

THE IDENTIFICATION OF BERBERIS AQUIFOLIUM AND BERBERIS REPENS.

By CHARLES V. PIPER.

Capt. Meriwether Lewis collected the type specimens of *Berberis aquifolium* and of *Berberis nervosa* at the Great Rapids or Cascades of the Columbia River, April 11, 1806. From these specimens, at least in large part, Pursh described the two species in his *Flora Americae Septentrionalis*,¹ with colored figures of both. The type sheets of both species are now in the possession of the Philadelphia Academy of Natural Sciences, having been secured in some unknown manner from the Lambert Herbarium, where Pursh's types were deposited. There are no duplicates in the set of Lewis's plants left by Pursh at Philadelphia and now at the Philadelphia Academy of Natural Sciences.² In passing it may be stated that these two species with others constitute in the opinion of some botanists a distinct genus, *Mahonia* Nutt. or *Odostemon* Raf., the latter name being the older.

So far as *Berberis nervosa* is concerned little need be said except that the flowers on the type sheet, as also in Pursh's illustration, are those of another species, probably *B. aquifolium*, which fact apparently misled De Candolle to redescribe the plant as *Mahonia glumacea*,³ as first pointed out by Hooker.⁴

Lewis reached the mouth of the Columbia River on November 15, 1805. Later, at the camp at Fort Clatsop, on Young's Bay near Astoria, he had leisure to describe and figure in his journal the common plants of the neighborhood. In his journal⁵ of February 12, 1806, Lewis describes the two species of *Berberis* (*B. aquifolium* and *B. nervosa*) found there as follows:

"February 12, 1806.—There are two species of evergreen shrubs. This is the leaf of one, which I first met with at the grand rapids of the Columbia River, and which I have since found in this neighborhood also; they usually grow in rich dry ground not far from some watercourse. The roots of both species are creeping and celindric. The stem of the first (as above) is from

¹ 1: 219. 1814.

² See Meehan, Proc. Acad. Phila., Jan., 1898.

³ DC. Reg. Veg. Syst. 2: 20. 1821.

⁴ Fl. Bor. Amer. 1: 29. 1829.

⁵ Thwaites, Original journals of the Lewis and Clark expedition 4¹: 62-63.

a foot to 18 inches high and as large as a goose quill; it is simple and erect. Its leaves are cauline and spreading. The leaflets are joined and oppositely pinnate 3 par and termonateing in one, sessile widest at the base and tapering to an acuminate point, an inch and $\frac{1}{2}$ the greatest width, and $3\frac{1}{2}$ inches in length. Each point of their crenate margins armed with a thorn or spine, and are from 13 to 17 in number. They are also veined, glossy, crinated and wrinkled; their points obliquely pointing towards the extremity of the common footstalk.

"The stem of the 2nd is procumbent, about the size of the former, jointed and unbracated. Its leaves are cauline, compound and oppositely pointed; the rib from 14 to 16 inches long and 1 inch wide. The greatest width $\frac{1}{2}$ inch from their base which they are regularly rounded, and from the same point tapering to an acute apex, which is mostly but not entirely termonated with a small subulate thorn. They are jointed and oppositely pointed, consisting of 6 par and termonateing in one (in this form.) sessile, serrate, or like the teeth of a whipsaw, each point terminating in a small subulate spine, being from 25 to 27 in numb; veined, smooth, plane and of a deep green, their points tending obliquely towards the extremity of the rib or common footstalk. I do not know the frute or flower of either. The 1st resembles a plant common to maney parts of the United States called the Mountain Holly."

The drawings of the leaves by Lewis are good and unmistakable and together with the descriptions show clearly that the first of the two species described is *Berberis aquifolium*, the second *B. nervosa*. Clark copies Lewis's descriptions verbatim in his journal of the same date.

Further references to these plants occur in the journals only as follows:

April 2, 1806, when camped on the north bank of the Columbia opposite the mouth of Sandy River:

"and the several evergreen shrubs have ceased to appear except that species which has the leaf with a prickly margin."

April 9, 1806, on the Columbia River above Multnomah Falls, camped that night opposite Brant Island near the foot of the Cascades of the Columbia:

"The vineing honeysuckle has put forth shoots of several inches, the dog-toothed violet is in blume as is also both the species of the mountain holley."

April 12, 1806, camped at foot of Cascades or Grand Rapids:

"Near the river we find the cottonwood, sweet willow, broad leafed ash, a species of maple, the purple haw, a small species of cherry; purple currant, goosberry, red willow, vining and whiteburry, honeysuckle, huckleburry, sacacommis, two species of mountain holley, and common ash."

This is the last mention of "mountain holley" in the journals and written at the place where Lewis collected his specimens. From a study of these notes it is clear that Lewis had not seen either species in fruit, nor was this possible during the period he spent on the lower Columbia.

Pursh's original technical descriptions of the two plants (loc. cit.), to which it will be necessary to refer, are as follows:

2. *B. sarmentosa*, inermis; foliis pinnatis: foliolis sub-3-jugis oblongis repando-dentatis venosis, petalis bidentatis. *Aquifolium*.

B. pinnata. *Herb. Banks*.

On the great rapids of Columbia River, among rocks, in rich vegetable soil. *M. Lewis*. $\frac{1}{2}$. April, May, v.s. in *Herb. Lewis*. Flowers yellow, in large clusters; berries dark purple, eatable; called by Lewis's company *Mountain-holly*.

Caulis fruticosus, laxe ramosus; ramis sarmentosis, procumbentibus. *Folia* sempervirentia alterna, petiolata imparipinnata. *Foliola* 3-juga, opposita, sessilia, imparipetiolata, oblongo-ovata, basi oblique truncata margine cartilaginea repando-dentata, coriacea, utrinque glabra, laevigata, nitida: dentibus aculeatis. *Petioles* teretes, glabri. *Racemi* congesti, bracteati, e gemma precedentis anni. *Flores* aureae. *Bracteae* caduceae, solitariae, subcordatae, acuminatae, membraceae. *Calyx* triplex, deciduus, patens: exterior minimus, 3-phyllus: foliolis ovatis, acutis; medius triplo longior: foliolis suborbiculatis, membranaceis, nervosis; interior longior: foliolis ovalibus, membranaceis, nervosis. *Petala* 6. subrecta, oblonga, apice inciso-bidentata, vix longitudine calycis. *Filamenta* 6. corollae breviora, crassa, medio bidentata: dentibus oppositis. *Antherae* bilobae, crassae. *Germen* superum, ovatum. *Stigma* sessile, 3-lobum. *Bacca* 3-locularis, 3-sperma, abortione interdum monosperma.

3. *B. sarmentosa*, inermis; foliis pinnatis: foliolis 6-jugis ovato-oblongis repando-serratis, sub-5-nervibus, petalis integris. *nervosa*.

In the same situations. v.s. in *Herb. Lewis*.

The specific difference excluded, the description of the preceding species is applicable in every other respect, and together with another in the collection of A. B. Lambert, Esq., collected in Napaul by Mr. Buchanon, forms a new division of the genus, with pinnated leaves; which probably may become a new genus, whenever the fruit is perfectly known, as the statement I have given of it was taken from a single and imperfect berry.

Although Lewis had clearly not seen the fruit of either of the two "mountain holleys" on the lower Columbia River he nevertheless brought back seeds of a species of *Berberis*, from which plants were grown in Philadelphia by McMahon and later introduced into general cultivation. Nuttall took this cultivated plant to be *Berberis aquifolium* Pursh and in his *Genera of North American Plants*⁶ describes it as follows:

⁶ 2: 211. 1818.

307. * MAHONIA.†

Calix 6-leaved, unequal. *Petals* 6. *Nectariferous glands* none. *Filaments* irritable, each filiformly bidentate; *anthers* (as in *Berberis*) growing to the filaments; cells opening by so many vertical elastic valves. *Berry* many-seeded.

SPECIES. 1. *M. Aquifolium*. * * * Flowers sweet-scented, coming out in May (in Mr. McMahon's greenhouse). Cultivated for several years by Mr. McMahon from seeds collected in the Rocky Mountains by the late Governor Lewis.

† In memory of the late Mr. Bernard McMahon, whose ardent attachment to Botany, and successful introduction of useful and ornamental horticulture into the United States, lays claim to public esteem.

After the plant grown by American nurserymen was introduced into England, Lindley described and illustrated it as a new species, *Berberis repens*.⁷ Lindley, who apparently overlooked Nuttall's reference, comments as follows:

A native of north-western part of North America, where it was originally found by the party accompanying Captain Lewis and Clarke in their expedition across the continent of America.

From seeds procured on that occasion plants were raised in America, which have lately been sold into Europe at the rate of twenty-five dollars each. One of these now growing in the Garden of the Horticultural Society afforded our figure and the opportunity of examining the species; it had been purchased of Mr. Michael Floy, Nurseryman at New York, under the name of *Berberis aquifolium*.

It appears, however, from the researches of Mr. Douglas, that this is not the true *Berberis aquifolium*. That species was described by Pursh, in part from an inspection of specimens in the collection of Captain Lewis, but chiefly from the Banksian Herbarium, in which it had been placed by Mr. Menzies, who discovered it on the northwest coast of America. From this last source the drawing in the *Flora Americae Septentrionalis* was also taken. It is probable that the specimens in Captain Lewis's Herbarium were of the plant now under consideration; but it is also certain that those of Mr. Menzies belong to a very distinct species. Hence it seems that Pursh confounded two plants under the same name. That he intended to call Captain Lewis's plant *B. aquifolium*, there can be no doubt; but it is equally certain, that in consequence of his having figured Mr. Menzies' species, the world now applies the name to the latter. This being the case, it has become necessary to distinguish the former by a new name, which has been suggested by its singular property of creeping at the root; a habit peculiar to this species among Berberries."

Lindley's statements have been the prime cause of much of the confusion that has since followed. His statements are certainly unfortunate and probably unwarranted, since it would appear that he had not seen or had not carefully examined the Lewis specimens. This would seem to be implied in the words "It is probable that the specimens in Capt. Lewis's Herbarium were of the plant under consideration," that is, *Berberis repens*. Nor could he have asserted that Pursh's plate was drawn from Menzies' specimens in the Bank-

⁷ Bot. Reg. 14: pl. 1176. 1828.

sian Herbarium, provided such a specimen existed, if he had compared Pursh's plate with Lewis's specimens.

Indeed Lindley's last statement was flatly contradicted in 1831,⁸ where in a discussion of *Mahonia diversifolia*, supposedly from Montevideo, Uruguay, described as a new species, the following appears:

"Two leaflets [*leaves* perhaps intended] of certainly the same species as ours, are preserved in Pursh's Herbarium, now in the collection of A. B. Lambert, Esq. pasted on the same paper with the true *M. aquifolium*, figured by Pursh in his *Flora Americae Septentrionalis*; and one of those [leaflets] is added by the side of his figure. Mr. Lindley's observations on Pursh's *B. aquifolium* are wrong; the very specimen figured by Pursh is now in his Herbarium in Mr. Lambert's collection; the name of *B. repens*, published in the Botanical Register, must therefore be disused."

The writer of this paragraph, apparently Sweet, was clearly acquainted with the Lewis specimen then in the Lambert Herbarium, which he recognized as the basis of Pursh's plate. His statement accusing Lindley of error could scarcely have been made so emphatic unless he felt sure of his ground and of the fact that Lindley had not seen this specimen. It is also apparent from the last clause that Sweet regarded the sheet in the Lambert Herbarium as a mixture of two species, by his referring the two leaves to his *Mahonia diversifolia* and by his implying that the flowering branch is the same thing as *Berberis repens* Lindl.

At my request, Dr. A. B. Rendle has kindly examined the Banksian Herbarium, and writes that he finds there no *Berberis* specimens of Menzies, but does find one labeled "*Berberis pinnata*" collected at Nootka by David Nelson. This is without doubt the specimen referred to by Pursh and besides is the type of "*Mahonia Aquifolium* β *Nutkana*" D.C.⁹ It may be the specimen referred to by Lindley, who may have written "Menzies" inadvertently. Menzies, however, collected both *B. aquifolium* and *B. nervosa*, as the specimens are cited by Hooker.¹⁰ Hooker also cites the Nootka specimen of Nelson under *B. pinnata*. Whether any of Menzies' specimens of *B. aquifolium* were in the Banksian Herbarium when Lindley wrote it is probably impossible to determine. As Pursh consulted with Menzies,¹¹ he perhaps saw Menzies' specimens, though he did not cite them. It may indeed be that some of Pursh's statements in reference to the fruit were supplied by Menzies.

The only Menzies specimens that have been located are those at Kew, upon which Dr. Otto Stapf has kindly reported in much de-

⁸ Sweet, Brit. Fl. Gard. II. 1: under *pl. 9*.

⁹ Reg. Veg. Syst. 2: 20. 1821.

¹⁰ Fl. Bor. Amer. 1: 28-29. 1829.

¹¹ Pursh, Fl. Amer. Sept. xvii. 1814.

tail. The sheet contains four separate specimens, the upper left-hand one in flower, but with only one good blossom; the upper right-hand one in fruit, with only one not quite ripe fruit remaining; the lower left-hand specimen with two deflorate racemes; the lower right-hand one sterile, but with a developed winter bud. The sheet is stamped "Herb. Hooker 1867" (the date of the acquisition of the herbarium), and is labeled in Sir William Hooker's handwriting "Plains of Columbia, A. M. *Berberis acuiifolia*." To this is added in Planchon's hand, "*Mahonia aquifolia* DC. Syst." A question mark has been added after "*aquifolia*" by some unknown person.

In reference to the locality label on the Menzies specimen, it may be pointed out that Menzies did not collect at all on the Columbia River, as he was not with the vessel that explored that river. He could easily, however, have collected the specimens at Nootka or at almost any place along the shores of Puget Sound where he did have opportunity of collecting. As the specimens include both fall and spring gatherings, all could not possibly have come from the Columbia River, since the exploration of this river by Lieutenant Broughton consumed only the interval from October 21 to November 6, 1792. In a recent letter Dr. C. F. Newcombe, of Victoria, B. C., states that there is no mention of *Berberis* in the manuscript of Menzies's journal now in his possession. Dr. Stapf comments as follows:

"There is no doubt whatever in my mind that the Menzies specimens are *Berberis aquifolium* as you understand it and as represented in the photo you sent. Unfortunately, we have no records to show how Menzies's specimens came to be included in William Hooker's herbarium, but we know from the sale catalogue of Lambert's herbarium that the latter contained a set of Menzies's plants and that they were purchased at the sale by William Pamplin, and further that at that time (1842) business relations existed already between Pamplin and Hooker. It is, therefore, very probable that Hooker acquired the Menzies specimens from Pamplin, and that they are actually the set originally included in the Lambertian herbarium. We may consequently assume that Pursh, who used Lambert's collection freely, saw the very specimens of Menzies's collection that are now in the Kew herbarium. If this is so, he may have got his notion of the berries of *B. aquifolium* being dark purple from that specimen, though it does not explain the statement that they are eatable. Where he had it from I do not pretend to know—maybe, as you say, from Menzies himself by word of mouth. It appears to me indisputable that the plant described and figured by Pursh as *B. aquifolium* is the one represented by the specimen collected by Lewis on the 11th April, 1806, and that the name *aquifolium* has to be applied to it. Lindley was no doubt prejudiced by the thought that the seeds which Lewis brought home must be of the same species as he collected and which Pursh used for his description. But as the figure did not tally with Lindley's plant he concluded that Pursh had made a mistake. It is quite clear that Lindley had either not seen Lewis's specimen, or, if he did, looked at it very superficially.

"On the other hand, he knew evidently Menzies's specimen, part of which, the upper left-hand corner, might almost do for Pursh's figure, and comparing it with his new species he might very well say of it that it belongs 'to a very distinct species,' that is, distinct from *his* species.

"I have not seen Nelson's Nutka specimen (*B. pinnata*), but do not think that Lindley could have had it in mind and written 'Menzies' instead of 'Nelson.' Incidentally, I might remark in this place that we have also Menzies's specimen of *B. nervosa* which is cited by Hooker.

"I might finally add that we have a branch of *B. aquifolium* from 'Hort. Lambert.' Lambert had it, therefore, evidently in his collection. There is no date or any other evidence to show when the specimen was taken; it may have been when Pursh was in London, in which case he would have seen it—but why did he not add his 'V. V.'? There are neither flowers nor fruits with it, which, of course, does not exclude that it flowered or fruited. Thus, it is just possible that Pursh not only saw it but saw it in fruit, with 'berries dark purple, eatable.'"

De Candolle¹² had before the publication of *Berberis repens* Lindl. examined the Nelson specimen in the herbarium of Banks, and apparently also the Lewis specimen in the Lambert Herbarium. The former he regarded as perhaps specifically different, but described it as *Mahonia aquifolium* β *nutkana*. In his description of *M. aquifolium* he quotes partly from Pursh and partly from Nuttall. It will be recalled that Nuttall's description was based wholly on plants cultivated by McMahan from the seeds brought back by Lewis, that is, the plant later named *Berberis repens* Lindl. Perhaps this confusion in the descriptions, rather than the Lewis specimen, may have influenced De Candolle to consider the Nutka plant distinct.

Torrey and Gray¹³ were strongly influenced by Lindley's statements, though they were aware of Sweet's contradiction above quoted. They included both the shiny-leaved and the glaucous-leaved plants as varieties of one species. In reference to the glaucous-leaved plant they write: "The former [i. e., *B. repens* Lindl.] is moreover the plant originally brought to the United States by Lewis, and described and figured (chiefly) by Pursh, and cultivated in gardens under the name *Berberis aquifolium*; so that it ought, in accordance with the rule in such case, to remain the original name." In a footnote these authors also write as follows: "The separate leaflets attached to Pursh's specimen in herb. Lambert, one of which is figured in his plate, are said in Brit. fl. gard., under *Mahonia diversifolia*, t. 94, to belong to that species. There is little doubt, however, that they were taken from the specimen of Menzies in herb. Banks."

In reference to Torrey and Gray's treatment of the two plants, Lindley comments¹⁴ as follows: "People in this country will be sur-

¹² Reg. Veg. Syst. 2: 20. 1821.

¹⁴ Bot. Reg. 25: 5. 1839.

¹³ Fl. N. Amer. 1: 50. 1838.

prised to find that our American friends suppose *Berberis repens* to be a variety of *B. aquifolium*."

Torrey and Gray's conclusions as to the identity of *Berberis aquifolium* Pursh and *B. repens* Lindl. were later adopted by Watson¹⁵ and by Brewer and Watson.¹⁶

On these grounds Rydberg¹⁷ considers that the name *Berberis aquifolium* Pursh really belongs with the glaucous-leaved species occurring in Montana, that is, *B. repens* Lindl., and comments as follows:

"It is evident that Pursh's description and plate, except one leaflet, belong to what has generally been known as *B. repens* Lindl. Lindley made a mistake when he supposed that the name *B. aquifolium* belonged to the tall shrub of the Pacific coast, and this mistake has been followed by most American authors."

Kearney¹⁸ had several years before reached the conclusion that "it was to the low plant of the Plains and Rockies, not to the tall shrub of the Pacific slope, that Pursh applied this name," i. e., *Berberis aquifolium*, and he therefore renamed the shiny-leaved shrub *Berberis nutkana* (DC.) Kearney.

Greene,¹⁹ in proposing the name *Berberis nana* for the Rocky Mountain plant, considered it different from *B. repens* Lindl., but retained the name *B. aquifolium* Pursh for the shiny-leaved plant of the Pacific northwest.

Upon request, Dr. B. L. Robinson, of the Gray Herbarium, has searched for such records as Dr. Gray may have made of the Pursh specimens, and he reports as follows:

"In Life and Letters of Dr. Gray, Vol. I, p. 22, under date of 1839 of his autobiography, Dr. Gray says: 'Old Lambert, too; he had the Hookers and myself at dinner, and gave me as good opportunity as he could to consult the Pursh plants, etc., in his herbarium, which, not long after, was scattered, but it was in his dining room, which was very much lumbered, and to be reached only at certain hours.'

"The original of Dr. Gray's autobiography, in his own handwriting, is in the Gray Herbarium, where this quotation has been verified.

"In a letter of Dr. Gray dated February 1, 1839, he says: 'I spent the earliest part of the morning in my own room, then went to Lambert's and commenced the examination of Pursh's plants.' In his manuscript notes on Pursh's herbarium he says:

"*Mahonia Aquifol.* β *Nutkana* DC. Menzies is from a form approaching Lindley's *B. repens*. Pursh could not have taken his separate leaf from this—but doubtless from the other specm. in herb. Lamb. on the same sheet—for which see Don in Brit. fl. Gard.'

"In Sweet's British Flower Garden, new ser., Vol. II, 1833, under plate 171, which is dated December, 1832, this comment on *Berberis nervosa* D. Don is

¹⁵ In King, Geol. Expl. 40th Par. 5: 13. 1871.

¹⁶ Bot. Calif. 1: 14. 1876.

¹⁷ Mem. N. Y. Bot. Gard. 1: 170. 1900.

¹⁸ Trans. N. Y. Acad. Sci. 14: 29. 1894.

¹⁹ Pittonia 3: 98. 1896.

given: 'Pursh having erroneously added the flowers of *B. aquifolium* to his plate of *nervosa*, misled De Candolle, who has reproduced the species under the name of *glumacea*.' "

Dr. Gray evidently refers to the Menzies specimen then in the Lambert Herbarium now at Kew. The comment in the British Flower Garden quoted above is seemingly not the reference Dr. Gray intended, and it can scarcely be the remarks of Sweet previously quoted.

Inasmuch as the first part of Torrey and Gray's Flora of North America containing their treatment of *Berberis* was published in 1838, these notes of Dr. Gray could have had nothing to do with the conclusions reached by them at that time.

In Dr. Gray's last publication on the subject²⁰ he writes under *Berberis aquifolium* Pursh, "Fl. 1: 219, in part and t. 4, mainly," while under *Berberis repens* Lindl. he states, "*B. aquifolium* Pursh, l. c. 219, mainly as to descr." This apparently means that Pursh's plate is mainly the shiny-leaved tall plant and his description mainly the dull-leaved low plant, but the basis for these conclusions does not appear.

The fundamental error of Lindley, as likewise of Nuttall before him and of later authors who have followed them, lies in the assumption that the seeds brought back by Lewis were of the same plant of which he collected specimens in flower at the Great Rapids of the Columbia. When Lewis was at the mouth of the Columbia he expressly notes that he had not seen either the flowers or fruit of the "mountain holley." He recrossed the Bitter Root Mountains in the latter part of June, 1806, far too early to have secured ripe fruit in the neighborhood of Kamiah and Weippe, Idaho, where he had been during most of June. It is apparently certain, therefore, that he secured the seeds he brought back east of the Bitter Root Mountains and most probably in Montana. Nuttall says "Rocky Mountains," but in Lewis's journal no record of the collecting of these seeds has been found. It is certain that he could not have gotten the seeds at the Great Rapids, where he collected the types of *B. aquifolium* and *B. nervosa* in flower.

This brings us to the question as to whether the type of *B. aquifolium* Pursh, collected at the Great Rapids, is the same species as *B. repens* Lindl., grown from seed collected by Lewis probably in Montana, where only this latter species occurs.

The writer has previously expressed the opinion²¹ that this could not be the case, as the glaucous-leaved species, *B. repens*, was not known to occur so far down the Columbia River as the Cascades.

²⁰ Syn. Fl. 1: 69-70. 1895.

²¹ Contr. U. S. Nat. Herb. 11: 282. 1906.

In September, 1916, the writer collected abundant material of the species of *Berberis* occurring at the Cascades or Great Rapids of the Columbia River. The original spot, where Lewis almost certainly collected his specimens, is now occupied by the Cascade Locks, but on the bench above, lying about 30 meters higher and one-fourth mile distant, *Berberis* is abundant. In this place two distinct species of *Berberis* are found: *B. nervosa*, abundant in underbrush; *B. aquifolium*, with shiny leaves, abundant in shady places, and to a less extent in the open; and in addition in very open places and much scarcer occurs a somewhat dull or glaucous-leaved plant, which closely simulates *B. repens* Lindl. However, there are very numerous intermediates between the shiny-leaved species and the glaucous-leaved plant. The latter was at first taken to be *B. repens* Lindl., but microscopic characters hereafter discussed, as well as the form of the leaflets, point to its being a dull-leaved form of *B. aquifolium* Pursh. Specimens of *B. aquifolium* and *B. repens* are usually at once distinguishable by the tall habit of the former and the low habit of the latter. No great stress can be put upon the character of creeping branches, which Lewis had mentioned in his notes on *B. nervosa* and *B. aquifolium*, as they occur at the mouth of the Columbia. This character was mentioned by Pursh in his description of *B. aquifolium*, in which species it often occurs, as was especially observed at the type locality; but creeping branches are far more developed in *B. repens*. Very careful comparisons of the details of the flowers and seeds failed to disclose any characters that could be regarded as crucial. The leaflet characters of form and dentition suffice to separate the two species in the great majority of cases, but occasional specimens occur in which these characters are insufficient. The best distinguishing characters are those of the leaf surface. The leaflets of *B. aquifolium* are nearly always shiny above, but occasionally dull, and beneath pale green, but never glaucous; while those of *B. repens* are nearly always dull on the upper surface and glaucous beneath. In ambiguous specimens the under surface of the leaflets when examined under a binocular supplies a critical difference to separate the two species, as first clearly indicated by Dr. Otto Stapf.

In reference to the characters exhibited by the under surface of the leaves, Dr. Stapf writes as follows, October 30, 1919:

"I have compared the anatomical structure of the lower epidermis of the leaves of *B. Aquifolium* and *B. repens*, and the other North American *Mahonias* immediately allied to them, and have come to the conclusion that the characters of the presence or absence of papillae is indeed a very great help in discriminating otherwise doubtful specimens. If they hybridize we might of course expect intermediate forms, but among the Kew material I have found none."

In 1916 Dr. Albert Mann made a careful microscopic examination of the leaves of three variants of *B. aquifolium* from the type locality. The dull-leafed form was then supposed to be *B. repens* and the plant is thus named in his report, which is as follows:

"A microscopical examination of the leaves of *Berberis repens* and *B. aquifolium* gives no satisfactory distinctions on which one could base a claim for difference of species. Transverse sections of these leaves, made at the same place in the lamina, show that *aquifolium* has the same number of rows of palisade cells as *repens*, but the cells are smaller and consequently there are more in number in a given area; the spongy parenchym is not so loose, and has thicker walls; the cuticle, especially of the upper epidermis, is thicker. This difference could readily be accounted for by a difference of habitat, as these characteristics are strongly influenced by light, and especially by a minimum quantity of moisture.

"A comparison of the epidermal surfaces torn from the leaf shows more marked distinctions, but hardly justifying a specific separation. The upper epiderm of *aquifolium* consists of smaller cells than that of *repens*, far less serpentine in outline, quite thick, and abundantly cut across by canaliculi; those of *repens* quite sinuous, thinner, and only slightly, if at all, perforated. The under epiderms contrast even more strongly. The stomata of *aquifolium* are more abundant and with larger guard-cells, with occasionally lenticels on the surface, the other cells of the epiderm being considerably smaller—from two to four times—than those of the stomata. The cells of *repens* are from one to one-half the size of the stomata, and the walls are, as in the upper epiderm, very much thinner.

"I do not see how any specific distinction can be drawn from these contrasts, as I am not at all sure that if the habitats of the two plants were exchanged, the differences noted by me would not be reversed and almost as marked as above recorded.

"There is a striking difference in the coloration of the leaves, which results in the stomata of *aquifolium* standing out from the rest of the epiderm as deep brown chlorophyll-containing cells; but this is doubtless due in part to the greater age of the specimen of this species."

Since the receipt of Dr. Stapf's letter, numerous specimens have been examined to test the value of the character that he points out, and it seems that in all critical cases it furnishes a definite basis of determination. The lower epidermal cells in both species project on their free surfaces as low papillae. In *B. repens* these papillae, as viewed vertically, are small, circular, prominent, and distinctly separated; in *B. aquifolium* they are lower, larger, and contiguous, thus assuming almost exactly the cell outline. A reexamination of Pursh's type specimen on the basis of this distinction alone, places it definitely with the shiny-leafed species.

On the basis of the specimens examined, *Berberis aquifolium* ranges from Vancouver Island and southern British Columbia southward to the Callipooia Mountains of Oregon and eastward to western Idaho. The only other species in which the lower epidermis has a similar structure is *Berberis pinnata* Lag., of the coast region of

California. No specimens from California representing true *B. aquifolium* have been seen.

Berberis repens ranges from the Cascade Mountains eastward to the Black Hills of South Dakota and from about the 55th parallel of latitude southward to New Mexico and California. In Arizona and California particularly occur divergent forms or perhaps distinct species, such as *B. pumila* Greene, *B. dictyota* Jepson, and *B. wilcoxii* Britt. & Kearney. All these exhibit the same papillate character in the under epidermis of the leaf as does *B. repens*. The relationship of these forms is not here especially considered, but a few words need to be said about a peculiar plant of southwestern Oregon and northern California which in habit, stature, and its somewhat shiny leaves resembles *B. aquifolium*. From that species it is at once separated by the under surface of the leaves, which is covered with a rather dense, somewhat ferruginous bloom that under the binocular shows a papillate appearance quite like that of *B. repens*, *B. pumila*, and *B. dictyota*. The leaves are reticulate less strongly than those of *B. dictyota* and *B. pumila*. For the present it seems best to associate this plant with *B. dictyota*. The larger thinner leaves may well be the result of less arid conditions. The specimens referred to include the following:

OREGON: Gold Hill, Walpole 146, March 25, 1899. Cascade Mountains, Austin 1467, August 20, 1897. Black Mountain near Keno, Applegate 2007, May 8, 1898. Wimer, Hammond 13, April 30, 1892. Four Mile Creek, Klamath County, Coville & Applegate 272, July 29, 1897. Grizzly Peak near Medford, Leiberger 4139, June 22, 1899.

CALIFORNIA: Yreka Creek, Butler 1807, August 1, 1910; Butler 1169, April 11, 1910. Truckee, Sonne 11, April, 1885.

The original specimens of Lewis, which must be considered the types of *Berberis aquifolium* Pursh, are illustrated in Plates 24 and 25. The specimens are sewed to the sheet with olive-green silk thread in a uniform manner. The two large leaves are darker in color and a trifle more shiny than the rest of the specimens. On the back of the sheet appears in Pursh's handwriting, "N. American Herb. Lewis & Clark. Fred. Pursh." There is no inherent reason why all the specimens on the sheet may not have been collected by Lewis at "Great Rapids," as all of them can be matched perfectly by material collected at the type locality. The two larger leaves are typical of the shiny-leaved plant growing in copses in partial shade. The leaf of the flowering branch is likewise matched by that of a fruiting specimen growing in the open, which from both its tallness and its shiny leaves is the same species as the more shiny-leaved plant of the copses.

By comparing Pursh's illustration (Plate 26) with the type specimen (Plates 24 and 25), it is clear that the large figure is drawn

from the left-hand specimen on the type sheet, but with some minor errors as regards the small leaf below the inflorescence. It seems highly probable that the separate leaflet of the plate was drawn from the one missing on the lower leaf of the type specimen. In form and dentition it agrees extremely closely with its probable mate still on the specimen, so closely indeed as to suggest that it may be the same reversed and drawn to show the underside. Dr. Gray apparently reached essentially the same conclusion when he wrote, "Pursh could not have taken his separate leaflet from this—but doubtless from the other specm. in herb. Lamb. on the same sheet." The very close similarity of Lewis' specimen and Pursh's plate should be convincing that Lindley was in error when he asserted that Pursh's illustration was drawn wholly from Menzies' specimens in the Banksian Herbarium. This is also supported by the criticism in *British Flower Garden*,²² previously quoted. It is a remote possibility that the two complete leaves on Pursh's type sheet are from some other collection than Lewis's, but such an assumption in the lack of evidence is gratuitous.

It further may be again mentioned that it is extremely doubtful if there ever was a Menzies specimen in the Banksian Herbarium, so that Lindley apparently meant either the Nelson specimen in the Banksian Herbarium or the Menzies specimen in the Lambert Herbarium.

In Pursh's original description of the two species occur some statements which still remain questionable. These descriptions need to be considered in the light of the following paragraphs from the preface of his book.

"The descriptions of those plants, as far as the specimens were perfect, I have inserted in the present work in their respective places, distinguishing them by the words *v. s. in Herb. Lewis*. Several of them I have had an opportunity of examining in their living state, some being cultivated from seeds procured by Mr. Lewis, and others since my arrival in England from seeds and plants introduced by Mr. Nuttall." (p. xi.)

"Perfect seeds from the last-mentioned tree [Osage apple] were given by Lewis to Mr. McMahon, nursery and seedsman, at Philadelphia, who raised several fine plants from them, and in whose possession they were when I left America." (p. xii.)

"Besides these general collections, there were a number of interesting new plants in the Banksian Herbarium collected by different persons in North America. Among them I found a number of those collected by Archibald Menzies, Esq., during the famous expedition under Vancouver, on the north-west coast of America. As several of them had been described by me from the Lewisian collection, I requested permission of Mr. Menzies to adopt such as were immediately connected with my plan, which he very obligingly complied with. (p. xvii.)

²² II. 1: under *pl.* 94.

"After the usual sign of duration, and the time of flowering, each species has been faithfully marked whether I have seen it myself in a living state (*v. v.*), or only in a dried specimen (*v. s.*); in the latter case the name of the herbarium I had it from is generally mentioned. Those I have adopted without seeing them myself in either state, and which are but few, I have marked (+)." (p. xxi.)

In the descriptions of the two species the symbol "*v. v.*" does not occur with either, yet in that of *Berberis aquifolium* Pursh says, "berries dark purple, eatable," and "*Bacca* 3-locularis, 3-sperma, abortione interdum monosperma." The last phrase is apparently explained in the note under *B. nervosa*, where Pursh says that "the statement I have given of it was taken from a single and imperfect berry." This statement is that above quoted, as in the description of *B. nervosa* only the leaves are described, with the explanation, "The specific difference excluded, the description of the preceding species [i. e. *B. aquifolium*] is applicable in every other respect." The description of the fruit may have been taken from Menzies' specimen or more likely from the Nepaul species collected by Buchanan and referred to by Pursh in the note under *B. nervosa*. The origin of the information "berries dark-purple, eatable" is wholly obscure.

On the basis of the series of specimens collected at the Great Rapids and a reexamination of the type specimen, the writer believes that all of the type sheet was in reality collected by Lewis and that it all represents the shiny-leaved species. The flowering shoot has leaves less lucid than usual, but certainly too shiny to associate it with typical *Berberis repens* Lindl.

There seems no other basis than Lindley's statement, already discussed, that Pursh's plate was drawn from a specimen of Menzies. Lindley labored under the idea that Lewis's Great Rapids specimen was the same at least in part as that of which he brought back seeds, the progeny of which seed was the basis of *Berberis repens* Lindl. Lindley in all probability had not seen Pursh's type. The conclusions of Torrey and Gray are largely based on Lindley's statements, as it is not clear that either of these botanists had examined Pursh's type specimen before the time they published their comments; indeed they quote "ex Lindl."

In the light of the data presented above, the specific name *aquifolium* should be retained for the shiny-leaved, usually tall species of the northwest coast, which extends into the interior of Washington as far as Spokane, while the name *repens* should remain associated with the smaller plant of Montana, which in various forms ranges over much of the area east of the Cascade Mountains from British Columbia and Montana to California and New Mexico. A very extensive bibliography of these *Berberis* species up to 1878 may be found in Watson's Bibliographical Index (pp. 34-35).

EXPLANATION OF PLATE 24.—Photograph (reduced) of the type specimen of *Berberis aquifolium* Pursh, now in the herbarium of the Philadelphia Academy of Natural Sciences. From the labels it is clear that Pursh originally intended to publish the plant as a new genus. The principal label in Pursh's handwriting reads as follows: "————— *ilicifolia*, Nov. genus. Mountain Holly. The flowering stem springs up from near the ground and is upright; the infertile shoots trail along the ground. Rich soil among rocks. Great rapids of Columbia. April 11, 1806. Capt. Lewis."

The unpublished genus name of Pursh is omitted and it has also been obliterated from the plate, to avoid bringing additional synonymy into the literature of the subject.

EXPLANATION OF PLATE 25.—A portion of the type specimen of *Berberis aquifolium* Pursh, shown in Plate 24. Natural size.

EXPLANATION OF PLATE 26.—Photograph of Pursh's colored plate of *Berberis aquifolium*. It is clearly evident that the flowering shoot was drawn from the Lewis specimen. The separate leaflet probably depicts the missing leaflet of the lower leaf of the Lewis specimen. The three-lobed stigma on the fruit is erroneous.

INDEX.

[Synonyms in italic.]

	Page.		Page.
<i>Berberis acutifolia</i> -----	442	Berberis—Continued.	
<i>aquifolium</i> -----	437	<i>repens</i> -----	440,
438, 439, 440, 441, 442, 443,		441, 443, 444, 445, 446, 447, 448, 450	
444, 445, 446, 447, 448. 450		<i>willcoxii</i> -----	448
<i>dictyota</i> -----	448	<i>Mahonia</i> -----	437, 440
<i>nana</i> -----	444	<i>aquifolium</i> -----	440, 441, 442, 443
<i>nervosa</i> -----	437,	<i>nutkana</i> -----	441, 443, 444, 451
438, 439, 441, 443, 444, 445, 446, 450		<i>diversifolia</i> -----	441, 443
<i>nutkana</i> -----	444	<i>glumacea</i> -----	437, 445
<i>pinnata</i> -----	441, 443, 447	<i>Odostemon</i> -----	437
<i>pumila</i> -----	448		vii





BERBERIS AQUIFOLIUM PURSH.



BERBERIS AQUIFOLIUM PURSH.



BERBERIS AQUIFOLIUM PURSH.