Leeds. Oct. 16. 1891

Dear Darwin

I continue memoranda on Nymphaeaceae.

II. Nymphaea alba (Kildwick Hall, July 30; Kew, Sept. 1891)

Having noticed that the leaf of N. alba is usually a little upturned at the edge, it occurred to me to try whether the rim was of use in freeing the leaf of water. I cut the rim away from several leaves, but found that they freed themselves quite as well as before. I have since thought that the raised rim may be a slight indication of the feature so prominent in Victoria, & that it might tend to prevent leaves from gliding one over another. It certainly does not effectually prevent such accidents, which are frequent with N. alba, Nuphar, &c. in crowded situations.

The basal cleft in this & other Nymphaeas is an important feature. When the leaf is draining itself there is a steady outflow by the cleft.

When the leaves of N. alba turn yellow, they are unable to free themselves of water. This looks as if the surface were affected by age or diminished vigour. I could not by mere inspection discover that the quantity of air in the leaf or leaf-stalk was diminished, but will observe this point again, taking leaves which are far gone in decline.

Leaves well rubbed with cotton wool did not lose any of their power of repelling water.

In shallow tanks the leaves, when they become crowded, push out of the water altogether. Such leaves are often very vigorous, & no doubt discharge their function as well as the floating ones. It would be useful to study the degree of development of the vascular bundles in such leaves, possibly too the distribution of the stomata. Nuphar & very likely other water-lilies behave in the same way.

III. Nymphæa lotus, var. dentata, & other species with frilled margins (N. stellata,

N. gigantea, N. Ortgiesiana, &c)

The leaves of these species are, so far as I have seen, a good deal larger than those of N. alba. The central part is stiffened by prominent veins, the margin flexible (more so than in N. alba).

Thinking that the frilled edge might be a means of getting rid of water, I submerged a large number of leaves. The pointed teeth nearly always came up first & freed themselves, then the water receded along the radiating ridges & escaped into the hollows, flowing away by the basal cleft. Now & then a leaf was found in which some prominence towards the centre emerged first, but the general result was the same.

I then made a circular wooden plate, 8 in. in diameter. One side was plane, the other divided into 16 radiating ridges with sloping sides. When the plate was thrown into water, & allowed to come up with the plane side uppermost, it brought up a pool of water, which remained

on it, till it sunk in or evaporated. But when the ridged side came uppermost, the water drained off immediately.

I have not been able to think of a good test for the explanation offered. To cut off the margin of a frilled leaf & thus get rid of the folds, would alter the conditions materially, reducing the surface & especially removing the thin flexible margin, which is probably the part most difficult to free. In other words, cutting off the margin would at the same time diminish both the difficulty & the means of dealing with it. I tried this however. When a very narrow strip was taken off, little difference was observed, & the ridges continued to act. When a broad strip was taken off, the buoyancy of the leaf-stalk pushed part of the leaf out of the water altogether, while the opposite side became submerged. The experiment was instructive because it showed that the buoyancy, form & size of a leaf require adjustment with

respect to one another in order to avoid a bad result. In one way or another the leaves of water-lilies often go wrong. I have frequently found leaves of Limnanthemum nymphæoides, Nuphar luteum, Nymphæa alba & Hydrocharis with a greater or less part of the leaf permanently submerged, & this before decay has set in.

One half of a leaf of N. dentata was well rubbed with cotton wool. After rubbing it freed itself of water rather better than before, probably because some dirt had been removed.

N. dentata has, I think, a somewhat more repellent surface than N. alba, which often brings up a good deal of water & gets rid of it rather slowly.

IV. Euryale ferox (Jardin des Plantes, Brussels, Sept. 1840).

On the upper side of each leaf are a number of low pyramidal prominences, which increase in height towards the centre of the leaf. These occupy the spaces between the veins.

When the leaf is submerged, the prominences emerge first, & the water rolls off along the intervening furrows, escaping by the basal cleft.

V. Nelumbium speciosum. The leaves of this plant, which are both floating & aerial, exhibit a power of repelling water beyond that of any plant which I have seen. When well rubbed with cotton wool the leaf became capable of wetting. ~~Bl~~ Both floating & aerial leaves are peltate. The aerial leaves are cup-shaped, with wavy margin, & much larger than the others. The floating leaves have a slightly raised centre, & two opposite gutters, basal & apical, the basal one being rather deeper than the other. The gutters are shallow & extend outwards almost to the margin, which is slightly depressed at these points. When submerged, the floating leaves remain covered with a glistening film of air. If a leaf is allowed to approach the surface slowly, the layer of

water above the leaf of course gets thinner & thinner. At last the film breaks & disappears in a moment, the last indications being large spherical drops, which roll outwards along the gutters with great speed, & roll over the slight elevation at the end. Here the rim, though lower than the rest of the rim, is higher than the floor of the gutter.

The surface of the leaves is so repellent of water that a very simple arrangement suffices to prevent water from lodging. A cup-shaped leaf would not of course be well-suited for floating on water. It does not lodge water when carried high in the air, because the stalk of the aerial leaf is long & flexible, & bends down when the leaf is weighted with water. The floating leaf is nearly flat, & can only be encumbered with small floating drops. If such form, they roll into the gutters & acquire a sufficient speed to carry them clear of the rim.

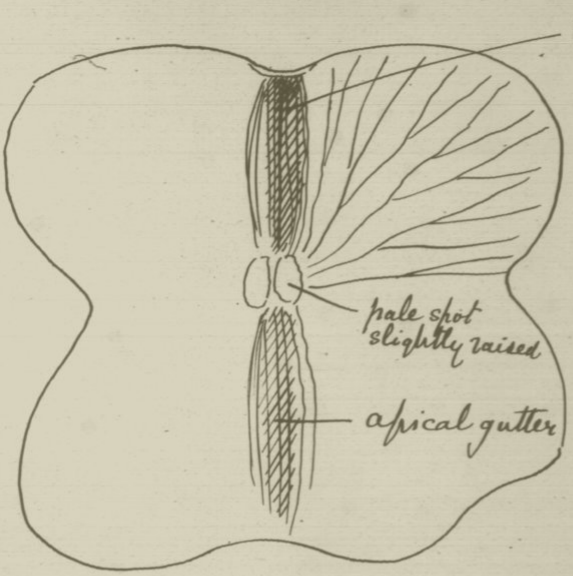

Diagram of leaf of Nelumbium (floating)

The photograph sent, though not good, shows the form of the leaf. In one of the floating leaves the gutters can be seen.

Yours very truly,
L. C. Miall.