Leeds. Oct. 12. 1891

Dear Darwin

I send a few notes on Floating Leaves, & hope to continue them from time to time. I am keeping a copy, to prevent repetition.

I. Victoria regia.

Expt to ascertain how the leaf frees itself of water. (Kew, Sept. 1891). A young leaf, the only one suited for observation, as the older ones had holes in them, was selected. This leaf is shown in photographs 1 and 2. About two gals. of water was poured upon it as it floated in its natural position. Most of the water flowed out with great ease by the basal and apical notches in the rim, especially by the basal apical one. As the water in the leaf diminished, the basal notch began to rise above the surface, & no more escaped that way, but the bottom of the apical notch was still submerged, & a steady outflow continued through it until nearly all the water was discharged. This occupied about a minute. It was observed that the apical part of the

leaf was now somewhat depressed, & formed a shallow pool into which the water drained, flowing along channels between the prominences on the surface of the leaf. These prominences are more marked in a young leaf, such as that in question, & reminded one a little of the leaf of Euryale. When the discharge of water seemed to have ceased, about a quart remained in the pool, but a quarter of an hour later the quantity seemed to have increased, probably by drainage, & the pool appeared to have become heavy enough to depress the apical margin, ~~so~~ so that some of the water was everted. This was not repeated so long as the leaf was watched, but in two or three hours all the water had been got rid of. It seemed as if the tract adjacent to the apex of the leaf was less rigid than the rest & formed a kind of shallow pouch opening by the apical notch. Here the pool formed, & the greater flexibility of the leaf at this place seemed to facilitate the escape of the water. The result was plain enough,

but the way in which it was brought about was not quite clear, & there was no opportunity of repeating the expt.

The basal cleft which in many Nymphaeaceae helps to free the leaf of water does not ~~ext~~ exist in Victoria.

The old leaves in the tank were unfitted for expt because all were pierced by holes due to decay. I was told that Mr. Massee of Kew had examined the disorganised tissue for fungi, but without success, & that the cause of the decay was unknown.

Use of the raised rim. A large & tolerably perfect leaf was submerged with considerable difficulty by two men, who pressed with all their weight upon a board, which rested on the leaf. By getting one edge down first, the leaf was gradually sunk. When released it rose, & got rid of nearly all the water in a very short time. The rim had been much torn & the notches did not therefore come into play to any considerable extent. I next

cut off the whole rim (see photograph 2) & resubmerged the leaf. It freed itself of water with as great ease as before. It was noticed that the leaf was not now so flat as at first, a rising in the centre marking the thrust of the very buoyant leaf-stalk.

I had previously thought that the raised rim was of use in overcoming the resistance of the surface-film. It seemed to me probable that if the uninjured leaf were submerged, the effect of its buoyancy would be concentrated upon the rim, that this would be forced through into the air, & that the repellent surface would then come into action. This explanation was refuted by the expt described above. On reflection I think that the mistake made is pretty evident. Forces due to capillarity, such as the resistance of the surface-film, vary as the length of the line of contact, i.e. in the case of similar bodies, directly as any linear dimension. But such forces as gravitation vary as the cube of any linear dimension.

The capillary forces which may be all-important in the case of smaller bodies become negligible in very large ones. The leaves of Victoria are so large that capillarity becomes unimportant & we have only to consider what we may call the mechanical arrangements of the leaf.

The use of the rim therefore remains to be explained. Mr Watson, keeper of the tropical lilies at Kew, thought that the rim, aided by the prickles with which it is set, was a defence against small swimming mammals, which might climb upon the leaf & injure it. When I imitated with my fingers as well as I could the action of a mammal trying to climb upon a leaf, I thought the obstacles rather ineffective. It was easy to press down the smooth side without getting pricked. The parenchymatous tracts of the leaf are so tender that the fingers go through very easily, & I thought that no animal bigger than a rat could run upon the leaf without putting its feet through at every step. Until some positive

evidence is to be had, I think it unlikely that these leaves would run serious risk from mammals, or that the rim would be an effective defence.

I have noticed that in some pools the leaves of Nymphæa & Nuphar become much crowded, & slide one over another. The parts overlaid before long turn yellow & become incapable of throwing off the water, so that they are always submerged. It is possible that the raised rim may be a protection against such accidents. [Photographs 3 & 4 illustrate the effect of crowding. 3 is of N. alba, 4 of N. tuberosa.] Nuphar luteum has no rim, N. alba a slight & inconstant one, but the rim of Victoria must be a great protection against overlapping. I am told of a photograph of Victoria regia in a S. American river, in which the leaves are much crowded, some of them being raised out of the water. Mr Watson will try to borrow this photograph for me.

The leaf-buds of Victoria show strong

ridges due to the prominent leaf-veins. These, or the intervening gutters may be of use in draining the surface, but this is probably of little consequence. I suppose that they have no capillary effect. If the parts were sufficiently small for capillarity to act, the ridges would, I suppose, tend to keep a leaf submerged & not to free it.

Yours very truly
L. C. Miall.