

double vibrations per second, and carrying a strip of tinsel to serve as an index, is firmly fixed in a vice or in the wall, and arranged so that its index may vibrate in the direction of the generating lines of the cylinder. These vibrations serve to mark the time, and the tuning-fork serves as a chronograph, obviating the necessity of giving to the cylinder a regular and uniform motion. Further, the feather is moved forward, so that its point may just touch the blackened paper, and that it may vibrate quite close to the index, and, like the latter, in the direction of the generating lines of the cylinder.

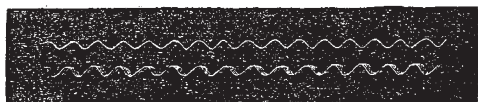


FIG. 2

These arrangements being made, the tuning-fork is set in vibration, either with a bow or by striking it with a stick covered with leather, and the musician plays, while the cylinder is turned at a suitable rate either by the hand or by any convenient motive power.

In this manner a tracing is obtained like that of which a fragment is shown in Fig. 2, each note of the melody being represented by a form of vibration peculiar to itself. The number of vibrations for each note, corresponding to 100 vibrations, for example, of the tuning-forks, is counted, and the ratio of the numbers thus obtained gives the values

of the intervals. The vibrations are sometimes complicated with harmonics (Fig. 3), but they are almost always octaves, rarely fifths, very rarely thirds; moreover, it is not possible to make a mistake on this point.

To preserve the tracing after it is detached from the cylinder, it is split longitudinally, dipped for an instant into a 4 per cent. solution of shellac in alcohol, whereby it becomes covered with a very thin layer of unalterable varnish.

If, instead of measuring intervals of melody, we wish to measure the harmonic intervals of two sounds, two strings of the instrument are tuned simultaneously (in the ordinary way), to the third, fifth, sixth, &c., till beats are no longer perceptible, and the ear is perfectly satisfied; the sounds of the two strings thus tuned are then separately traced.

We have made numerous experiments with several persons, in particular melody experiments with M. Léonard, the Belgian violinist, and M. Séligmann, the violoncellist. The mean values of the results obtained with the assistance of these eminent artists are given in the following table; other experiments gave octaves equal to 2.

	Do.	Re.	Mi.	Fa.	Sol.	La.	Si.	Do.
Mean of the results.	1'000	1'123	1'265	1'330	1'500	1'686	1'917	...
Pythagorean Scale.	1'000	1'125	1'256	1'333	1'500	1'687	1'893	2'000
Ordinary Scale.	1'000	1'125	1'250	1'333	1'500	1'666	1'875	2'000
Values of the Comma.*	0'013	0'014	0'016	0'017	0'019	0'021	0'024	0'025

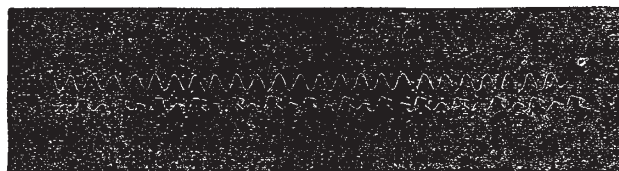


FIG. 3

It is necessary to add that the mean deviations of the experiments rarely exceed the third of a comma. As to the differences between the mean values of the results and the values of the intervals of the Pythagorean Scale, it is a mere fraction of the comma, insensible to the ear. For the seventh alone the difference amounts to five-sixths of the comma; but this result is remarkable, inasmuch as it exhibits a fact well known to musicians, namely, that in the case where the sensitive note Si is resolved upon the tonic Do (which is precisely what occurs in the four cases in which we obtained sevenths), it is perceptibly higher than in the inverse movement.

E. MERCADIER

DISCOVERY OF A LARGE BONE CAVE IN BAVARIA

DURING the cutting of the railway from Nuremberg to Regensburg by the Bavarian Eastern Railway Co., it was necessary to cut directly through a piece of mountain chain in Schelmengraben near Regensburg. It was owing to this that this bone cave was discovered, and its miscellaneous contents were able to be examined and arranged. Since the railway cut right across the middle of the cave, it allowed it to be very thoroughly examined, and under the most favourable circumstances and in daylight, as has been the case in very few other instances. The railway company have given every facility in their power that the cave should be thoroughly examined, and under

the direction of Profs. Fraas and Zittel, a gang of men were actively employed for many days, and the objects so obtained were carefully preserved. From the local German papers the following particulars have been obtained, which, allowing for a little local colouring and exaggeration, show the find to have been a most important one, and one that may well come under the notice of the International Congress of Archæology and Anthropology at their meeting this year, where the whole question of bone caves and their contents is to form a prominent subject for discussion.

The cave in question was originally, when first discovered about two years ago, 28 metres (about 91 ft.) long, and was simply a fissure in the Jura limestone which had been enlarged by running water. Its opening was visible half way up the mountain side, partly hidden in dense woods. It stretched from North to South, with a slight turn towards the West of about 15°. The new line of railway cut deeply into the hill side, and during the course of this year has already cut away one half of the cave, but unfortunately the contents were employed on the line. On this account, only the part not touched was able to be excavated and examined, and this was 11 metres (36 ft.) long, 2 metres (6½ ft.) wide, and in the middle 3 metres (9½ ft.) deep. Wood ashes and pieces of coal, together with pieces of pottery, had accumulated to about the height

* These numbers are the differences between the numerical value of each interval I, and the mean of this same interval raised by a comma, that is to say,

$$\left(\frac{81}{80} - 1\right) \times I = I \times 0'015$$

of three feet, in the midst of which were sharp splinters of flint, and a thick mass of broken and split bones, and the shattered skulls and jaw bones of a heterogeneous mass of animals of all kinds. In the lowest layer no trace of men, either by their remains or by their handiwork, could be found, all the remains consisted of bones of animals, chiefly the cave bear, hyæna, and lion. These cave-dwelling animals appear to have been the first and earliest possessors of the cave. But soon after this men must have discovered the cave and inhabited it, for from this layer up to the newest layer of all the presence of man is clearly shown, and the remains of their feasts and of their daily life are mingled with those of the previously-named animals. The most numerous remains consist of flints of which many thousand were found, but these do not appear to have been used as implements, but come rather under the category of flint-flakes, the chippings from knives, saws, lances, &c. The most perfect one found is three inches long, and half-an-inch wide, and is toothed like a saw, and was probably used as such to saw off the ends of the deer's horns, of which quantities were found.

In order to judge the age in which men began to inhabit this cave, we must examine the remains of the bones and skeletons of the animals which they hunted, and whose flesh was eaten in the cave. The most conspicuous amongst these is the cave bear, and although it might at first sight appear very difficult to recognise in the broken and burnt bits of bone that they really do belong to the cave bear, nevertheless, careful comparison with specimens in museums has proved that this is the case. Every care seems to have been made to utilise to the utmost all parts of this animal, which was apparently the most important game in the surrounding forests, and which no doubt required much labour and time to capture. At the same time, together with the bones of the cave bear are found bones of the elephant and of the rhinoceros, but not many in comparison. These remains, however, show conclusively, by the way in which they have been split up and broken, that man hunted these animals at the time he first appears on the scene. Remains of horses, oxen, cats, and wolves were also met with, and in proof that the early inhabitants were not un-mindful of fish, there are the bones and scales of large pike and carp. The smaller bones of mice and frogs do not appear to owe their origin so much to man as to the owls which seem to have held possession of the cave as well.

Great interest attaches to the fragments of pottery which were found in the cave, and which rival the flint flakes in quantity. It appears to have been all hand made, but although rough, shows considerable beauty of shape and form. It is possible to put together from the fragments one or two more or less complete vessels, which, however, show great diversity as to size, &c., some being between 10 and 20 centimetres in diameter. The material of which they are made appears to be clay mixed with sand, but few, if any, seem to have been regularly burnt. Much of the pottery is ornamented with lines or rows of dots, which run in zigzag lines over the wider parts. The internal smoothness would appear to be due to the river mussel, *Unio*, obtained from the River Naab which flows close by, and of which many well rubbed and polished specimens were found in the cave. A block of granite with one side rubbed smooth, and by long usage appearing quite polished, can hardly be anything else than a well-worn millstone, and this is rendered more probable by two holes having been bored into the upper side as if for the purpose of affixing a handle. The presence of this millstone would indicate the cultivation of land in the immediate neighbourhood, which is confirmed by the finding of several spindles made of clay.

The different objects found in this cave are of great

interest, as they apparently run counter to the somewhat hard and fast lines which have been drawn as to different well marked periods in the early history of man.

THE PARIS SIEGE BALLOONS

THE lessons learnt at Paris in regard to balloon navigation will be of great value in any future employment of aerial machines, and the statistics which have now been collected and published are well worthy of a brief notice. As many as sixty-four balloons, it appears, actually started from Paris in good order, with a *personnel* of 161, and with something like three million letters. The first ascent was made on the 23rd of September, 1870, by M. Duruof with safety, and the fifth balloon carried in it Gambetta, who arrived without accident at Amiens after a voyage of four hours. M. Janssen, whom, it will be remembered, was desirous of watching the approaching eclipse in the south of Europe, left Paris with all his instruments complete in the balloon *Volta*, on the 2nd of December, landing at Savenay (Loire Inférieure) after a journey of five hours and a half. One of the later voyages was made with two cases of dynamite, to be dropped and exploded at a seasonable moment; but fortunately for the enemy no such opportunity presented itself. The last balloon left Paris on the 28th of January, 1871.

Of these sixty-four balloons only seven were unsuccessful in fulfilling their purpose, two of the machines being utterly lost at sea; while five were captured by the enemy. As many as sixteen actually fell within the hostile lines; but the aeronauts were in most cases too quick for their pursuers, and managed to escape. Indeed, of the five actually taken only three were really captured by the enemy's forces, the other two falling in fact upon German soil, namely, in Prussia and Bavaria. The most interesting voyage was certainly that of M. Rollier, who travelled safely from Paris to Christiania in fourteen hours, after a journey across the North Sea of nearly twelve hours. Of the two lost at sea, one was observed to go down by some sailors at Rochelle; while of the other nothing certain is known.

The regularity with which the balloon service was conducted during the winter of 1870 under grave disadvantages will be remembered by all who studied the daily newspapers at that period, the news from the French Capital never being interrupted for more than three or four days together. Most of the aerial machines contained 2,000 cubic metres of gas, and one of them consisted of twin spheres tethered together; they were usually started from the Orleans or North railway stations at nightfall, so that they might escape the vigilance of the German troops posted round the city. Besides a freight of letters the majority carried baskets of pigeons, and in five cases dogs, destined to return with news to the beleagured city; how well the pigeon-post itself was organised may be gathered from the fact that fifty thousand messages were sent into Paris by its means alone.

Some attempts were made by M.M. Tissandier Frères to return to Paris by means of aerial machines impelled by favourable winds; but two successive essays made from Rouen on the 8th and 9th of November were quite fruitless. M. Jules Godard, the aeronaut, and M. Nadar were the principal agents in organising the balloon service.

NOTES

At the Anniversary Meeting of the Royal Geographical Society, held on Monday last, the Royal medals for the encouragement of geographical science and discovery were presented. The Founder's Medal was given to Sir W. Baker for Colonel Henry Yule, C.B., in recognition of the eminent services he has ren-