continued.)

SANDSTONE DISINTEGRATION THROUGH THE FORMATION OF INTERSTITIAL GYPSUM.

A BLOCK of Carboniferous sandstone from New Brunswick, carved in the form, and in imitation, of the Old Liberty Bell, was some years ago, owing to the crowded condition of the Exhibition Halls of the National Museum in Washington, removed to a point near the northwest entrance, outside of the building.



When placed in position the stone was fresh, and surface smooth throughout. Within the space of a couple of years there appeared on the northwest side a slight roughening of the surface and a whitish efflorescence which during the two ensuing years extended gradually two-thirds around the northern and southern sides, but was always most marked on the northwest. On examination the efflorescence was found to be due to the formation of small gypsum crystals, and the roughening of the surface to the falling away of the siliceous granules. The process has gone on until now more than an eighth of an inch in thickness of material has been removed from the point of surface first attacked, and the inscription in part obliterated, as shown in the accompanying illustration. It is to be noted that the zone of disintegration is limited wholly to that portion of the bell just above the middle, where the surfaces stand nearly vertical, while elsewhere the material is almost as fresh and unaltered as when first exposed.

An examination of the stone shows it to contain numerous small segregations of marcasite which are quite inconspicuous, or show up as small dark spots on the weathered surface. Chips of the fresh rock effervesce slightly in dilute acid, indicating the presence of calcite. The disintegration is doubtless due, therefore to the oxidation of the marcasite through the downward percolation of rain water, and the reaction of the sulphuric acid formed upon the calcium carbonate. The resultant calcium sulphate is then brought to near the surface by capillarity where it crystallizes, and, as growth takes place always from the base of the crystals the sand granules are gradually forced off in the manner so often exemplified in the lifting of soil through the formation of hoar frost. The writer has described (Proc. U. S. Nat. Mus., Vol. XVII., 1894, p. 80) the splitting of blocks of limestone through similar gypsum growths, as noted in the dry portions of Wyandotte and Mammoth Caves, but has never seen the phenomenon so well illustrated in sandstone as here. In as much as it offers an explanation for the disintegration of sandstone of this type where exposed in the walls of buildings, the case is worthy of mention.

The gypsum efflorescences, it should be