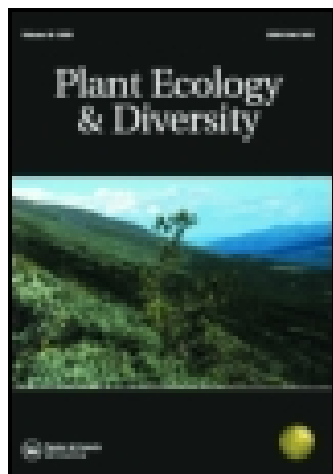


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Transactions of the Botanical Society of Edinburgh

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tped18>

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Published online: 01 Dec 2010.

To cite this article: Professor Balfour (1860) II. Notice of the Palm-House in the Royal Botanic Garden at Edinburgh , Transactions of the Botanical Society of Edinburgh, 6:1-4, 128-136, DOI: [10.1080/03746606009467714](https://doi.org/10.1080/03746606009467714)

To link to this article: <http://dx.doi.org/10.1080/03746606009467714>

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him an undying reputation remains, which must increase as long as the great science of life is studied and understood.

II. *Notice of the Palm-House in the Royal Botanic Garden at Edinburgh.* By PROFESSOR BALFOUR.

The Botanic Garden has always had a most important connection with the University of Edinburgh, although it does not form a part of that institution. In all stages of its existence, whether as the Physic Garden in the centre of the city, or in its position at Leith Walk, or in its present site, it has been associated with the Chair of Botany, and the University course of lectures has been conducted more or less completely within its precincts. Thus, from the time of its foundation, in 1670, up to the present day, the garden has contributed, in no small degree, to the cause of botanical education. The value of the instruction in botany, given in this University, has thus been materially enhanced. The student has facilities of becoming practically acquainted with plants which are not afforded by any other school in Britain. And it is satisfactory to know, that from the Edinburgh University there have been sent forth men who have occupied most distinguished positions in the botanical world in this and in other countries; and that, at the present moment, applications are often made to us for medical men to fill the situation of botanists and naturalists in scientific expeditions. Dr Balfour Baikie, who is now conducting so successfully the Niger expedition; Dr John Kirk, who is associated with Livingstone in the exploration of Central Africa; and Dr Hector, who acts as naturalist in Palliser's North American expedition, are all distinguished botanical students and graduates of this University. Much of our scientific fame is thus necessarily connected with our excellent garden.

In its early condition there do not appear to have been any houses for the cultivation of plants from hot climates. In the Catalogue published by Sutherland in the year 1683 no notice is taken of such plants. Such houses were, however, subsequently added, more particularly when the garden was removed to Leith Walk.

In a description of the garden at Leith Walk, it is stated

that the soil was light, either sandy or gravelly. In the centre of the garden, a spring of water was formed into a basin. In the east division there was a systematic arrangement of plants. On each side of this area were placed officinal plants, with trees and shrubs. This division contained about 2000 species. In the west division there was a collection of tender plants and of hardy trees properly arranged. The conservatories formed a front of 140 feet, consisting of a greenhouse in the centre, and a hothouse at each end. They were said to be too small for the collection in 1788.

Among the plants mentioned as deserving attention were *Illicium anisatum*, the star anise; *Musa sapientum*, the banana, which produced ripe fruit; a number of Abyssinian plants, and the moving plant of India (*Burru chundalli*). All these required the protection of hothouses. The extent of glass houses, however, was not great, and there was no house for the cultivation of large palms and the loftier exotics of warm countries.

When the present site was occupied by the garden in the year 1820, Dr Graham, my predecessor in the chair of botany, persuaded the government to increase the hothouse accommodation. A considerable sum was expended on the erection of suitable buildings, and from time to time additions were made.

In 1834 a large palm-house was added, which cost about L.1500. It was intended at first that this building should occupy the vacant space in the centre of the front range, but from a fear that it would encroach too much on the present walk, and might possibly cast too great a shade on the contiguous houses, a site was chosen for it behind the buildings then in existence. Here a house of an octagonal form was erected; the length from east to west, and from north to south, being nearly 60 feet. The sides are 27 feet high, formed of stone pillars set upon a continuous base, and connected at the top with stone lintels, the spaces between the pillars being filled up with glazed wooden sashes. The roof, which is of wooden rafters, is covered with glazed sashes, and is of a conical form, rising to the height of 20 feet above the sides, making in all a height of 47 feet from the floor to the apex of the roof.

At the time of its construction, it was, I believe, the largest palm-house in the kingdom. The heating was at first effected partly by steam and partly by hot water. Subsequently, however, hot water alone was used. There were two cast-iron boilers, with distinct arrangements of cast-iron pipes attached to each, so that one or both might be used as required. The boilers and pipes were renewed about the years 1847-48. This palm-house was found to be admirably fitted for the growth of palms, and, under the judicious management of Mr William M'Nab, it acquired great celebrity. The plan of construction was found so successful, that it has been followed by Mr Matheson in the recent magnificent addition to the building.

In course of time the palms outgrew the house. Several of them, such as *Caryota urens* and *Sagus Rumphii*, sent their leaves through the roof; and a noble specimen of the former, about 41 feet high, had to be turned out into the open ground, where it was an object of interest during the meeting of the British Association in August 1852, and astonished a famous Italian Professor of Botany (Parlatore), who, not knowing the history of its transplantation, was led at first to entertain a very favourable impression of the warmth of our climate. The palm of course died as the cold weather of October approached. Other palms in the house were materially injured by overcrowding. Among them might be noticed particularly *Acrocomia aculeata*, *Livistona chinensis*, and *Sabal umbraculifera*. These circumstances led me to apply for an addition to the palm-house, and, after a series of representations to the Commissioners of Woods and Forests, more particularly to Sir William Molesworth and Sir Benjamin Hall, aided by an excellent photograph by Dr James Duncan, portraying the mode in which the palms sent their leaves for many feet through the roof, I at length succeeded in getting a sum of L.6000 voted by Parliament in 1855 for this purpose.

After some delay in regard to contracts, &c., the building was commenced in May 1856, and was completed in about two years.

The new palm-house is situated to the west of the old one, with which it communicates by the removal of one of

the sides of the octagon, thus making the two to appear as one building, and facilitating much the transmission of the plants. The new house is substantially built of beautiful sandstone from a quarry at Bishopbriggs, near Glasgow, and the roof is formed of curvilinear iron rafters. The advantage of having much solid masonry is great, and was strongly advocated by the late Mr M'Nab, than whom none was more successful in palm cultivation. This mode of cultivation is preferable to the plan of using iron and glass almost entirely. The solid masonry prevents rapid cooling in this variable climate; it retains the heat better, and it gives a certain amount of shade, which is very important in the growth of palms, more especially of such as are social. Moreover, the effect is much more imposing. Too great sun-light in a palm-house appears to be prejudicial, and hence the western exposure of the front of the present palm-house has some advantages, by enabling us more easily to screen the plants from intense light.

The sandy nature of the soil required that the foundation should be laid on two feet of concrete. The laying of this was attended with some difficulty, owing to the vast quantity of water which poured in on all sides. Above the concrete, there is placed six feet of underground solid masonry. This is succeeded by solidly-built stone pillars 4 feet 4 inches in breadth, separated by arched windows 8 feet 8 inches wide and $22\frac{1}{2}$ feet high. There are about 35 feet of iron-work above the stone building.

The building has the form of a parallelogram, its length on the west side, or the front from north to south, being 100 feet over the foundation, 96 feet 6 inches over the walls, and about 90 feet within the walls; its width from east to west, 57 feet, and its height 70 feet 6 inches. The total length from the west side of the new palm-house to the east side of the old one, is nearly 120 feet.

The sides of our new palm-house form an arcade 35 feet high all round, set upon a continuous base, having the outside face relieved by pilasters and entablature of the Tuscan order—the arches being filled in with glazed cast-iron frames. The roof, which is of cast-iron rafters and glazed sashes, forms a dome of two stages, each about $17\frac{1}{2}$ feet high—the lower one rising from the top of the sides to

half the height of the roof, where a base is formed for the upper one. The glass of the roof is sheet-glass, twenty-one ounces to the foot.

Galleries are provided at the base of each of the domes for convenience of access in case of repairs, and the accumulation of snow or ice. Inside there is a series of fourteen light cast-iron pillars placed at a distance of 12 feet from the side, forming a rest for the top of the lower dome, and for the base of the upper one. One gallery is projected from the sides by cast-iron brackets, at the height of 35 feet from the floor, to which the public have access by two cast-iron spiral staircases. Another gallery is formed at the base of the upper dome, 51 feet from the floor. A stone stage, 2 feet high, is formed round the sides, and another, at 4 feet distance inside, for the smaller palms, leaving the entire centre area for the larger ones. During the present session of Parliament L.1000 have been voted for the removal of the wooden roof of the old palm-house, and the substitution of an iron one. This will complete the arrangements for the present.

The ventilation is effected by the lowest centre panes in each of the sashes of the side arches being made to open, and three large valves are placed at the top of the roof, which, being opened, produce a general upward current. When more air is required, it is obtained by opening certain of the upright compartments at the base of the upper dome. The heating is by hot water, supplied by four cast-iron flued saddle-boilers, on an improved principle, suggested by Mr M'Nab. These boilers are connected with 1316 feet of 5-inch bore cast-iron pipes. Two of the boilers are connected with pipes which pass round the whole house, one set of pipes going to the right and the other to the left. The other two boilers are connected with pipes which go to the centre of the building in the first instance, and then return by the outside, the pipes connected with each thus passing round half of the building. By this means, provision is made for increasing and diminishing the heat as may be required.

The building has cost L.6500. It was opened on 1st April 1858, and the palms were transferred to it and arranged by Mr M'Nab by the 30th April. This was a great feat,

when we consider that the greater part of the palms had been re-tubbed; and some of the specimens, such as *Livistona chinensis* and *Sabal umbraculifera*, weighed, with the earth at the roots, from seven to eight tons. They have been all successfully placed, and the effect of the whole is such as to give one a good idea of tropical vegetation. The tubs used are large round ones, which are more convenient, and have a better effect to the eye than the square ones previously used. Some of the tubs are 22½ feet in circumference.*

The construction of the house enables one to see the palms in all directions, both from below and from above. On the outside of the upper dome there is a gallery where a fine view is obtained of Edinburgh and the country around it, extending from the Pentland Hills on the west, to North Berwick Law and the Isle of May on the east, and including also a view of Fife and Stirlingshire, of the Ochils, and of some of the Highland hills.

The building does great credit to Mr Matheson of Her Majesty's Works, who planned it. The mason-work has been most substantially built by Messrs Beattie, and the iron-work is highly creditable to the Shotts' Company.

We are certainly much indebted to Sir Benjamin Hall, late Chief Commissioner of Works, for the deep interest which he took in the building, and for the strenuous support which he gave on all occasions. He visited the building several times during its construction, and at all times showed a desire to promote botanical instruction.

* Mr McNab states that, among the numerous adventures attending the removal of the palms to their new abode, one circumstance ought to be recorded, viz., the perilous task of cutting the top off the *Caryota urens*, which had to be done before it could be removed from the high lantern part of the roof of the old house. William Bell, one of the journeyman gardeners, volunteered the task, and accomplished it with safety. The glass was broken on the outside, and the top removed with a saw.

Mr McNab also gives the following details as to the operations connected with the Palm House:—

1856.	1857.
April 8. New Palm House staked off.	July 3. Last rib put up.
„ 22. Commenced taking out foundations.	Sept. 9. Glazing commenced.
May 13. Commenced concrete and building foundations.	Nov. 17. Glazing completed.
Nov. — Finished stone-work of House.	„ 18. Hot-water pipes commenced.
1857.	1858.
April 9. Commenced to erect iron pillars.	Jan. 29. Hot-water pipes finished and tried.
April 17. First rib put up.	April 1. Commenced removing plants.
	„ 30. Completed the removal.

The following is a list of some of the palms which have flowered in the Botanic Garden :—

<i>Caryota urens.</i>	<i>Chamærops Palmetto.</i>
<i>C. sobolifera.</i>	<i>Chamædorea Schiediana.</i>
<i>Seaforthia elegans.</i>	<i>C. Hartwegii.</i>
<i>Euterpe montana.</i>	<i>C. coronata.</i>
<i>Sabal umbraculifera.</i>	<i>Rhapis flabelliformis.</i>
<i>Harina caryotoides.</i>	<i>Calamus Wightii.</i>
<i>Chamærops humilis.</i>	<i>Areca triandra.</i>
— var. <i>arborescens.</i>	<i>Desmoncus elongatus.</i>

The following are the heights of some of the present palms :—

	Feet.		Feet.
<i>Livistona chinensis,</i>	43	<i>Plectocomia elongata,</i>	38
<i>Sagus Rumphii,</i>	43	<i>Seaforthia elegans,</i>	26
<i>Caryota urens,</i>	42	<i>Corypha australis,</i>	23
<i>Euterpe montana,</i>	38	<i>Phoenix sylvestris,</i>	20
<i>Acrocomia aculeata,</i>	37	<i>Elais guineënsis,</i>	22
<i>Sabal umbraculifera,</i>	30	<i>Phoenix dactylifera,</i>	21

The above heights include the depth of the tubs.

The following account of the mode of re-tubbing the palms has been supplied by Mr James M'Nab :—

In the January number of the *Scottish Gardener* for 1856, I gave a detailed account, accompanied by wood-cuts, of the method which had been practised in the re-tubbing of the palms, and other large exotic trees, in the old Palm-House of the Botanic Garden.

Previous to removing the plants from the old to the new house, nearly all of the large plants had to be re-tubbed ; two of these, *Livistona chinensis* and *Sabal umbraculifera*, grew in large square oak boxes without bottoms, each 4 feet 6 inches in diameter, and 4 feet 3 inches deep ; in these boxes they had existed for the last eighteen years. The *Livistona* has a stem 6 feet in circumference at base, and 42 feet high. The *Sabal* has a stem 5 feet 6 inches in circumference at the base, with a globular-shaped top 28 feet in diameter. Owing to their enormous weight, it was found impossible to re-tub these two plants on the plan previously adopted here, and minutely described in the *Scottish Gardener*. The method practised with the two above-named plants was as follows :—Three small mines or borings were

forced under the bottom of the plants on the surface of the stone floor, one in the middle, and two others equidistant between the centre and the ends; each of these mines were made large enough to introduce a rope $1\frac{1}{4}$ inch in diameter. After the three ropes were passed through, a portion of the bottom, 10 inches broad at each side, was undermined, and strong oak staves introduced, sufficiently long to catch under the bottom of the box at each end; these oak planks were placed to prevent the ropes cutting the ball during the process of lifting; two flat iron plates were then laid parallel with the lifting ropes, and resting on the ends of the oak planks, and also beneath the edge of the old oak box which contained the plant, the ends of the iron plates were then racked together by means of ropes. Three long Norway poles were tightly fixed on the stem in a tripod form, in order to support the tree during the process of raising.

As it was found impossible to raise the mass (consisting of six or seven tons) sufficiently high to pass a tub underneath, the following method was adopted, and with perfect success:—After the new tubes (formed of double-strong oak) had been prepared, each 26 feet in circumference and 5 feet deep, they were taken down into four pieces, first fixing in a temporary way portions of hoops both inside and outside, for the purpose of keeping the staves together. Two strong malleable iron rollers, resting in greased cradles, fixed on two strong wooden tresses, 6 feet high, were placed round the plant, and the six ends of the ropes, which were previously introduced under the plant, were now brought up and fixed round the rollers. The plant was then wound up by means of strong handspikes. This heavy and important part of the operation was accomplished by eighteen men; a man was also placed at each of the three tripod poles, to prevent them, by means of a moveable wedge, from slipping back; three guy-ropes were fixed to stationary blocks intermediate between the tripod poles. The under surface of the bottom of the tub having been previously prepared with fixed battens, and raised on small temporary iron rollers, was run beneath the plant when raised, and all the hoops introduced at the same time, with the exception of the smallest or under one. Charred pieces of battens were laid on the surface of the bottom parallel with the lifting ropes, taking

care to keep open spaces, so as to allow the ropes to be easily withdrawn. The plant was then lowered, the old sides and superfluous trappings removed, the new tub put round, taking care that the bottoms of the staves were inserted properly into the groove; the iron hoops were then driven up, the lower hoop previously kept out was cut, and the ends prepared, so as to be drawn together by means of a screw; drainage was then inserted, and the tubs finally filled up with soil.

The method here noticed for the re-tubbing of the two large plants was also practised on all the others, where the ball of roots was too large to raise high enough with safety to enable the new tubs to be run under. In these cases the drainage was put into shallow tubs 8 and 10 inches deep, placed on the centre of the bottom, the plants were lowered upon it, and the vacant spaces filled up with drainage after the sides had been put together.

III. *Notice of an Excursion along the Line of the Roman Wall from Chollerford to Wall-Town Crags.* By MR JOHN SADLER.

The author gave a general description of the Roman Wall and its principal camps, observed on the way from Newcastle to Carlisle, and noticed the following plants which he found on the Wall:—*Trollius europæus*, *Draba verna*, *β. inflata*, *Teesdalia nudicaulis*, *Helianthemum vulgare*, *Viola lutea*, *Drosera anglica* and *rotundifolia*, *Polygala vulgaris*, *Genista anglica*, *Lonicera Xylostium*, *Valeriana dioica*, *Antennaria dioica*, *Carduus heterophyllus*, *Erica cinerea* and *Tetralix*, *Vaccinium Myrtillus*, *V. Oxycoccus*, *V. uliginosum* and *V. Vitis-Idea*, *Menyanthes trifoliata*, *Digitalis purpurea*, *Pinguicula vulgaris*, *Utricularia minor*, *Lysimachia nemorum*, *Empetrum nigrum*, *Habenaria albida* and *H. bifolia*, *Allium schænoprasum*,—a plant which was probably cultivated by the Romans, —*Endymion nutans*, *Athyrium Filix-femina*, *Blechnum boreale*, *Botrychium Lunaria*, *Cystopteris fragilis*, *Lastrea Oreopteris*, *Polypodium Dryopteris* and *P. Phegopteris*, *Lycopodium clavatum* and *L. Selago*, &c.