curves obtained by other means shows that they all lack the finer details that appear in the sound tracks and that all except a very few are so distorted that they can scarcely be said to be vowel curves at all. Of all the previously published vowel curves, only those obtained from gramophone records by myself and the Gramophone Company, those obtained by Miller with an oscillating mirror, those of Crandall with a special oscillograph, and those of Gemelli with a cathode ray oscillograph, resemble those in the sound tracks; even these lack the finest details.

E. W. SCRIPTURE.

University of Vienna.

[1] NATURE, **130**, 275, Aug. 20, 1932.
[2] Vercelli, "Analisi delle periodicità nei diagrammi (Cimanalisi)", *Att. Ist. Naz. Assicurazioni*, **3**, 1; 1930.

Just Intonation

IF the tones *C* and the seventh harmonic of *A*♭ are sustained together in the ratio 5 : 7, the two chief resultant tones are *A*♭ and *E*♭, the four tones together giving the true form of the accord known as the German sixth, 2 : 3 : 5 : 7, expressed in cents by the numbers 814, 316, 1,200, 583.

Now if the highest of the four tones is raised 20*c*. to 603*c*., and *C* remains, these two are as 12 : 17, and with their two resultant tones, *A* and the seventh harmonic of *F*, they form the accord 5 : 7 : 12 : 17, in cents 884, 267, 1,200, 603. This is the true form of the chord of the diminished seventh.

The difference of 20*c*. is one-fifth of an equal semitone.

The tenor part, moving from and back to *C* major on the notes 386, 316, 267, 204, 471, 386, divides the semitone *E*♭–*D* in the enharmonic proportions proposed by Archytas, contemporary of Plato, as recorded and rejected by Ptolemy, namely:

$$\tfrac{36}{35} \times \tfrac{28}{27} = \tfrac{16}{15}, \text{ or } 49 + 63 = 112c.$$

The succession in the bass, meanwhile, is simply *G*, *A*♭, *A*, *G*, *G*, *C*, that is, 702, 814, 884, 702 and 0 (1,200)*c*.

WILFRID PERRETT.

University College,
Gower Street,
London, W.C.1,
Nov. 29.

Distribution of Molybdenum

A VERY few elements constitute all save a minute fraction of the material of which plants and animals are made; but the small residuum contains a considerable, even a large, number of elements, stored up and accumulated by the organism and so present in larger amount than in the surrounding medium. We all know that iodine, for example, is abundant in seaweeds though the amount present in sea-water is very small indeed; and molybdenum is another element in much the same case. M. Eugène Cornec, several years ago, demonstrated the spectrum of molybdenum and of no less than seventeen other metals besides in the ash of seaweeds; and now I have succeeded in separating and estimating the molybdenum present in various plants and animals.

I happened to be analysing a certain coal-ash, and found traces in it of a metal the sulphide of which was soluble in sodium sulphide; by working on large quantities I was able to isolate enough of this metal for identification, and it proved to be molybdenum. One kilogram of coal was found to contain 0·21 mgm. of the metal, or 21 parts in a hundred million. I then began to look for molybdenum in all sorts of plants and vegetable products, and always found it, though the quantities were always small. The largest amount was found in beans and peas, namely, 3 to 9 mgm. per kilo; cereals come next in order, with 0·2 to 0·6 mgm.; while wood, leaves, and various fruits and vegetables contain only minute traces cucumbers, for example, with 0·01 mgm. per kilo. Demarçay[1] had already demonstrated molybdenum in wood-ash, spectroscopically; my own method is a colorimetric one, based on the orange colour exhibited when a sulphomolybdate is heated in solution with ammonium chloride.

Ordinary plants must draw their supply of molybdenum from the earth, and accordingly I began to search for this element in various samples of soil; in a fertile soil I found from 0·1 to 0·3 mgm., on a moor I found 0·01, and on a barren sandy waste only 0·005 mgm. per kilo. I next analysed a number of mineral waters; but the only one (out of nineteen different samples) which contained an appreciable amount of molybdenum was the Source Perrière of La Bourboule, which contained 0·13 mgm. per litre. Mineral oils were found to contain molybdenum, sometimes in large quantity; the least amount was found in Persian crude oil, namely, 0·013 mgm., the largest in Mexican crude, which yielded no less than 5·55 mgm. per kilo. I then proceeded to look for molybdenum in the tissues of man and animals. The largest amounts I found in liver, and in the milt: for example, 1·5 mgm. per kilo, in the liver of ox or pig; while much smaller quantities, from 0·14 to 0·03 mgm. per kilo were to be found in blood, bile, milk, eggs and sundry tissues. Cod's liver contained 0·12 mgm. while haddock (whole fish) contained 0·03 mgm. per kilo; but in contrast to this I was unable even to detect molybdenum in a sample of forty litres of sea-water.

A relatively large quantity of molybdenum is contained in *Azolla*, a little aquatic plant which has become very abundant on the smaller canals in the neighbourhood of Delft. 264 gm. of the dried plant gave 0·298 mgm. of molybdenum, or 1·13 mgm. per kilo; and another sample, of 226 gm., gave 1·12 mgm. per kilo. On the other hand, the amount of molybdenum present in the canal water was very small indeed; it was necessary to operate on 23 litres before a titration could be made; and the amount obtained was only 0·021 mgm., or 0·0009 mgm. per litre. *Azolla* is remarkable for having a minute alga, *Anabæna Azollæ*, living in symbiosis in its tissues, and this alga is believed to be capable of fixing atmospheric nitrogen. Now H. Bortels[2] has made the interesting discovery that a certain microbe, *Azotobacter chroococcum*, which also possesses the power of fixing atmospheric nitrogen, is dependent for its healthy growth on the presence of molybdenum; and one begins to wonder what part the metal plays in *Azolla* and its symbiotic *Anabæna*. It has not been possible to separate these two symbiotic plants for purposes of analysis; and the amount of molybdenum which I have ascribed to *Azolla* is that of the two plants in their normal association.

H. TER MEULEN.

Delft.

[1] *C.R. Acad. Sci.*, **130**, 91; 1900.
[2] *Arch. Mikrobiol.*, **1**, 333; 1930.