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XXXIII.—*On the Batrachian Ranunculi of Britain.*

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It is with much diffidence that I venture to attempt the elucidation of the Batrachian Ranunculi of Britain, for the great difficulty of the subject necessarily presses heavily upon the mind. Also, it cannot be otherwise than disheartening to feel, that however successful I may be in my own estimation and even in that of my friends, and, that although my endeavours may result in a close approach to the acquaintance with the plants that has been attained in Sweden and France, it is certain that several of the most eminent of the botanists of Britain will consider that I have been wasting my time and retarding rather than advancing science. Had the views of those learned men been generally held by persons of equal scientific rank in other countries, I should have thought it my duty to adopt them; but as several of the most distinguished botanists of continental Europe do not think that they are "idling away their time by catching at shadows," when they expend it upon an earnest endeavour to attain the most accurate possible knowledge of the plants inhabiting their respective countries, I am led to the belief that I am really doing well when trying distantly to follow their example.

It has been justly remarked, that we have no good definition of a species amongst plants, and that it is hard or even impossible to apply those which we possess. Until species can be defined, each botanist is left to judge as best he can of what ought or ought not to be so considered. In the case which is about to be

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presented to the reader, I have been led, or rather driven to the conclusion that the forms described below are species, by having had most of them under my observation in a growing state for several years, and finding them to continue constant in their characters when raised from seed under varying circumstances through successive generations: also, by remarking that they not only possess permanent definable distinctions, but present such differences at first sight as to enable the practised eye to distinguish them easily. Surely, in such a case, the minuteness or obscurity of the structure upon which the technical character is founded can be no just argument against the claims of the plants to be considered as entitled to specific rank. Neither can we accept as conclusive against them the fact that some eminent botanist, such as Smith (Eng. Flora, iii. 55), has combined them under two names; or, Seringe "long ago recorded his decided opinion, that all were mere varieties of one species." Neither Seringe (Mélanges Botaniques, ii. 8 & 49) nor Schlechtendal (Animadv. Bot. in Ran. 8), who is also used as an authority by those who persuade themselves that all these plants form only one species, appears to have had any knowledge of the characters that are now employed in this group of plants; and I think that no botanist of the present day lays stress upon the hairiness or smoothness of the plant or its capsules; neither would plants be considered as distinct solely on account of the presence or absence of the broad floating leaves. It is nearly certain that several of the species (as I consider them) that are to be described presently (viz. *R. heterophyllus*, *R. Baudotii*, *R. floribundus*) would each afford a series of forms, extending from a state in which there are no capillary-divided leaves to one consisting solely of them, similar to that recorded by Schlechtendal under the name of *R. aquatilis*. The existence of such series assuredly rather tends to prove that there are several species of *Batrachian Ranunculi* than that they are all of one species. Doubtless it requires a considerable familiarity with the plants to enable a person to refer all these forms to their proper species, and mistakes are very frequently made in attempting to do so. Also innumerable errors and difficulties arise when names are required to be given to scraps, such as are often collected and preserved even by good botanists.

We are told that a series of specimens from all parts of the world proves that there is only one species of *Batrachian Ranunculus*. Doubtless it would be easy to form a series apparently justifying such an opinion, but our success in so doing does not seem necessary to prove the non-existence of several species; for it may, and I believe has, happened in many such cases that

the supposed connecting links are single specimens of distinct species, which consist of multitudes of similar individuals in their native districts, although only one or two may have been preserved in the herbarium employed for study. Let the living plants be carefully examined in a country, such as Britain, where they are numerous, and if, after an unprejudiced endeavour to arrive at the truth, they prove undistinguishable, then let them be combined. But if, as my observations lead me to believe, the best known of them are quite constant in their form and habit, it does not seem to be the pursuit of truth that leads to their neglect, but rather the adherence to a preconceived theory. Take as an example the *R. circinatus*: this plant inhabits the most different situations, growing upon a muddy or gravelly bottom, in swift streams or stagnant ditches and pits, in water or on mud, and yet the well-known structure of its leaves is invariable.

Many years since it fell to my lot to attempt to controvert the opinion then prevalent in England, that the *R. aquatilis*, *R. circinatus* and *R. fluitans* formed one species (Ann. Nat. Hist. Ser. 1. vol. iii. p. 225-230), and I showed conclusively, as I venture to think, that the depth, motion, or stagnancy of the water in which they grow has nothing whatever to do with the size, shape or structure of the leaves, nor with the direction of them. Of course certain slight alterations are the result of the circumstances in which the plants are placed, but they are not such as to affect the characters upon which the species are founded. In doing this I was performing little more than restoring to recognition in this country species known to Ray, and defined and named according to the Linnæan method by Sibthorp. On the European continent several eminent men had already adopted them. Since that date my attention has been often turned towards these beautiful plants, and during the last few years I have made them a special subject of study. Within the same period, such men as Fries, Koch, Godron, Cosson and others, have been led to think that the *R. aquatilis* required further subdivision. Accordingly many attempts have been made to do so with greater or less success, and it is a cause of much satisfaction to me to find that, with a single exception, the British species have already been detected and described in other countries. That those botanists should have arrived at different conclusions, and even changed their opinions once or more, is certainly not a valid excuse for neglecting the study in which they have partially failed; for in this, as in all other departments of knowledge, correct results are not usually attained until after many attempts. Let it not be thought from these remarks that I claim to have succeeded; for all that I propose to myself is to

make a small step towards success, and to place before those who may follow up the study a few additional facts, or an improved application of those already known.

In this group of plants we are not acquainted with any single character which may safely be stated to be always deserving of confidence; but if a combination of several characters is employed, there will rarely be any serious difficulty in identifying the supposed species, even when the structure of some of the parts has undergone change. The look of the plant is generally distinctive of the species; and the difficulties commence when an attempt is made to draw up technical definitions, or to determine the names from "specific characters." Such is found to be the case in most groups of closely allied species inhabiting the "metropolis," as it has been called, of extensive and difficult genera. We may call the plants varieties or hybrids, but, until they are proved to be such, we are only avoiding a difficulty, not stating a fact in science.

Having made these preliminary observations, I will now endeavour to point out the characters upon which we seem to have the most reason for placing dependence in preparing specific characters for the *Batrachian Ranunculi*.

It has long been known that the absence of hairs from the receptacle, and of any submersed and filiformly-divided leaves, distinguishes *R. hederaceus* and its more recently noticed ally, *R. canosus*, from the rest of our native species. It was pointed out by Sibthorp, that the submersed leaves of *R. circinatus* and *R. fluitans* had a different form from those of *R. aquatilis*, under which latter name he included plants which I have failed in reducing to less than eight species. In these latter plants (*i. e.* the *R. aquatilis* of Sibthorp), the submersed leaves are formed of repeatedly-dividing filiform or setaceous parts, which spread in such a manner from their first division, where the leaf trifurcates, as to take the shape of a greater or less segment of a sphere. These three divisions of the leaf are forked at very short or more distant intervals; they are fine or rather thick, rigid or flaccid, and accordingly retain their direction when taken out of the water, or collapse so as to resemble a painter's pencil.

In all the species, the floating or emerged leaves have an outline which is nearly circular, or only forms part of a circle; they are divided more or less deeply into lobes, or quite to the top of their petioles into leaflets; in some cases these leaflets have partial petioles of a considerable length, and then the circular outline of the whole leaf is not apparent. When the leaf is formed of lobes or sessile leaflets, the outer margins of the lateral

lobes or leaflets, that is, the outer margins of the leaf, are either straight from their base throughout a considerable part of their extent, or their lower part is much rounded; therefore the leaflets are wedge-shaped or obovate.

In most of the species, the peduncles spring from the same nodes as both the divided and submersed, and the flat and floating leaves; but in the plant called *R. peltatus* in this paper, they are very rarely produced in the former situation; so rarely, as to have caused Fries to denominate the floating leaves "*folia necessaria*" in that plant. The peduncles either about equal the leaves or much exceed them, and then raise the flowers considerably out of the water. They are either equally thick throughout their length, or narrow more or less gradually towards the flower.

The petals are either broad with many veins, or narrow and usually few-veined. In the former case, the edges of contiguous petals are close together, and often overlap; in the latter, they are usually distant, and give what I have called a star-like appearance to the flower. As the flowers of the broad-petaled species advance towards decay, they acquire a slightly similar look; for the petals, which had originally a rounded form, lengthen so much that their lower part becomes wedge-shaped, and the flower rather star-like.

In two of our species, the stamens are so short as to be exceeded by the pistils, but usually they conspicuously overtop those organs.

Although the stigma varies in shape, it is not easy to apply this difference to the discrimination of the species, for it changes its form as it acquires age.

Not much dependence should be placed upon the position of the style, for apparently it generally forms a continuation of the inner, or nearly straight side of the ovary.

The carpels differ much in shape, but usually form the half of an ovate or obovate figure; the inner or upper edge is usually almost straight, but not always so, and then the carpel is often nearly ovate or obovate. On these latter forms of carpel, the persistent base of the style, or slight apiculus that represents it, nearly terminates the diameter of the carpel; but on the others it usually is connected with the straight side, being placed at its end, but forming an angle with it. The carpels are usually compressed laterally, and their coats closely enclose the seed; but in some cases they are inflated in their upper part, or slightly so throughout. These inflated carpels are, therefore, broadest at the end; but in some of the species where they are not inflated, a narrowing and flattening occurs at the end.

RANUNCULUS, Linn.

Section I. *Batrachium*. Fruitstalks arching. Carpels transversely wrinkled. Petals white (with a yellow claw in all our plants).

This section includes all the species which it is now proposed to consider. It constitutes the genus *Batrachium* of Fries; but I must be permitted to think, that there is no valid reason for separating it generically from the other *Ranunculi*. *R. sceletatus*, although a true *Ranunculus*, has several points in common with the *Batrachia*. It has minute seeds traversed by faint transverse wrinkles, and when growing in water its lower leaves float in a similar manner to those of the species of *Batrachia*, and very closely resemble them.

Subsection A. Submersed leaves twice or thrice trifurcate with filiform segments spreading in the form of a section of a sphere, rarely wanting. Receptacle hispid.

1. *R. trichophyllus* (Chaix); *submersed leaves* closely trifurcate, segments short rigid *not collapsing* into a pencil when taken out of the water, *no floating leaves*, peduncles not narrowing upwards about equalling the leaves, flowers small, *pet.* obovate 5-7-nerved not contiguous *eranescent*, stigma oblong, receptacle oblong, *carpels* $\frac{1}{2}$ -ovate laterally apiculate *compressed*.

R. trichophyllus, *Chaix in Vill. Dauph. i.* 335; *Gren. et Godr. Fl. de Fr. i.* 23.

R. pantothrix, *DC. Syst. i.* 235 (in part); *Bert. Fl. Ital. v.* 575.

R. cæspitosus, *Godr. in Mém. Nancy*, 1839, 30. f. 6 (the terrestrial state).

R. capillaceus, *Lloyd! Fl. de la Loire Inf. 5*; *Godr. Fl. Lor. i.* 15.

R. aquatilis v. *pantothrix*, *Koch, Syn. Fl. Germ. ed. 1.* 11; *Sturm, Deutschl. Fl. fasc. 67. t. 11*; *Fries! Herb. Norm. ix.* 27 (specimen).

R. heterophyllus var. *succulentum*, *Fries, II. N. xi.* 33 (specimen)?

Batrachium trichophyllum, *F. Schultz, Fl. Gall. et Germ. exsic.* 805 bis & 1203; *Van den Bosch, Prod. Fl. Batav. 5.*

Stem floating, rooting at the lower joinings, obtuse-angled, hollow. Submersed leaves with filiform segments diverging slightly, and when mature so rigid as not to collapse when removed from the water: middle branch at the first fork the smallest. Petioles plane-convex, short. Upper leaves sessile. When growing upon mud from which the water has retired, the segments of the leaves are very short and thick. Floating leaves always absent. Stipules large, rounded, auricled, $\frac{1}{2}$ or $\frac{2}{3}$ rds adnate. Peduncles falling short of, or slightly exceeding the leaves. Buds globular. Flowers small, star-like. Sepals

ovate, very blunt, concave, green with a diaphanous margin. Petals distant, white, wedge-shaped, slightly clawed and yellow below, about twice as long as the calyx when full-grown. Nectary round, scarcely at all margined or prominent; but probably this structure is not constant, for I have seen, on what is apparently a plant of this species, a prominent bracket-shaped nectary. Stamens from about 10 to 15, exceeding the pistils. Style prolonging the inner edge of the ovary, short, curved. Stigma at first oblong, afterwards elongating. Carpels blunt, a little hairy, and slightly narrowed at the end. Receptacle nearly globose, as thick as the peduncle. Colour of the plant dark lurid green.

This plant differs from *R. heterophyllus* by its small few-nerved evanescent petals, globular receptacle, dark green dense rigid small submersed leaves; from *R. confusus* and *R. Baudotii* by its short peduncles which are equally thick throughout, its oblong not ligulate stigmas and globose receptacle, deciduous small petals, and in other respects. *R. floribundus* and *R. peltatus* are large-flowered plants that cannot be confounded with it even when the former happens to want the floating leaves. It differs from all the other species of the subsection by never having been observed to have floating leaves, nor to show any tendency to produce them. Its nearest ally is *R. Drouetii*. It is well marked by its stems, which float close to the surface of the water, being furnished with small dense rather closely placed dark green leaves, and small flowers which only just rise out of the water. No species resembles it in these respects.

Flowering in May and June.

R. trichophyllus is plentiful in Cambridgeshire, Norfolk and Suffolk, but is perhaps not very generally distributed throughout the kingdom. *R. Drouetii* is probably often mistaken for it, as is also the wholly submersed state of *R. heterophyllus*.

2. *R. Drouetii* (F. Schultz?); *submersed leaves* rather closely trifurcate, segments rather rigid but *collapsing*, floating leaves (rare) tripartite with subsessile or stalked wedge-shaped bifid leaflets, peduncles not narrowing and about equalling the leaves, flowers small, petals obovate 5-7-nerved not contiguous evanescent, stigma oblong, receptacle oblong, *carpels* $\frac{1}{2}$ -obovate sublaterally apiculate *inflated at the end*.

R. Drouetii, F. Schultz in Gren. et Godr. *Fl. de Fr.* i. 24?

R. Godronii, Gren. in F. Schultz, *Fl. Gall. et Germ. exsic.* No. 1202 (specimen).

Stem floating, rooting from the lower joinings, very bluntly

angular, hollow. Submersed leaves with filiform segments which are rather short, diverge greatly at their trifurcations, less so at the bifurcate divisions: middle branch at the first fork the smallest. Petioles plane-convex, short. Upper leaves nearly or quite sessile. Floating leaves very rare, tripartite; divisions stalked, bifid, wedge-shaped, the sides being very nearly straight, except the outer side of the lateral ones, which is slightly but decidedly rounded; middle division much more shortly stalked than the others, or very nearly sessile, usually placed at an angle with the other divisions, and directed downwards, so as to be always submersed. These tripartite leaves soon decay, and the plant produces beyond them a series of filiformly-divided submersed leaves, similar to those that had preceded them. Petioles of the tripartite leaves rather long, nearly cylindrical. Stipules large, rounded, auricled, $\frac{1}{2}$ to $\frac{2}{3}$ rds adnate. Peduncles falling short of, or slightly exceeding the leaves, from both kinds of leaves. Buds oblong. Flowers small, star-like. Sepals ovate, very blunt, concave, greenish, dotted with purple, especially towards the edge; the whole margin diaphanous. Petals distant, white, wedge-shaped, yellow below and slightly clawed, about twice as long as the calyx when full-grown. Nectary round, scarcely at all margined or prominent. Stamens fewer than 10, exceeding the pistils. Style prolonging the inner edge of the ovary, short, curved. Carpels blunt, more or less hairy at the end, which is a little inflated so as to have a broad flat edge; base of the style small, rather variable in position, not central nor truly lateral. Receptacle oblong, as thick as the peduncle. Colour of the plant bright green.

This plant agrees in so many respects with the descriptions of *R. Drouetii*, and with specimens of that plant obligingly sent to me by my excellent correspondent M. R. Lenormand, that I am led to consider it as belonging to that species, notwithstanding the occasional presence of floating leaves. When those leaves are absent, the English plant appears to be identical with that described as *R. Drouetii* by Dr. Godron. That botanist places much dependence upon the "style . . . inséré presque à l'extrémité du long diamètre du pistil:" such is not the case in our plant, nor is the rudiment of the style central upon the carpel of the French specimens, on some carpels of which it somewhat approaches that position, but upon others it is decidedly lateral. There is similar variety in the position of the apiculus on the carpels of the English plant.

The presence of flat floating leaves is an apparent objection to the identification of the plants; but I think that the widening of the divisions of some of the upper leaves, indicating an

approach to a floating leaf, such as is occasionally although rarely found upon our plant, may be detected upon M. Lenormand's specimens. Of this, however, I am not quite certain.

I am much indebted to my friend the Rev. W. W. Newbould for directing my attention to the floating leaves of our plant.

The *R. Godronii* (Gren.), specimens of which I have received from Dr. F. Schultz, appears similar to our plant when it is furnished with the floating leaves, but I am unable to see in what other respects it differs from the typical *R. Drouetii*. I cannot find any description of *R. Godronii*.

R. confervoides (Fries, H. N. xiii. 45) is closely allied to this species, but has long slender peduncles. *R. paucistamineus* (Tausch) may be a stronger form of *R. confervoides*.

R. Drouetii can only be confounded with *R. trichophyllus* or *R. heterophyllus*. From the former it is distinguished by its bright green colour, collapsing leaves, inflated and very blunt carpels, and much more lax habit; from the latter by its very peculiar floating leaves, fewer-nerved and evanescent petals, inflated and minutely apiculate carpels, and nearly globose receptacle.

Flowering in May and June.

I have received *R. Drouetii* from several places in Cambridgeshire, Burnham in Norfolk, Byford in Herefordshire, and Hook in Surrey.

3. *R. heterophyllus* (Fries); *submersed leaves* loosely trifurcate, segments long *collapsing*, floating leaves subpeltate tripartite with sessile or stalked wedge-shaped 3-5-lobed leaflets, peduncles not narrowing scarcely exceeding the leaves, flowers large, *petals* broadly obovate-cuneate 7-9-nerved not contiguous *persistent*, stigma oblong, *receptacle conical*, carpels $\frac{1}{2}$ -ovate laterally pointed.

R. heterophyllus, Fries, *Summa*, 140, & *Herb. Norm.* ii. 32 (specimen).

R. aquatilis α . pseudo-peltatus, Godr. in *Mém. de Nancy*, 1839, p. 25. f. 5 c & g.

R. aquatilis var. *pantothrix*, Fries, *Herb. Norm.* ix. 27 (specimen).

R. aquatilis, Eng. Bot. t. 101.

Batrachium heterophyllum, Van den Bosch, *Prod. Fl. Batav.* 8.

Stem floating, rooting from the lower joinings, prominently but irregularly angular, hollow. (A plant apparently referable to this species which grew in shallow water has a solid stem. Much stress has been laid upon such a difference, but it seems of little consequence.) Submersed leaves two or three times trifurcate, afterwards bifurcate; segments filiform, rather rigid. At the first fork the branches are divaricate and the middle one

is the smallest, at the succeeding forks they are more and more approximate. Petioles semicylindrical, short. Upper submersed leaves sessile. Floating leaves usually flat, with bifid leaflets, each segment deeply lobed; when they rise out of the water, as is frequently the case, they form a nearly or quite circular disk; their outer edge is usually straight from its base, but occasionally is slightly rounded from thence. Stipules broad, adnate nearly throughout. Peduncles from both kinds of leaves. Buds globular, or slightly depressed and obscurely pentagonal. Flowers becoming star-like. Sepals ovate, very blunt, convex, brownish green towards the top with a dark irregular edge, yellowish at the base, the whole margin diaphanous. Petals sometimes with more than nine nerves, white, yellow below, fully twice as long as the calyx. Nectary round, very prominent, bracket-shaped, so as to open nearly at right angles to the plane of the petal. Stamens many, exceeding the pistils. Style prolonging the inner edge of the ovary, curved. Stigma straight. Carpels blunt with a large apiculus, slightly hairy at the end, inner edge nearly straight.

When the floating leaves are not produced, the plant is similar in all other respects. Both states are frequently to be found in the same place.

The differences between this plant and *R. trichophyllus* and *R. Drouetii* have been already pointed out. Its collapsing leaves distinguish it from the four following species. Its uniformly thick and short peduncles separate it from *R. confusus*, *R. Baudotii* and *R. peltatus*; its wedge-shaped leaflets from *R. confusus*, *R. floribundus* and *R. peltatus*. In swift streams it sometimes much resembles *R. fluitans*, but has not the structure of that plant.

Flowering from May to July; rarely flowers may be found in April and August.

I have obtained this plant from Cambridgeshire, Leicestershire, Chichester, the River Lea near Hertford, Battersea in Surrey, and Pangbourn in Berkshire. I believe it to be pretty generally distributed.

4. *R. confusus* (Godr.); *submersed leaves* loosely trifurcate, segments long rather rigid *not collapsing*, *floating leaves* long-stalked subpeltate *subtripartite* with *sessile obovate* 3-5-lobed segments, peduncles slender narrowing gradually exceeding the leaves, flowers large, petals obovate-cuneate 7-9-nerved not contiguous persistent, stigma tongue-shaped, receptacle ovate-conical, carpels $\frac{1}{2}$ -ovate compressed and narrowed upwards.

R. confusus, Godr. in *Fl. de Fr.* i. 22.

R. Petiveri, *Koch in Sturm, Deutschl. Fl. fasc. 82. t. 2.*

R. Petiveri a. minor, *Koch, Syn. ed. 2. 13.*

Stem floating, rooting at the lower joinings, roundish, hollow; the upper part, when flowering, often rising out of the water. Submersed leaves two or three times trifurcate, afterwards bifurcate; segments rather thick. At the first fork the branches are nearly equal, long and divaricate, at the succeeding ones more and more approximate. Intermediate leaves with fewer, shorter and linear segments. Petioles semicylindrical, short. Floating leaves flat, marked with brownish irregular spots; segments diverging, slightly combined at the base or sessile, lateral ones much rounded at base externally; outline of the floating or emerged leaves scarcely more than a semicircle. Petioles thick, semicylindrical. Stipules oblong, much adnate. Peduncles very long, rising high out of the water, from both kinds of leaves. Buds globular, but slightly depressed and a little pentagonal. Flowers rather large, star-like. Sepals oblong, blunt, convex, green, with a broad diaphanous margin. Petals elliptic-cuneate or obovate, white, yellow and shortly clawed below, 2 to $2\frac{1}{2}$ times as long as the calyx even when first expanded, their lower half much lengthened afterwards. Nectary shortly oval, strongly margined below, scarcely at all so above, forming an acute angle with the plane of the petal. Stamens about 20, exceeding the pistils. Style rather long, recurved from near its base, prolonging the inner edge of the ovary. Carpels ultimately rather acute, the inner edge nearly straight. Persistent base of the style long and conical, nearly erect. Receptacle as thick as the peduncle. Flowers strongly scented like honey.

Differs from *R. heterophyllus* by its submersed leaves not collapsing, its stem often rising out of the water, its long slender and narrowing peduncles, and ligulate stigma; from *R. Baudotii* by the obovate segments of its floating leaves, slender peduncles, half-ovate carpels compressed and narrowed at the top, and stamens exceeding the pistils.

Flowering from June to September.

I have obtained this plant from near Chichester, Dunster and Weston-super-Mare in Somersetshire, Stackpole and Tenby in Pembrokeshire, and the mouth of the Tees on both sides of the river I believe. It seems to prefer the neighbourhood of the sea, and does not object to slightly brackish water.

5. *R. Baudotii* (Godr.); submersed leaves closely trifurcate, segments rather rigid not collapsing, floating leaves long-stalked tripartite with sessile or stalked *wedge-shaped* 2-4-lobed segments, peduncles thick narrowed at the top ex-

ceeding the leaves, flowers moderate, petals 7-nerved not contiguous persistent, *stamens not exceeding the pistils*, stigma tongue-shaped, receptacle elongate-conical, *carpels* $\frac{1}{2}$ -obovate *inflated at the end*.

R. Baudotii, *Godr. in Mém. de Nancy*, 1839, p. 21. f. 4, and *Fl. de Lorr.* i. 12, and *Fl. de France*, i. 21; *Koch, Syn.* ed. 2. 434.

Batrachium Baudotii, *Van den Bosch, Prod. Fl. Batav.* 7.

Stem floating, rooting from the lower joinings, very bluntly angular, with a shallow furrow on two sides, hollow. Submersed leaves two or three times trichotomously divided into short filiform segments, forking like those of *R. confusus*. Intermediate leaves with fewer and linear segments. Petioles short or none. Floating leaves flat; divisions wedge-shaped regularly to their base, 3-4-lobed, or often of many linear blunt segments. Outline of the floating or emerged leaves not more than a semicircle. Petioles long. Stipules adnate nearly throughout. Peduncles long, thick, from both kinds of leaves. Buds globular, depressed (?). Flowers rather large, star-like. Sepals like those of *R. confusus* (?). Petals white, yellow below, $2-2\frac{1}{2}$ times as long as the calyx. Nectary shortly oval. Stamens 15-20. Style long, recurved from its middle, prolonging the inner edge of the ovary. Carpels very many (50-100 on each receptacle), forming a globose mass. Inner edge often considerably rounded near the top; apiculus small. Receptacle thicker than the peduncle.

Owing to neglect, the above description is imperfect in a few particulars.

This plant is very nearly allied to *R. confusus*, with which species I long confounded it. *R. confusus* appears to be always a more slender and elongated plant, never to have stalked segments to its floating leaves, nor the deep lobes often replaced by broad linear blunt segments, nor the short stamens, nor the globose clusters of many rather pointed carpels with inflated tops, of this plant. Here also the segments are truly wedge-shaped, the outer margins of the lateral ones appearing to be constantly straight quite to their base. The narrowing long peduncles, tongue-shaped stigmas, many and inflated carpels, and great difference of appearance, separate it from *R. heterophyllus*.

I am much indebted to my liberal friend M. R. Lenormand for authenticated specimens of this plant; and Dr. F. Schultz has identified with it a plant gathered by Mr. Syme at Guilan, near Edinburgh, specimens of which the latter gentleman has kindly given to me.

The *R. marinus* of Fries (*Mant.* iii. 51; *Herb. Norm.* ix. 28) is closely allied to *R. Baudotii*; but he is probably correct in

believing (Summa, 555) them to be distinct. In some respects it seems more nearly related to *R. confusus*, and I have suspected that they may be identical.

Flowering from May to August; but sometimes flowers may be found in April.

R. Baudotii appears to delight in slightly brackish water. I possess it from Edinburgh, Seaton Carew in the county of Durham, Burnham in Norfolk, near Chepstow in Gloucestershire and Monmouthshire, Shirehampton near Bristol in Gloucestershire, Dunster in Somersetshire, and near Cork (?).

6. *R. floribundus*; submersed leaves closely trifurcate, segments rather rigid divaricate not collapsing, floating leaves long-stalked subpeltate $\frac{1}{2}$ -trifid or 3-partite with sessile obovate 3-5-lobed segments, *peduncles not narrowed* scarcely exceeding the leaves, flowers large, *petals* obovate-cuneate 9-many-nerred *not contiguous* persistent, stamens many exceeding the pistils, *stigma tongue-shaped*, receptacle spherical, carpels $\frac{1}{2}$ -obovate very blunt.

Stem floating, rooting from the lower joinings, bluntly angular, hollow, often rising out of the water. Submersed leaves dark green, two or three times trifurcate, afterwards bifurcate, segments rather short filiform; intermediate primary subdivision smaller. Petioles short, semiterete. Floating leaves convex, divided more than halfway down; lateral segments bifid, each lobe bicerate; middle segment 3-crenate; *outer edge of the leaf much rounded at the base*. Outline of the floating or emerged leaves forming about $\frac{2}{3}$ rds of a circle, but the rounded outer bases often overlap. Petioles nearly cylindrical. Stipules very broad, with a free rounded end. Peduncles from both kinds of leaves. Buds slightly depressed, slightly pentagonal. Flowers star-like. Sepals ovate, greenish, with a diaphanous margin. Petals at first nearly contiguous, afterwards distant, white, clawed and yellow below, more than twice as long as the calyx. Nectary ovate, its margin thickened all round and slightly prominent below. Stamens 20-30. Style short, recurved, prolonging the inner edge of the ovary. Inner edge of the carpels nearly straight. Receptacle as thick as the peduncle.

I am unable to identify this plant with any described species. It is most nearly allied to *R. peltatus*, with which I was much inclined to have combined it. It differs from *R. peltatus* by its deeply trifid floating leaves, dark green submersed leaves with unequal segments branching at shorter intervals, peduncles not narrowing upwards, nor very long, nor almost solely springing in company with the floating leaves (in *R. floribundus* they spring as frequently with the petioles of the submersed as of

the floating leaves), the ovate nectary, and depressed buds. From *R. heterophyllus* it may be known by its submersed leaves not collapsing, its floating leaves (when tripartite) with sessile segments, and not straight-sided, its ovate nectary, and depressed buds; from *R. confusus* by its floating leaves being usually convex, not spotted; peduncles not long, slender, and narrowing upwards; carpels not compressed and narrowed upwards; and by its dark colour; from *R. Baudotii* by the markedly rounded base of the outer margin of its convex leaves, its peduncles not narrowed towards their top, many-nerved petals, long stamens, and much fewer carpels.

A Sicilian specimen from Prof. Gasparrini, which he named *R. aquatilis*, appears to be *R. floribundus*.

Flowering from May to September.

I possess this plant from Heden near Hull, Denver Common in Norfolk, and a pit by the road-side near Legge's Farm near Hatfield in Hertfordshire.

It is the most beautiful of our species; its large white flowers being so numerous as to cover the places that it inhabits with a sheet of bloom.

7. *R. peltatus* (Fries); submersed leaves loosely trifurcate, segments rather rigid divaricate not collapsing, floating leaves long-stalked subpeltate nearly half-3-5-fid with obovate 3-4-crenate segments, *peduncles* narrowing gradually from floating leaves and exceeding them, flowers large, *petals* round becoming obovate-cuneate 9-nerved *contiguous* persistent, stamens many exceeding the pistils, stigma club-shaped, receptacle ovate, carpels $\frac{1}{2}$ -obovate very blunt.

R. peltatus, *Fries, Summa*, 141, and *Herb. Norm.* xii. 48 (specimen).

R. aquatilis α . *peltatus*, *Sturm, Deutschl. Fl.* fasc. 67. t. 7.

Stem floating, rooting from the lower joinings, bluntly angular, hollow, often rising out of the water. Submersed leaves light green, 2 or 3 times trifurcate, afterwards bifurcate; segments long, slender, filiform; primary subdivisions about equal. Petioles short, semiterete. Floating leaves convex; *outer edge of the leaf much rounded at the base*. Outline of the floating or emerged leaves forming about $\frac{2}{3}$ of a circle, but the rounded outer bases often overlap. Petioles plane-convex. Stipules adnate nearly throughout, rounded at the end. Peduncles long, rising high out of the water, from the floating leaves; very rarely a peduncle springs with a submersed leaf. Buds globular. Flowers very large, sweet-scented. Sepals ovate, diaphanous except at the centre, where they are slightly green. Petals quite contiguous, ultimately slightly separated by the lengthening of their lower part, white, clawed and yellow below, more

than twice as long as the calyx at their first expansion. Necessary oblong, its margin slightly thickened all round and a little prominent below. Stamens about 30. Style curved, short, prolonging the inner edge of the ovary. Carpels not inflated; inner edge nearly straight. Receptacle small; its shape is rather doubtful, owing to the cultivated plant perfecting few carpels, and its shape not having been observed in the wild plant when fresh.

This plant differs from *R. heterophyllus* and all the other species, except perhaps *R. tripartitus*, by its "necessary" floating leaves, for the presence of a flower springing in company with a submersed leaf is extremely rare, with $\frac{1}{2}$ -trifid not tripartite nor wedge-shaped lobes, and by their being nearly always convex; by its submersed leaves not collapsing; its long narrowed peduncles; and petals contiguous except when about to fall; from *R. confusus* by its convex not tripartite floating leaves, contiguous petals, $\frac{1}{2}$ -obovate and very blunt carpels; from *R. Baudotii* by its convex not tripartite leaves with obovate segments, narrowing peduncles, contiguous petals, long stamens and short receptacle.

Flowering from May to September.

I possess this plant from St. Pierre in Monmouthshire, (where it was first noticed as being a distinct species by the Rev. F. J. A. Hort), Bream in Gloucestershire, and Hoveton in Norfolk.

Sturm's figure quoted above represents the petals as not being contiguous, but is doubtless intended for this plant. Fries's specimen contained in the *Herb. Normale* is very imperfect, but leaves no doubt upon my mind of the identity of our plant with it. A specimen sent to Fries, with the name of *R. peltatus* attached to it, was stated by him to be correctly so named.

8. *R. tripartitus* (D.C.); "submersed leaves divided into capillary segments collapsing," floating leaves long-stalked subpeltate deeply trifid with cuneate-obovate 2-1-fid segments, peduncles not narrowing falling short of the leaves, flowers very small, petals oblong 3-nerved not contiguous, stamens few exceeding the pistils, stigma small on a long subulate terminal style with a slender base, receptacle globose, carpels unequally obovate much inflated with a nearly terminal point.

R. tripartitus, *DeCand. Pl. Gall. Rar.* p. 15. t. 49; *Eng. Bot. Suppl.* t. 2946; *Lloyd, Fl. Loire*, 4!

R. tripartitus a. *microphyllus*, *DeCand. Syst.* i. 234.

Stem floating or creeping, rooting from the lower joinings, slightly furrowed, rising out of the water. Submersed leaves (which have not yet been observed in Britain) several times

trifurcate; segments long, slender, filiform. Floating and emerged leaves deeply trifid, forming about $\frac{3}{4}$ ths of a circle; the lateral segments with 3, the central with 2-4 crenatures, the outer edge of the lateral segments rounded in their upper half, but straight below. Upper *stipules free*. Buds globular. Sepals ovate, dark green tinged with purple, the whitish margin diaphanous. Petals very small, slightly exceeding the sepals, rather acute, narrowed into a claw, pinkish-white, yellowish below, with 3 distant nerves. Nectary roundish, its border a little thickened only below. Stamens 5-10. Style straight, placed nearly upon the middle of the end of the ovary. Carpels very blunt, glabrous; inner edge rounded. Receptacle globose.

This plant and *R. ololeucos* (which has not as yet been found in Britain) are distinguished by having very slightly adnate stipules, much inflated carpels having a much rounded inner edge, and minute stigmas. The slender base of the long subulate deciduous style also is a mark of *R. tripartitus*. In *R. ololeucos* the style is persistent, sickle-shaped, and thickened at the base, the petals are much larger and wholly white (in all our species of *Batrachian Ranunculi* they are more or less yellow at the base), and the peduncles much exceed the leaves.

Flowering from May to August.

Mr. H. C. Watson discovered this plant on Esher Common in Surrey. I have found it between Haverfordwest and Robeston in Pembrokeshire.

It is probable that by descending the little streamlets in which this plant has been found until they increase in size and depth, the form producing submersed leaves will be found. My valued friend Mr. Borrer has given to me a specimen grown in deep water in his garden which has loosely twice trifurcate leaves with long narrowly linear segments. Such leaves are found interposed between the capillary divided and the subpeltate leaves of several of these *Ranunculi*, for instance in *R. Baudotii*. It is scarcely necessary to remind botanists, that the form of the style is not to be seen upon dried specimens, for it shrinks so much as in the dry state to appear as if it were broadest at the base. I possess a specimen, gathered by my friend Mr. F. Townsend near Tunbridge Wells, which probably, but not quite certainly, belongs to *R. tripartitus*. It appears to have grown in rather deep water, but does not now possess any of the submersed leaves. It has no petals remaining, and may be *R. ololeucos*.

Subsection B. Submersed leaves not like those of Subsection A. Receptacle hispid.

9. *R. circinatus* (Sibth.); leaves all submersed and sessile trifurcate with repeatedly and very closely forked *rigid segments*

all placed in one roundish plane not collapsing, peduncles narrowing much exceeding the leaves, flowers large, petals obovate many-nerved nearly contiguous persistent, stamens exceeding the pistils, stigma cylindrical, receptacle oblong, carpels $\frac{1}{2}$ -ovate compressed rather acute.

R. circinatus, *Sibth. Fl. Oecon.* 175; *Reichenb. Fl. excur.* 719, et *Icon. Fl. Germ.* iii. Ran. t. 2; *Fries, Herb. Norm.* ix. 29 (specimen); *Eng. Bot. Suppl.* t. 2869.

R. divaricatus, "*Schrank*," *Koch, Deutschl. Fl.* iv. 152, et *Syn. Fl. Germ.* ed. 2. 13; *Godr. Fl. Lor.* i. 15, et *Fl. de Fr.* i. 25.

R. stagnatilis, *Wallr. Sched. Crit.* 285.

R. aquaticus albus, *circinatus tenuissimè divisis foliis, floribus ex alis longis pediculis immixis*, *Raii Syn.* ed. 3. 249.

Stem submersed, ascending, branched, angular, furrowed, hollow, rooting from the lower joinings. Leaves small, their capillary brassy-green divisions repeatedly forked, but all lying exactly in one plane, which is placed usually at right angles to the stem and has a round outline. Stipules sheathing, adpressed, not auricled. Buds obovate, depressed. Sepals ovate, blunt, greenish, tinged with purple towards the tip, the margin broadly diaphanous. Petals 2 or 3 times as long as the calyx, about 9-nerved, white with a yellow claw. Nectary roundish, small, rather strongly bordered below. Stamens 15-20. Style prolonging the inner edge of the ovary. Stigma recurved, but straight. Receptacle narrower than the peduncle both in flower and when bearing carpels. Carpels ultimately rather acute, and tipped with the recurved persistent style.

The structure of the leaves is sufficient to distinguish this plant from all known *Ranunculi*.

Flowering from June to August.

This plant is not unfrequent. For its distribution in Britain I may refer to Watson's 'Cybele Britannica.'

From the remark of Messrs. Hooker and Arnott (*Brit. Fl.* ed. 7. p. 7) that they "cannot believe this to be distinct from the following" (*R. aquatilis*, including the *R. heterophyllus*, *R. trichophyllus*, *R. confusus* and *R. Baudotii* of this paper), I am necessarily led to the conclusion that they have no practical acquaintance with it, and perhaps have paid no attention to it except when preserved in an herbarium. As I have on several occasions received specimens of *R. heterophyllus* under the name of *R. circinatus*, when the petioles were shorter than is usual and the leaves small, I presume that it is not so generally known to botanists as its distribution would have rendered probable. It is so constant to its characters, that, even when the water has dried up in its place of growth, it retains its distinctive structure and grows and flowers in the air.

10. *R. fluitans* (Lam.); leaves all submersed about twice trifurcate with very long linear twice or thrice forked nearly parallel segments, peduncles narrowing, flowers large, petals broadly obovate many-nerved contiguous persistent, *stamens falling short of the pistils*, stigma cylindrical, receptacle conical, carpels obovate inflated much rounded at the end laterally apiculate.

R. fluitans, Lam. *Fl. Fr.* iii. 184; *Reichenb. Fl. exsic.* 886 (specimen), et *Icones Fl. Germ.* iii. Ran. t. 2; *Gren. et Godr. Fl. de Fr.* i. 25; *Van den Bosch, Prod. Fl. Batav.* 6.

R. peucedanifolius, Desf. *Atl.* i. 444.

R. fluviatilis, Sibth. *Fl. Oxon.* 176; *Wallr. Sched.* 284.

R. sive Polyanthemo aquatili albo affine Millefolium Maratriphyllum fluitans, Ray, *Syn.* 250.

Stem floating, very long, branched above, nearly round, hollow, wholly submersed. Leaves together with their petioles often a foot in length. Segments thick. Petioles of the upper leaves often short. Stipules broadly lanceolate, strongly auricled, $\frac{1}{2}$ -adnate. Sometimes at the end of the stem a few stalked 3-furcate leaves with short broad linear segments are found; in these leaves the middle segment is entire, the lateral ones are simply forked; they do not at all resemble the floating leaves of the other species. When the seedling plant has been deserted by the water, all the leaves are of this form. Bud shortly pyramidal, pentagonal. Peduncles thick, much shorter than the leaves. Flower often semidouble. Sepals ovate, blunt, green, bordered with purplish black and a broad diaphanous edge. Petals 2-3 times longer than the calyx, slightly clawed, 9-15-nerved. Nectary round, bordered slightly below. Stamens many, short. Style prolonging the inner edge of the ovary. Stigma straight, a little inflexed at the top. *Receptacle* conical, *slightly pilose* immediately after the flowers have fallen. Carpels with a small lateral point.

The structure of the long whip-shaped leaves is sufficient to distinguish this plant. It is also remarkable for the tendency of the flowers to produce a second imperfect whorl of petals. It does not change its form even when growing in stagnant water.

Not uncommon in rivers. Watson's 'Cybele' may be referred to for its distribution in Britain.

Flowering in June and July.

The *R. Bachii*, Wirten (Schultz, *Archives de Flore*, i. 292; Billot, *Exsic.* No. 1103!), is a form of *R. fluitans*. The form of the petals does not afford a constant character, neither does the length of the peduncle. I have observed it in the River Whiteadder in Berwickshire. It is much smaller in all its parts and more elegant, but I cannot detect any other difference. Mr.

J. Lange has sent it to me from Denmark. It has sometimes been mistaken for the *R. marinus* (Fries), with which it has very little in common.

Subsection C. No submersed leaves. Receptacle not hispid.

11. *R. canosus* (Guss.); leaves all roundish cordate with 3-5 rather deeply divided lobes which widen from their base, petals exceeding the calyx, style terminal upon the ovate-conical ovary, carpels unequally obovate with a terminal point.

R. canosus, Guss. "Prod. Suppl. 187," and *Syn.* ii. 39; *Godr. in Fl. de France*, i. 19; *Bab. Man.* ed. 3. 7.

R. Lenormandi, P. Schultz in *Flora oder Bot. Zeit.* 1837, p. 727!; *Walp. Repert.* i. 34; *Bab. Man.* ed. 2. 6; *Eng. Bot. Suppl.* t. 2930.

R. hederaceus β . *grandiflorus*, *Bab. Man.* ed. 1. 5.

Stem floating or creeping upon mud, branched, nearly round but with slight angles. Leaves not spotted; lobes very blunt and broad at the top, entire or with 1-3 notches. Petioles long, terete-compressed. Stipules $\frac{1}{2}$ -adnate, bluntly pointed, the floral ones very broad. Peduncles not narrowed, nearly equaling the leaves. Buds oblong. Flowers large. Sepals obovate, concave, greenish, tinged with purple towards the tip, with a diaphanous margin. Petals about twice as long as the calyx, narrow, obovate, 5-nerved, white with a slight tinge of pink, slightly clawed and yellowish below. Nectary round, bordered below. Stamens 8-10, about equalling or a little exceeding the pistils. Style nearly central upon the ovary (that is, the upper edge of the ovary is nearly as prominent and rounded as the lower edge) which narrows gradually into the style. Style short, thick, and slightly curved outwards. Stigma oblong. Receptacle spherical, naked. Carpels with their inner (upper) edge much rounded towards the top, inflated, tipped with the terminal although not always quite central style.

Flowering from June to August.

I possess this plant from near Coniston Lake in Westmoreland, near Sheffield, Needwood Forest in Staffordshire, Charnwood Forest in Leicestershire, near Aberystwith in Cardiganshire, near Swansea in Glamorganshire, near Haverfordwest in Pembrokeshire, near Llanberis in Caernarvonshire, Esher Common in Surrey, Tunbridge Wells in Kent, Lucott Hill in Somerset, and near Plymouth in Devonshire.

Messrs. Hooker and Arnott indirectly hint (*Brit. Fl.* ed. 7. p. 8) that near Glasgow this plant may be an altered state of *R. hederaceus*, for "it is principally met with in ditches where the temperature is raised by warm condensed steam," "and where formerly *R. hederaceus* only occurred." This seems to require more proof than a simple statement affords. We want

(1) to be rendered quite sure that *R. canosus* is the plant that now inhabits those ditches, and (2) that it was the true *R. hederaceus* alone that grew there formerly. I have most frequently found *R. canosus* in rather elevated situations, where no source of artificial heat could affect it.

12. *R. hederaceus* (Linn.); leaves all roundish reniform with 3-5 shallow rounded lobes widening to their base, petals scarcely exceeding the calyx, style prolonging the inner edge of the ovary, carpels $\frac{1}{2}$ -oval or $\frac{1}{2}$ -obovate with a lateral point.

R. hederaceus, Linn. *Sp. Pl.* 781; *Eng. Bot.* t. 2003; *Reichenb. Icon. Fl. Germ.* iii. Ran. t. 2.

Stem floating or creeping upon mud, branched, nearly round. Leaves usually spotted; lobes separated by shallow notches, widening gradually from their base to a narrow rounded end, often broadly triangular, entire or rarely with a slight notch at the top. Petioles long, semicylindrical. Stipules long, much adnate, blunt, denticulate. Peduncles not narrowed upwards, much falling short of the leaves. Flowers very small. Petals about equalling or a little exceeding the calyx, narrow, 3-nerved. Stamens 6-8. Stigma short, oblong. Receptacle spherical, naked. Carpels compressed below, blunt and inflated above, inner edge nearly straight, laterally tipped with the style or pointless.

Flowering from June to September.

This plant is probably generally distributed, but as *R. canosus* is often mistaken for it, I may mention that I know of its existence at Inverarnan at the head of Loch Lomond, near Llanberis in Caernarvonshire, Lanwarne in Herefordshire, Needwood Forest in Staffordshire, Tiptree Heath in Essex, Triplow and other places in Cambridgeshire, near Haverfordwest in Pembrokeshire, Ninham in the Isle of Wight, and Bovey Heathfield in Devonshire.

XXXIV.—*On the Mechanism of Aquatic Respiration and on the Structure of the Organs of Breathing in Invertebrate Animals.*
By THOMAS WILLIAMS, M.D. Lond., F.L.S., Physician to the Swansea Infirmary.

[With a Plate.]

[Continued from p. 329.]

General and Minute Anatomy of Branchial Organs in the Gasteropod Mollusks.

THE author is not acquainted with any English or continental researches on the subject of the present paper. While the