to this question. They look as if they were outgrowths from the margins of the carpellary leaf, and I should probably have considered them to be so were it not for certain appearances in the ovules to which I proceed now to allude. In the free carpels, in the flowers I examined, no ovules were apparent, but only the petaloid plates just described; but in those cases where the carpels were combined into a trilocular ovary, the ovules were present on each side of the ventral suture, not indeed in a perfect condition, but in a more or less abortive state, consisting merely of a funicle and an irregular plate of cellular tissue more or less blue in colour, the only representative of the coats of the ovule, while the nucellus, so far as I could see, was entirely wanting. Still, the general appearance was that of imperfectly developed, pendulous, anatropal ovules.

Petalody, and especially phyllody, of the ovules is not a very uncommon phenomenon among Dicotyledons, and their peculiarities have been discussed at length in numerous classical treatises, to which it is not necessary here to refer. The corresponding changes in the ovules of Monocotyledons must be very much less frequent. There are none recorded in my "Vegetable Teratology," in which I endeavoured to render the bibliographical notices as complete as possible up to the time of publication, and there are none that I have hitherto been able to find in any subsequently issued publication. It is quite certain then that ovular changes must be of extremely rare occurrence in Monocotyledons. Another point remains to be mentioned—the ovules or their abortive representatives were decidedly pendulous from the ventral suture, but in the same carpel it often happened that two flat, tongue-shaped, petaloid processes projected one on each side vertically upwards from the base of the ventral suture, but quite free from it above their point of origin. These may be the representatives of ovules in spite of their different direction, for a different position of the ovules in the same carpel is by no means an uncommon circumstance, though I am not aware that it has ever been observed in *Dianella*. Naturally one is disposed to connect them with the petaloid plates projecting from the placenta above described; but unfortunately I was unable to find any intermediate condition between the petal-like plates attached to the placenta for its whole length and those which arose from the base of the carpel free throughout their entire length. It is to be hoped that this variety may have been introduced into our conservatories, where, independently of the opportunity for more complete investigation that would thus be afforded, it would be welcomed for the brilliancy of its masses of flowers.

MAXWELL T. MASTERS

MUSICAL SCALES OF VARIOUS NATIONS[1]

AT the Society of Arts yesterday, Sir F. Abel, C.B., F.R.S., Chairman of the Council, in the chair, Mr. Alexander J. Ellis, F.R.S., read a paper on "The Musical Scales of Various Nations," illustrated by playing the scales on his Dichord (a double Monochord, corrected so as to give the true intervals) and five English concertinas, specially tuned by Messrs. Lachenal, which also enabled him to play strains in some of the scales, and by various native instruments lent for the purpose by Rajah Ram Pal Singh, Mr. A. J. Hipkins, and Mons. V. Mahillon. The nations represented were chiefly those of ancient Greece, Arabia, India, Java, China, and Japan, with rapid glances at subordinate places. The relation to his former paper on the. History of Musical Pitch was this, that whereas that paper gave the variations in the pitch of the European tuning note, the present endeavoured to discover the system by which different nations tuned. This was obtained when possible by theory, taking as authorities Prof. Helmholtz for ancient Greece; Prof. J. P. N. Land, of Leyden, for Arabia and Persia, and Rajah Sourindro Mohun Tagore for India. When theory was not possible, results were obtained by measuring with his series of 100 tuning-forks the pitch of the notes produced by instruments of fixed tones (as the wood and metal bar harmonicons in Java and elsewhere), or those produced by native players on other instruments (as by Rajah Ram Pal Singh for India, the musicians of the Chinese Court of the Health Exhibition, and of the Japanese village). In obtaining these pitches Mr. Ellis was materially aided by the delicate ear of Mr. A. J. Hipkins, who most kindly cooperated with him in every way. From the pitches thus obtained, the intervals were expressed in hundredths of an equal Semitone (for brevity called cents) of which 1200 make an Octave, 702 a perfect Fifth, 498 a perfect Fourth, 386 and 316 perfect major and minor Thirds. Then these were plotted down on the movable fingerboards of the Dichord, and the scales were made audible. Occasionally forks were constructed of the pitch observed, and from them concertinas were constructed, and thus the most unusual intervals were reproduced to the ear, and their exact relation to those on a well-tuned piano rendered sensible to the eye. After rapidly exhibiting the ancient and later Greek scales, Mr. Ellis turned to Arabia, for which Prof. Land had furnished the data in his *Gamme Arabe* read before the Oriental Congress at Leyden. This showed first the Pythagorean scale, and then its modification by the lutist Zalzal, 1000 years ago, whereby a fret was introduced between those for E flat, 294 cents, and E, 408 cents (supposing the open string to be C), producing the neutral Third of 355 cents, so that the scale became C 0, D 204, E neutral 355, F 498 cents, followed by the same a Fourth higher, and by a whole tone. This was the system prevalent at the time of the Crusaders, who seem to have brought it to Europe in the shape of the bagpipe, and it is still preserved on good highland bagpipes (as those of Glen and Macdonald) as was proved by taking the scale of one kindly played by Mr. C. Keene, the artist. After the time of the Crusades, Arab theorists, scandalised at giving up the series of Fourths to produce the neutral Thirds and Sixths, carried on the system of Fourths to 17 notes, using 384 and 882 cents for Zalzal's 355 and 853 cents, but preserving his name. So came about the mediæval Arabic system of 17 notes to the Octave, from which 12 scales were constructed, of which Mr. Ellis was able to play 10 on one of his concertinas. But Zalzal's system did not die out, and in 1849 Eli Smith, an American Missionary at Damascus, translated a treatise by Mesháqah, a learned contemporary musician, showing that it led to the division of the Octave into 24 Quarter-tones, with the normal scale of 0, 200, 350, 500, 700, 850, 1000, and 1200 cents, while the player was allowed, in certain cases, to increase or diminish the interval by 50 cents, or a Quarter-tone. Eli Smith gives 95 Arabic airs in this system, of which a few were played on a special concertina. The two important points of Arabic music were the introduction of the neutral Third and Sixth, and the variation of normal notes by a Quarter-tone, both thoroughly inharmonic.

In India the ancient scale was the same as our just major scale, with the exception of the Sixth, which was a comma sharper. Hence it had C 0, D 204, E 386, F 498, G 702, A 906, B 1088, C 1200 cents. But then the major Tones were considered to be divided into 4 degrees, the minor Tones into 3, and the Semitone into 2 degrees, and tones were depressed by 1, 2, or 3, and in one case F, raised by 2 or 3 degrees, and thus the 12 changing notes were produced, answering to our 5 chromatic notes, with 7 notes altered by a degree from them, equivalent to the similar process in the Arabic scale. In modern times the scale was simplified by dividing the distance C to F on the finger-board into 9 equal parts, and from F to *c* (the Octave) into 13 equal parts, and then dividing the 22 degrees among the notes thus: (where the figure before the note indicates the number of

[1] Contributed by the Author.

degrees, and the figures after it the number of cents in the interval from the lowest note, while the terms "very" flat and sharp are those used by Rajah S. M. Tagore, President of the Bengal Academy of Music):—1 C 0, 2 D very flat 49, 3 D flat 99, 4 not used, 5 D 204, 6 E very flat 259, 7 E flat 316, 8 E 374, 9 E sharp 435, 10 F 498, 11 not used, 12 F sharp 589, 13 F very sharp 637, 14 G 685, 15 A very flat 736, 16 A flat 737, 17 not used, 18 A 896, 19 B very flat 952, 20 B flat 1011, 21 B 1070, 22 B sharp 1135, and then followed the Octave of the first degree. Mr. Ellis then showed that 4 scales played to him by Rajah Ram Pal Singh corresponded with some of the 32 scales of 7 notes formed by selections from the above 19 (3 of the 22 degrees not being used). There are also 112 scales of 6 notes, and 160 of 5 notes, or 304 scales in all enumerated by Rajah S. M. Tagore. In addition to this the peculiarities of the 6 modes (*rágas*) and their numerous "wives" or modelets (*rágints*) had to be taken into consideration.

This Indian system, based on stringed instruments, is, however, quite different from that (if any) of the uncultivated tribes. For instance, a wood harmonicon from Patna gave the scale 0, 187, 356, 526, 673, 856, 985, 1222 cents, where the intervals of the Fourth, Fifth, and Octave were mistuned; but the neutral Third and Sixth, 356 and 856, were introduced.

After dealing with some more instruments of the same kind from Singapore, Burmah, Siam, and West Africa, Mr. Ellis proceeded to the scales which are mainly pentatonic, the most perfect of which are those of Java, which he had acquired from the band at the Aquarium in 1882, checked by the observations of Prof. Land and others on similar instruments in Holland. These scales are of two totally different kinds, called Salendro and Pelog. The ideal of the first seems to be the division of the Octave into five equal parts, giving the scale 0, 240, 480, 720, 960, 1200 cents., so that there is a flat Fourth, sharp Fifth, and almost perfect natural Seventh (960 for 969 cents). By playing pentatonic Scotch airs on a concertina thus tuned, Mr. Ellis showed that the scale gave perfectly recognisable results, and he then played some Javese airs reported by Raffles. In this scale no interval between successive notes was so small as a whole Tone, or so large as a minor Third, but approached a neutral 250 cents, which is constantly accepted as one or the other almost indifferently.

The second or Pelog scales have also five notes, but they are selected from a fund of 7, which (being numbered I. to VII.) have the following intervals from the lowest in cents:—I 0, II 137, III 446, IV 575, V 687, VI 820, VII 1098, I 1200. From these the annexed scales were formed:—

Pelog	0,	446,	575,	687,	1098,	1200 cents.
Dangsoe	0,	137,	687,	820,	1098,	1200 ,,
Bem	0,	137,	575,	687,	1098,	1200 ,,
Barang	0,	137,	575,	687,	820,	1200 ,,
Miring...	0,	446,	575,	820,	1098,	1200 ,,
Menjoera	0,	137,	446,	575,	1098,	1200 ,,

These numbers represent the intervals as determined from the pitches actually observed, and it is very improbable that they properly represent the ideal of the intervals, but they were actually used, and hence satisfied Javese ears. It is noticeable, in contradistinction to the Salendro scales, that the Fourth is sharp and the Fifth flat, that there are five intervals approximating to a Semitone (one being exactly a diatonic and another an equal Semitone), and that two intervals are nearly a minor Third, while the Tone proper does not occur. In the individual scales intervals between adjoining notes occur of over a Fourth, or at least a major Third. These two descriptions of pentatonic scales, therefore, quite refute the usual theories, and show that other feelings than those of successions of Fourths and Fifths must have been at work. Mr. Ellis played short strains (not native) to show the effect of these scales on airs.

The presence of Chinese musicians at the Health Exhibition enabled Mr. Ellis, with the aid of Mr. Hipkins, and the cooperation of the Commissioners of the Chinese Court, to take down the pitches of the notes played by natives on (1) the *Ti-tsu*, or transverse flute; (2) the *So-na*, or oboe; (3) the *Sheng*, or mouth organ; (4) the *Yün-lo*, or set of 10 small gongs on a frame; (5) the *Yang-chin*, or dulcimer; (6) the *Tien-tsu*, or tamboura; (7) the *P'ip'a*, or balloon guitar. These scales were very diverse. Probably by different blowing and half covering the holes, 1 and 2 were much altered and could play together, but the scales noted were incompatible. Nos. 1, 2, 3, 4, 5 had all scales of 7 notes, though it was more usual to leave out two notes and play only 5. On 6 and 7 pentatonic scales only were played to them. Nos. 5 and 6 were tuned in their presence. No. 5 was supposed to follow what is given as the scale in Williams's Middle Kingdom, but must have been badly tuned. The following gives the transcription of the Chinese names followed by the cents in the interval from the lowest note; the notes marked * were omitted when only five notes were used:—*Ho* 0, *sz'* 169, **i* 274, *chang* 491, *ché* 661, *kung* 878, **fan* 996, *liu* 1200, which may possibly represent the scale of B flat major, begun on its second note, thus C 0, D 182, *E flat 294, F 498, G 680, A 884, *B flat 996, C 1200. Also the scale played on No. 6, if begun on its Fifth, seemed to be the same. This is the only instance Mr. Ellis met with where two scales were approximately the same. No. 6 has no frets, and hence any intervals were practicable upon it. None of the instruments used equal temperament.

The principal scales of Japan are pentatonic, but they have a means of sharpening notes on the *Koto* by pressure on the strings, thus producing more notes. The "classical" music came from China. The "popular" seems to be indigenous. In this case, in the *hiradio-shi* tuning of the *Koto* (the principal national instrument), both Mr. Ellis's authorities (Mr. S. Isawa, Director of the Institute of Music at Tokio, Japan, and a Japanese at present studying physics in Europe) agree that the intention is, given the note of the 1st and 5th strings in unison, to tune the 2nd a Fifth below it, and the 3rd a Fourth below it. As to the 4th they disagree. Mr. Isawa thinks it was tuned a major Third below, the other thinks his countrymen do not know a major Third, but only tune the 4th string by "a sort of instinct" as "a sort of" Semitone above the 3rd, in which case the interval between the 3rd and 4th will also be "a sort of" major Third, and the Fourth, from the 3rd to the 5th string, will be approximatively divided into a Semitone and a major Third, which is, singularly enough, the oldest Greek tetrachord of Olympos, possibly tuned by a similar "instinct." Then the Fourth, from the 5th to the 7th string, would be similarly divided by the 6th string. Hence, taking the 1st and 5th strings as E, we have 1 E, 2 A, 3 B, 4 C, 5 E, 6 F, 7 *a*, approximatively. Mr. Buhicrosan, of the "Japanese Village," Knightsbridge, kindly allowed Mr. Hipkins and Mr. Ellis to take the method of tuning *hiradio-shi* from one of his female musicians and her music-master. Writing the number of cents in the intervals between the strings, the following was the result:—

Theory ...	II 204	III 112	IV 386	V 112	VI 386	VII
Female ...	193	164	362	82	399	
Master ...	185	152	346	107	410	

The differences seem to bear out the other's views, and are an instructive lesson in the inaccuracies of most Asiatic tuning. Mr. Isawa identifies the intentional Japanese twelve pitch-notes with the twelve notes of our equally tempered scale, and the other says that if Japanese music is played on a piano no Japanese ear will be offended. Practically, however, the scale is more like any badly tuned piano, differing probably from performer to performer, and, as shown by the above comparison, often out by a quarter of a Tone.

Mr. Ellis's conclusion was that there is not anything approaching to a single "natural" music scale. That, on the contrary, the systems, where systems can be said to exist, are very diverse, and often very capricious, and are always very imperfectly carried out. This arises probably from harmony proper being unknown, though *ensemble* playing is common. In the latter case unisons are the rule, the effect being produced by diversity of quality of tone; but certain effects are produced by admitting Octaves, and rarely Fourths and Fifths—no more. Also a kind of polyphony may be remarked, some instruments, especially those with tones of very short duration, being allowed to *discant* while the others go on with the air.

On the whole, Mr. Ellis considers his work has only commenced an investigation which will have to be pursued for many years, principally by physicists with a slight knowledge of music, not by European musicians, whose thoughts are biassed by the system of music in which they are accustomed to think.

NOTES

THE Anniversary Meeting of the Chemical Society will be held on Monday, March 30.

THE Mercers' Company have made a contribution of 52*l.* 10*s.* to the fund on behalf of the family of the late Henry Watts, F.R.S.

WE are glad to see from the recent letter of Sir Spencer Robinson, in the *Times*, that the Admiralty are at last taking to experiment to decide the question as to the best form of war-ship. This is as it should be, and we hope the Admiralty will continue their experiments until they have obtained a solid scientific principle to guide them.

OUR readers may be interested in the following remarkable and well-authenticated instance of the effect of atmospheric influences in varying the distance at which lights are visible at night, communicated to us by a correspondent. The paragraph is taken from the *Aberdeen Journal* of March 21. The steamship referred to was on her weekly voyage from London to Aberdeen, being one of a well-known line of passenger steamers trading within these ports. "*Singular Phenomenon.*—Capt. Marchant, of the s.s. *City of Aberdeen*, reports that owing to the peculiar condition of the atmosphere yesterday morning he saw, quite clear and bright, the Girdleness Light (Aberdeen Bay) at 1 a.m., when his vessel was a little to the south of Montrose, a distance of over thirty-six miles, and when two miles north of Stonehaven he could distinctly see the Buchanness Light (about twenty miles north of Aberdeen and three miles south of Peterhead), at a distance of fully thirty-two miles. The lights are laid down on the Admiralty chart as visible at nineteen and seventeen miles respectively."

THE half-yearly general meeting of the Scottish Meteorological Society was held on March 23. The business before the meeting was:—Report from the Council of the Society; Report of the work of the Scottish Marine Station, by the Scientific Staff of the Station; Anemometrical observations at Dundee, by David Cunningham, C.E., Harbour Chambers, Dundee; Diagram to facilitate hygrometric calculations, by David Cunningham, C.E.; Formation of snow crystals from fog, by R. T. Omond, Superintendent of Ben Nevis Observatory; Meteorology of Ben Nevis, to February 1885, by Alexander Buchan, Secretary.

A TELEGRAM from Fort William reports that the Rev. John M'Kintosh, Free Church minister, and Mr. Colin Livingstone, of Fort William, made the ascent of Ben Nevis on Monday. The weather was fine, but, owing to the quantity of snow on the higher part of the mountain, footing in some parts was obtained with considerable difficulty. This was particularly the case for about 1200 feet above the Red Burn, and crossing steps had frequently to be cut in the frozen snow. The occupants of the observatory at the top of Ben Nevis were found in excellent health and spirits. The buildings, with the exception of the chimneys and tower, are buried in the snow, access to the rooms being obtained through the tower by means of a ladder. But, once reached, the rooms are very comfortable. The junior assistant was found amusing himself with a kind of raft, which was carried over the snow by means of a sail.

AT a special meeting of the Institution of Mechanical Engineers, held on the 20th inst., was read, amongst other papers, one by Mr. R. Heenan on the Tower spherical engine. As its name betokens, it consists of a system of parts contained within a sphere, so united as to enable them under the action of steam pressure to impart rotatory motion to a shaft. Considered kinematically, the three elementary moving parts of which the engine is composed are: a pair of quarter spheres, having a circular disk of the same diameter as the sphere interposed between them. The straight edges of the spherical sectors are hinged on opposite sides of the disks along diameters at right angles to each other. Each sector rotates upon an axis of its own, upon which it is fixed symmetrically; these two axes lie in the same plane, meeting in the centre of the disk at an angle of 135°. The two sectors thus correspond with the two bows of an ordinary universal joint, the disks replacing the crosspiece connecting the bows. Throughout each revolution there are consequently two cavities simultaneously in process of opening and two others in process of closing, all four alike changing at the same mean rate of increase and diminution. If, therefore, the disk with its pair of sectors be encased within a hollow sphere of the same diameter, and, if steam be admitted into the two opening cavities, and exhausted from the two that are closing, continuous rotatory motion will be produced, driving the two shafts represented by the axes of the two sectors. When one of the two opening chambers is only just commencing to open, the other is half open; so that, while the one is making no effort, the other is in the position of best effort. Although the whole of the engine may be said to be contained within the sphere, it is an interesting feature in the system that the capacity of the engine is no other than the full capacity of the sphere itself, inasmuch as four quarters of the sphere are filled and emptied in one revolution. The Tower spherical engines have been used for the electric lighting of trains on the Great Eastern Railway; they have continued running since October 26, 1884, with perfectly satisfactory results. The engine is coupled directly to a dynamo specially made, the two being together on one bed-plate. The whole is mounted on the top of the locomotive-boiler behind the dome, so that it occupies no space on the foot-plate, and the steam can be taken direct from the dome. The construction of the engine was illustrated by means of twenty-six diagrams.

WE have received the Report of the City and Guilds of London Institute for Technical Education for the past year.

M. ALBERT GAUDRY, Professor of Palæontology in the Museum of Natural History, has reproduced as a pamphlet a note read by him before the Academy of Sciences on the new gallery of Palæontology added to the Paris Natural History Museum. This is a provisional gallery for the large skeletons of fossil animals; but M. Gaudry has the vision of a far more perfect and elaborate gallery before his eyes. The new gallery,