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NOTES ON NEW ENGLAND HEPATICAE,— XV.[1]

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(Plate 126.)

THE genus *Nardia* is well represented in New England. Of the six species so far reported *N. hyalina* and *N. obovata* belong to Lindberg's subgenus *Eucalyx*, a group which Breidler has raised to generic rank. Two of the other species, *N. scalaris* and *N. Geoscyphus*, belong to the subgenus *Eunardia*, while the remaining species, *N. crenulata* and *N. crenuliformis*, form a connecting link between *Eucalyx* and *Jungermannia*. For a number of years the writer has been puzzled by a species of *Nardia* which is closely related to *N. hyalina* and *N. obovata*. It has been observed in several mountainous localities, especially in the White Mountains, and seems to retain its distinctive features, even while exhibiting a considerable range of variability. This species is here proposed as new, and the characters of the two allied species are discussed at some length for the sake of comparison. Another interesting addition to be reported is *Cephalozia Loitlesbergeri*, a species recently recorded from Nova Scotia. At the close of the paper a few additions to local state floras and a revised census of New England Hepaticae are given.

1. NARDIA HYALINA (Lyell) Carringt. Brit. Hep. 35. *pl. 11, f. 36.* 1875. *Jungermannia hyalina* Lyell; Hooker, Brit. Jung. *pl. 63.* 1814. *J. Schmideliana* Hüben. Hep. Germ. 99. 1834. *J. biformis* Aust. Proc. Acad. Philadelphia for 1869: 220. *Solenostoma hyalinum*

Contribution from the Osborn Botanical Laboratory.

Mitt.; Godman, Nat. Hist. Azores 319. 1870. *Southbya biformis* Aust. Hep. Bor.-Amer. *26*. 1873. *Aplozia hyalina* Dumort. Hep. Eur. 58. 1874. *Southbya hyalina* Husnot, Hep. Gall. 16. 1875. *Nardia biformis* Lindb. Acta Soc. Sci. Fenn. **10**: 530. 1875. *Eucalyx hyalinus* Breidl. Mitt. Nat. Ver. Steiermark **30**: 292. 1894. *Mesophylla hyalina* Corbière, Rev. Bryol. **31**: 13. 1904. [Text figs. 1–9.] On banks or earth-covered rocks. Maine: banks of the St. John River, Fort Kent (*A. W. E.*); St. John Pond, upper reaches of the St. John River (*G. E. Nichols*). New Hampshire: Randolph (*A.W.E.*). Vermont: Newfane (*M. A. Howe 32*); Quechee Gulf, Hartford (*A. Lorenz 773*); Brandon (*D. L. Dutton 440, 726*); Rochester, road from Brandon (*A. Lorenz*). Massachusetts: West Newbury (*C. C. Haynes*); Mt. Greylock (*A. L. Andrews*); Granville (*A. Lorenz*). Connecticut: Ansonia (*J. A. Allen*); Middletown (*A. W. E.*); Naugatuck (*A. W. E., G. E. Nichols*); Canterbury (*S. B. Hadley*); Watertown (*A. Lorenz*). Specimens from the following stations outside New England have likewise been examined by the writer: Lime Kiln Falls, Herkimer County, New York (*C. C. Haynes*); near Closter, New Jersey (*C. F. Austin;* distributed in Hep. Bor.-Amer. *28* in part, as *Jungermannia hyalina*); Delaware Water Gap, New Jersey (*C. F. Austin;* distributed in Hep. Bor.-Amer. *26*, as *Southbya biformis*); Milford, Pennsylvania (*G. E. Nichols*); Auburn, Alabama (*F. E. Lloyd & F. S. Earle*); Ohio (*L. Lesquereux;* distributed in Austin's Hep. Bor.-Amer. *28* in part, as *Jungermannia hyalina*); Urbana, Ohio (*Mrs. M. P. Haines*); Thompson Ledge, Geauga County, Ohio (*O. Hecker*); Fayette, Wisconsin (*L. S. Cheney*); dells of the Wisconsin River, Wisconsin (*L. M. Underwood*); valleys of the Montreal and Wisconsin Rivers, Wisconsin (*L. S. Cheney 3659, 3680, 3703, 5128, 5152*); Galesville, Wisconsin (*J. M. Holzinger*); Pacific, Missouri (*N. L. T. Nelson 2024*). Several of these specimens are in the herbarium of the New York Botanical Garden.

Since the discovery of *Nardia hyalina* in the British Isles, over a century ago, its known range in Europe has gradually been extended until it now includes the greater part of the continent. There, as on this side of the Atlantic, the species prefers low altitudes, rarely ascending above the foothills of the mountains. Outside of Europe it is known in the Old World from the Azores, Madeira and the Canaries, from Tunis, and from the southern shores of the Black Sea. Its range in America is still incompletely known. What is apparently

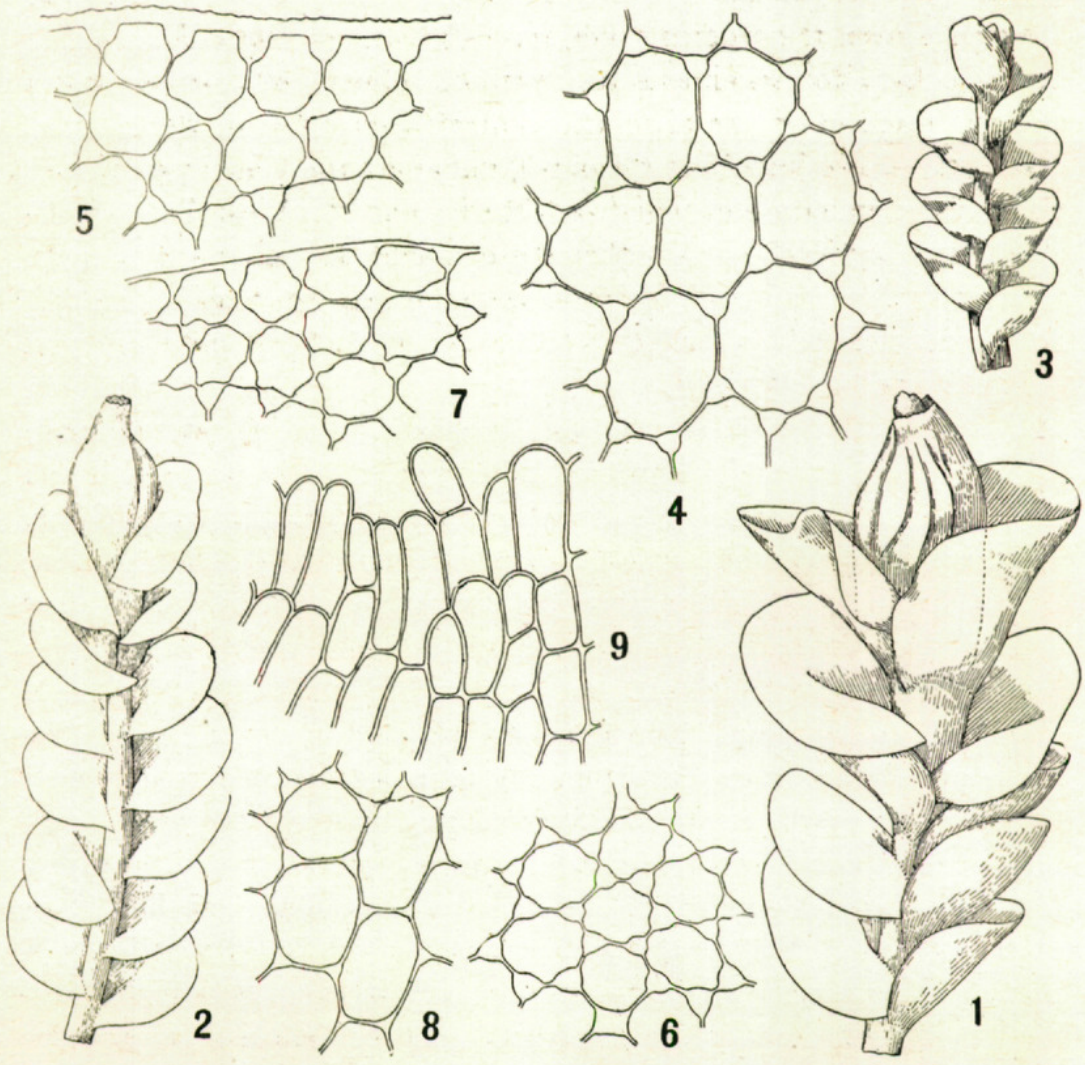
the earliest record for the species was made by Gottsche,[1] in 1863, and was based on specimens collected by F. Müller in the Orizaba region of Mexico. The following year the same author [2] reported it somewhat doubtfully from the province of Bogotá, in Colombia, and specimens from the Andes of Ecuador have since been described by Spruce [3] and distributed in his exsiccatae. The writer has seen no specimens from the tropics which represent unquestioned *N. hyalina*. Spruce's Ecuador specimens are certainly closely related but differ in their more erect habit, in the ventral decurrence of their leaves and in the dense bundle of rhizoids lying along the ventral surface of the stem. Similar specimens from Mexico and the West Indies have also been examined, but whether these should be regarded as a well-marked variety of *N. hyalina* or as a distinct species is not yet clear. Gottsche's Mexican and Colombian specimens have unfortunately not been available for study.

In the United States the earliest report of *N. hyalina* was made in 1873 by Austin,[4] who distributed specimens, correctly determined, from New Jersey and Ohio. In 1891, Underwood [5] accredited the species to California; in 1902 the writer [6] cited specimens from Maine, Vermont, Massachusetts and Connecticut; and in 1908,[7] from New Hampshire. In the same year, in conjunction with Nichols, he [8] listed four new stations for Connecticut and assigned to the species a North American range extending from New England to Minnesota and south to Maryland, this range being based largely on specimens in his own herbarium. Unfortunately, some of the published records for the species were based on plants which prove to have been incorrectly determined. Although definite stations for Maine, New Hampshire and Connecticut are included in the revised list given above, the original records for these states were based wholly or in part on other species, while the specimens from Minnesota and Maryland are either doubtful or incorrect. The confusion regarding the species is due largely to the great variability which *N. hyalina* and its allies exhibit. In the case of sterile material the difficulties of de-

[1] Kongel. Danske Videns. Selk. Skr. V. **6**: 185. 1863.
[2] Ann. Sci. Nat. Bot. V. **1**: 119. 1864.
[3] Trans. Bot. Soc. Edinburgh **15**: 519. 1885.
[4] Hep. Bor.-Amer. *28*. 1873.
[5] Zoe **1**: 365. 1891. This record has not been confirmed.
[6] Rhodora **4**: 209. 1902.
[7] Rhodora **10**: 192. 1908.
[8] Conn. State Geol. & Nat. Hist. Surv. Bull. 11: 51. 1908.

termination are still further increased, and species of other genera with undivided leaves, such as *Jungermannia*, *Jamesoniella* and *Odontoschisma*, are likely to be mistaken for the *Nardia*.

In its typical development *N. hyalina* forms more or less compact tufts, with the stems prostrate to somewhat ascending. The color is a pale or yellowish green, and the living plants show "a peculiar



Figs. 1–9. NARDIA HYALINA (Lyell) Carringt.

1, 2. Stems with perianths, dorsal view, × 15. 3. Male stem, dorsal view, × 15. 4. Cells from the median portion of a leaf, × 265. 5. Marginal cells from the same leaf, × 265. 6, 7. Median and marginal cells from a leaf of another specimen, × 265. 8. Median cells from another leaf of the second specimen, × 265. 9. Cells from the mouth of a perianth, inner surface, × 200. Rhizoids and the verruculae on the leaf-cells are not shown. Figs. 1, 3, 4, 5 and 9 were drawn from a specimen collected at Brandon, Vermont, by D. L. Dutton *726;* the remaining figures, from a specimen collected at Naugatuck, Connecticut, by the writer.

glistening appearance," which Macvicar[1] mentions and which often aids in their recognition. Sometimes a reddish pigmentation becomes manifest in the axes and leaves, and this may change the appearance of the plants completely. Since, however, a distinctly red plant often gives rise to new growths without pigmentation, the color cannot serve as a basis for distinguishing varieties.

The branches seem to be invariably intercalary in character. They are given off by the lateral segments and take their origin just above the leaves, close to the ventral end of the line of attachment. What induces the formation of branches is not always clear, but the cessation of growth in an axis seems often to stand in a direct causal relation. This cessation may be due to injury or to the development of archegonia. In the latter case, especially in the absence of fertilization, branching is almost sure to occur. The branches sometimes arise at some distance behind the inflorescence, but are more likely to develop as subfloral innovations, either between the perianth and an innermost bract, or between two successive bracts. The basal leaves of a branch are very small but these are succeeded, under favorable conditions, by larger and larger leaves, the branch soon acquiring the appearance of the axis from which it sprang. Schiffner[2] states that he has never seen stolons in *N. hyalina*, and most specimens seem indeed to be quite free from them. The species does not lack them completely, however, and they are sometimes produced in considerable abundance. Even a Bohemian specimen,[3] determined by Schiffner himself, shows an occasional stolon, indicating that these structures are by no means confined to American material. The stolons are somewhat more slender than ordinary stems and tend to grow downward. Their leaves are exceedingly rudimentary, and no cases have been observed where a stolon gave rise to a leafy shoot.

The leaves of *N. hyalina* (Figs. 1, 2) are usually somewhat imbricated, and the lines of attachment are long and oblique, bending abruptly downward at their ventral ends. The leaves are suborbicular, the broadest part being just above the base; they are normally about 1 mm. long and wide, but vary greatly, the extremes being usually between 0.75 mm. and 2 mm. The apex is broad and rounded or

[1] Student's Handb. British Hepatics 134. 1912.

[2] Ann. Naturhist. Hofmus. Wien **23**: 135. 1909.

[3] The label reads as follows: "Flora von Böhmen. Gegend von Hohenfurth — Schwarzwaldburg, Wegböschung, 680m. 1896. 2/9. lgt. et det. Schiffner."

rarely vaguely emarginate, and the margin is quite entire. At the dorsal base there is usually a narrow but distinct decurrent portion, but this is sometimes scarcely evident; it is especially marked when the margin shows an abrupt turn just above the region of decurrence. Although the leaves tend to spread widely from their long lines of attachment, they are sometimes more or less concave and then often assume an ascending or suberect position, the leaves of one side thus approaching those of the other. On vigorous plants the leaves tend further to be undulate, and this condition is usually best marked in the upper leaves of a female branch and in the bracts themselves. This is well shown in the figures published by Macvicar and Müller.[1]

As Schiffner has shown, the species of the subgenus *Eucalyx* exhibit wide extremes in the size of their leaf-cells (Figs. 4–8), and these extremes sometimes manifest themselves in the different leaves of an individual plant. Specific differences based on differences in the size of the cells must therefore be used with caution. The five specimens of *N. hyalina* distributed by Schiffner in his "Hepaticae europaeae exsiccatae" (Nos. 62, 63, 367, 368, 369), and coming from widely scattered localities, gave the following average measurements: marginal cells, 23–34 μ; median cells, 32–41 $\times$ 26–34 μ. These measurements agree essentially with those obtained from North American specimens, although one of the latter showed marginal cells ranging from only 15 μ to 28 μ. Except for a slight difference in size the marginal cells are like the others, and the leaves consequently lack the specialized border which forms so distinctive a feature in *N. crenulata* (Sm.) Lindb., *N. crenuliformis* (Aust.) Lindb. and certain other species of the subgenus. Another feature which will help in distinguishing the species from *N. crenulata* is the constant presence of trigones. These are usually distinct, even when minute, and are often conspicuous with bulging sides. In fresh material the oil bodies in the cells stand out clearly but cannot often be detected in dried specimens. Each cell contains from two to eight of these bodies, which are oval or bluntly fusiform and measure 10–14 μ in length and 5–6 μ in width. They have even outlines but present the appearance of being minutely granular in structure. According to Stephani [2] the cuticle of *N. hyalina* is papulose, but most authors describe it as smooth and thus distinguish it from the striate-verruculose cuticle

[1] Rabenhorst's Kryptogamen-Flora **6**: *f. 272.* 1909.
[2] Bull. de l'Herb. Boissier II. **1**: 502. 1901.

of the closely related *N. obovata* (Nees) Lindb., a species to be discussed below. Schiffner[1] has pointed out the need of caution in employing differences of this type in separating the species of *Nardia*. In the writer's experience the cuticle of *N. hyalina* is sometimes smooth throughout but often shows minute verruculae, which are exceedingly delicate and inconspicuous. They are narrow and parallel in the basal part of the leaf but gradually become shorter toward the margin and show an oval or circular outline. The verruculae are sometimes confined to certain leaves of a plant or to certain parts of a leaf; they are perhaps a little commoner in American material than in European.

Rhizoids are abundantly produced and often show a beautiful claret color, a feature which has been much emphasized in descriptions of the species. Since, however, the red color is not always present, and since the rhizoids of *N. obovata* and other allied species are sometimes even more deeply pigmented, it is unwise to attach much importance to the color as a specific character. The rhizoids spring mostly from the ventral surface of the stem but occasionally from the leaf-cells near the ventral base or even from the cells of the bracts and perianth. This last condition is especially well seen in a deeply pigmented specimen from Naugatuck, Connecticut, where some of the old perianths are almost shaggy with rhizoids. In certain tropical species the rhizoids show a tendency to grow backwards and to form a compact bundle lying close to the stem, but this tendency is not apparent in *N. hyalina*, the rhizoids growing out irregularly in all directions.

Underleaves are normally absent, as the descriptions indicate, but the ventral segments give rise to ephemeral appendicular organs which are homologous with underleaves. These were described and figured by Leitgeb[2] many years ago. They are in the form of minute clusters of slime-papillae, four or five being usually present in each cluster, and it is easy to demonstrate them by dissecting off the apical portion of a stem and clearing it with potash solution. As Leitgeb pointed out, the papillae are really borne on the margin of a rudimentary scale consisting of only a few cells.

Authors are now nearly unanimous in considering *N. hyalina* a dioicous species. At one time, however, certain hepaticologists

[1] Oesterr. Bot. Zeitschr. **50**: 454 (footnote). 1910.
[2] Unters. über Leberm. **2**: 8. *pl. 9, f. 10.* 1875.

thought that the inflorescence was variable and that both monoicous and dioicous plants occurred. Carrington,[1] for example, stated that the species "was not always dioicous" and described androecia in the form of "special branches attached to the ventral surface of fertile shoots." Although the occurrence of ventral male branches has apparently not been confirmed, Arnell [2] states that he has observed paroicous individuals in material from Norway and Lower Austria, and Müller admits an occasional paroicous inflorescence in the species. Upon studying paroicous plants from the British Isles, Schiffner noted that this type of inflorescence was associated with larger leaf-cells, larger cells in the walls of the capsule, larger spores and wider elaters. He therefore separated these plants from *N. hyalina* and described them as a new species under the name *N. paroica* Schiffn.,[3] a species which British botanists have been quick to recognize. In all probability the other paroicous plants, which have been referred to *N. hyalina*, belong to Schiffner's new species, although this has not yet been definitely established.

There is no sharp distinction between the leaves of *N. hyalina* and the perichaetial bracts (Figs. 1, 2). A general increase in size and especially in width is to be observed in most cases and often a greater degree of undulation, but these modifications are sometimes scarcely perceptible and even the innermost bracts may be essentially like the leaves. Bracteoles, except as an abnormality, are not developed. According to the descriptions the bracts in *Nardia* are more or less concrete with the perianth. This expression, however, is not wholly correct. There is really formed a shorter or longer perigynium in the form of a cup, upon the outer surface of which the bracts are borne. A similar but much deeper perigynium is characteristic of the genus *Isotachis*, as Goebel [4] has clearly shown. The margin of the cup, within the innermost bracts, gives rise to the actual perianth, the length of which tends to vary inversely with the height of the perigynium. In the case of *N. hyalina* the normal relation is figured by Macvicar.[5] On one side the cup is about a third the length of the perianth, on the opposite side about an eighth. This condition represents one extreme; in the var. *heteromorpha* (Gottsche) Schiffn.,

[1] Brit. Hep. 37. 1874.
[2] Leberm.-Stud. aus nördl. Norwegen 38. 1892.
[3] Lotos **58**: 320. 1910.
[4] Flora **96**: 141. 1906.
[5] Student's Handb. British Hepatics 133. *f.* 5. 1912.

which represents the other, the cup is about one eighth the length of the perianth on one side and scarcely developed at all on the side opposite.

The perianth may begin to narrow at once or broaden out slightly before narrowing, according to the height of the perigynium. If fertilization has taken place it usually projects well beyond the bracts; if fertilization has failed it remains shorter and often scarcely projects at all. It usually narrows to the mouth without forming a distinct beak. In the upper part and sometimes throughout the greater part of its length, the perianth is deeply and irregularly plicate, the number of folds varying usually from three to five. These folds involve the mouth itself, which has a longer periphery than at first appears. No distinct lobes can be made out upon dissection (except those formed by tearing when the capsule is extruded, but the marginal cells project as crenulations or short cilia (Fig. 9), which often bend inwards, and sometimes small groups of the cells project slightly beyond their neighbors and form vague crenations. In the vicinity of the mouth and sometimes throughout the greater part of its extent the perianth is composed of elongated cells. Usually, however, especially if fertilization has taken place, the basal part is composed of short, almost isodiametric cells, and these occasionally extend almost to the mouth. In the contracted terminal portion the cells on the inner surface (especially along the internal folds) sometimes project slightly as blunt and very short papillae (in Fig. 9 three such cells are shown) and thus help the marginal cells in blocking up the mouth.

A typical male inflorescence has been figured by Müller.[1] The bracts are loosely to closely imbricated and vary in number from one or two pairs to a dozen or more. The cluster is at first terminal but often becomes intercalary by the vegetative elongation of the branch. A bract is usually a little shorter than the vegetative leaves of the same axis and may be much shorter. When viewed from above it presents the appearance of being complicate-bilobed with a rounded keel tending to become straight or concave in the outer part, the dorsal lobe being distinctly smaller than the ventral. This dorsal lobe represents an inflexed dilation of the basal portion of the leaf, which (although slightly decurrent) is less obliquely attached than in normal leaves. The ventral lobe is distinctly concave. In the

[1] Rabenhorst's Kryptogamen-Flora **6**: *f. 272 D.* 1909.

pocket formed between the two lobes two or three antheridia are situated. The typical condition just described is not always realized, as Fig. 3 shows. The keel here is less rounded and the dorsal lobe is almost as long as the ventral, although still much narrower. The antheridia in bracts like these are sometimes borne singly.

According to Müller the stalk of the capsule consists normally of three concentric layers of cells, the outermost numbering twenty in cross-section, the second twelve, and the innermost four. He admits, however, that there are deviations from these numbers, and the writer would refer the stalk to the "type général" of Douin,[1] in which the number of cells present varies according to the robustness of the plants. The capsule shows the usual thickenings in the walls of the cells. Those on the outer surface average about 35 × 25 μ and show rod-like thickenings in both longitudinal and transverse walls. On the inner surface the cells average about 13 μ in width and usually measure 30–50 μ in length. Each cell shows from four to ten half-rings, according to its length. The spores are 15–17 μ in diameter and the bispiral elaters average 9 μ in width.

The various forms of *N. hyalina* in Europe have been carefully studied by Schiffner,[2] who recognizes the three following varieties, in addition to the typical form of the species: var. *heteromorpha* (Gottsche) Schiffn., var. *subaquatica* Schiffn., and var. *ovalifolia* Schiffn. These varieties have not yet been distinguished in American material, and the writer is not prepared to designate any of the American forms by varietal names on account of the inconstancy of their characters.

The synonyms of *N. hyalina* should evidently include *N. biformis* (Aust.) Lindb., as indicated above. This species has long been a puzzle to students of the Hepaticae. It was based on male material collected in 1867 by Austin at the Delaware Water Gap, New Jersey, where it grew on steep, wet rocks. The original specimens were distributed in Austin's exsiccatae, and no additional stations for the species have been recorded. According to the original description the species is "remarkable for the closely entangled and matted stems and surculi, and for the leaves of two forms." The leaves of one form, borne on the stems, are said to be obliquely semicircular or broadly ovate, decurrent at the dorsal base, and entire or retuse at

[1] Bull. Soc. Bot. France **55**: 274. 1908.
[2] See Verhandl. Zool.-Bot. Ges. Wien **53**: 418–421. 1904.

the apex; while those of the surculi, arising from the ventral surface of the stems, are said to be half as large as the stem-leaves, ovate or obovate in form, scarcely decurrent, and markedly obtuse at the apex. Austin noted further that the uppermost rhizoids were sometimes red but made no mention of the male bracts. These were detected by Lindberg, who recognized an affinity between *N. hyalina* and *N. biformis*, emphasizing the purple rhizoids, but who made no attempt to reduce the latter species to synonymy.

An examination of Austin's specimens indicates that they represent an environmental modification. Possibly the development of the numerous surculi has been induced by water flooding the prostrate stems. These surculi are not especially distinctive, very similar branches being often present in tufts of typical *N. hyalina*, especially when the plants are crowded. Many of the leaves on the surculi are distinctly though shortly decurrent, and the differences between the two forms of leaves are often less marked than the original description implies. The leaf-cells, as Austin notes, are thin-walled, but some of them show minute trigones and the cuticle is often vaguely verruculose. The male bracts agree closely with those of *N. hyalina*. On the whole there seem to be no trustworthy characters for separating *N. biformis* as a distinct species.

2. **Nardia obscura** sp. nov. Growing in more or less compact tufts, bright green varying to deep blackish purple: stems mostly 1–2 cm. long and 0.2–0.45 mm. in diameter, the older portions prostrate and closely adherent to the substratum, the younger portions usually free from the substratum, sparingly branched, the branches intercalary, arising from the lateral segments just above the ventral leaf-bases, sometimes leafy but often in the form of slender stolons; no subfloral innovations observed; rhizoids usually abundant on the prostrate stems and stolons, rare elsewhere, colorless to deep purple, not forming a ventral bundle; leaves distant to loosely imbricated, slightly decurrent dorsally and sometimes ventrally, attached by oblique lines but usually appearing subtransversely inserted at the dorsal base, broadly ovate to orbicular, mostly 0.9 × 1.5 mm. long and 0.75–1.5 mm. wide, usually rounded at the apex but sometimes retuse, margin entire; leaf-cells thin-walled but with minute trigones, marginal cells not differentiated, mostly 15–20 μ in diameter, median cells mostly 25–35 μ long and 20–28 μ wide, cuticle smooth to delicately striate-verruculose: underleaves lacking: inflorescence dioicous, the male and female plants sometimes in the same tuft: perichaetial bracts in about two pairs, a little broader and more undulate than the leaves but otherwise very similar; perigynium and perianth

together 1.5–2 mm. long and 0.7–1 mm. wide, the perigynium about as long as the perianth or longer, usually bearing one bract on one side and two on the other; perianth conical, shorter than the bracts, irregularly plicate in the upper part, composed throughout of more or less elongated cells, the mouth minutely crenulate (or short-ciliolate) from projecting cells: androecium short, the bracts mostly in two to six pairs, imbricated, deeply saccate and complicate, the dorsal part usually a little smaller than the ventral but sometimes equalling or surpassing it in size, keel strongly arched throughout or becoming slightly concave in the outer part; antheridia borne singly or in pairs: mature sporophyte not seen. [Plate 126.]

On steep, damp rocks, usually in shaded ravines. Maine: banks of the Carrabassett River, Jerusalem (*J. F. Collins 1609;* listed by the writer as *N. hyalina*, RHODORA **4**: 209. 1902). New Hampshire: banks of the Ellis River, Jackson (*A. W. E.;* distributed in Underwood & Cook's Hep. Amer. *83*, as *N. crenuliformis;* listed by the writer as *N. obovata*, Proc. Washington Acad. Sci. **2**: 298. 1900); the "V," Waterville (*A. Lorenz 203;* listed by the writer as *N. hyalina*, RHODORA **10**: 192. 1908); same locality (*A. W. E.*); between the Greeley Ponds, Waterville (*A. Lorenz*); Profile Brook and the Flume, Franconia Mountains (*C. C. Haynes, A. Lorenz & A. W. E.;* listed by Miss Lorenz as *N. hyalina*, Bryologist **11**: 113. 1908); Coosauk Falls, Triple Falls and the Ice Gulch, Randolph (*A. W. E.*); Huntington Ravine, Mt. Washington (*A. W. E.*). Vermont: Downer's Glen, Manchester (*A. J. Grout;* listed by the writer as *N. obovata*, RHODORA **7**: 58. 1905). Massachusetts: Mt. Greylock (*A. L. Andrews*). Connecticut: Beacon Falls (*A. W. E.;* listed by the writer as *N. hyalina*, Conn. State Geol. & Nat. Hist. Surv. Bull. 11: 51. 1908). New York: Rainbow Falls, Adirondack Mountains (*W. G. Farlow*). The specimen collected by the writer at the "V," Waterville, New Hampshire, on August 18, 1911, may be designated the type.

In some respects *N. obscura* is intermediate between *N. hyalina* and *N. obovata* and it is not surprising that it has been confused with both. It agrees with *N. hyalina* in its dioicous inflorescence and with *N. obovata* in its deep perigynium; all three species have in common the following features: suborbicular entire leaves, normally rounded at the apex; thin-walled leaf-cells with trigones, the marginal cells essentially like the others and therefore not differentiated to form a border; more or less abundant rhizoids, often pigmented with red or purple; and a plicate perianth without a beak, composed (at least in part) of elongated cells.

Although *N. obscura* descends into the lowlands it is more at home in the hills and lower mountains, not ascending above the tree line. It prefers steep rocks in dark shaded ravines, especially where trickling water is present during a part of the year; and the creeping stems and stolons cling so closely to the substratum that it is difficult to separate them. In some cases a sandy sediment collects about the plants, only the tips protruding. In its choice of a habitat it therefore differs from *N. hyalina*, which prefers the lowlands and is almost never directly attached to rocks, growing by preference on sandy banks or in similar situations. There are also certain differences in color to be observed: in *N. obscura* the color is originally a bright green, but the pigmentation, which is purple rather than red, is usually present to a greater or less extent and not infrequently involves the entire plant; in *N. hyalina* the original color is pale or yellowish green, and the pigmentation, which is reddish rather than purple, is often absent altogether and very rarely involves the entire plant. Stolons can nearly always be demonstrated in *N. obscura*, if the plants are carefully dissected apart, while in *N. hyalina* they are often not developed at all.

In the leaves (Figs. 1–5) there are certain differences to be detected when the plants are directly compared, but it is difficult to describe them in words. Although the leaves are attached in both species by long oblique lines, the basal part of the leaf in *N. hyalina* is usually plane or convex, somewhat as it is in *Plagiochila;* in *N. obscura*, on the other hand, it shows a tendency to be appressed to the stem for a short distance and then sharply revolute, giving the effect of a more transverse attachment. Retuse apices are perhaps a little commoner in *N. obscura* than in *N. hyalina*, and sometimes, when taken in connection with the purple pigmentation and the apparent subtransverse insertion of the leaves, produce a vague resemblance to certain species of *Marsupella.* According to the average measurements the leaf-cells of *N. obscura* are a trifle smaller than those of *N. hyalina*, and the cells are further distinguished by slightly smaller trigones (Figs. 6, 7).

The inflorescences, both male and female, yield excellent differential characters. In *N. obscura* the perigynium equals or exceeds the perianth in length (Figs. 1, 2, 8), and the latter organ is composed throughout of more or less elongated cells and does not project beyond the bracts; in *N. hyalina* the perigynium is considerably shorter than the perianth, and the latter organ (at least when fertilized) is

composed in part of short cells and projects well beyond the bracts. The male inflorescence in *N. obscura* (Figs. 3–5) tends to be shorter than in *N. hyalina*, the bracts are more deeply saccate, and the dorsal fold (or lobe) often equals or surpasses the ventral in size. It is to be regretted that the capsules present in the material of *N. obscura* are all immature, so that the characters exhibited by the valves and spores are still unknown. The stalk, however, as shown by cross-sections, conforms to Douin's "type général," just as in the case of *N. hyalina*.

An Asiatic species which should be compared with *N. obscura* is *N. subtilissima* Schiffn.[1] This species was based on material collected by Handel-Mazzetti in the province of Trebizond, Asia Minor, where it grew on shaded rocks at an elevation of about 650 meters. According to Schiffner's full description *N. subtilissima* is stoloniferous and dioicous, the perigynium is about as long as the perianth, and the dorsal lobes of the male bracts are larger than the ventral. It has been shown that this last feature is occasionally present in *N. obscura*, and the other characters mentioned are likewise found in the American species. The Asiatic plant, however, is much more delicate than *N. obscura*, and seems to show no signs of pigmentation; the leaves are elliptical, measuring only 0.5 × 0.4 mm., and the thin-walled leaf-cells with very minute trigones usually measure only 18 × 18 μ in the middle of the leaf, rarely attaining a size of 25 × 18 μ.

3. NARDIA OBOVATA (Nees) Lindb. Bot. Not. 1872: 167. *Jungermannia obovata* Nees, Naturg. Europ. Leberm. **1**: 332. 1833. *J. flaccida* Hüben. Hep. Germ. 87. 1834. *Southbya obovata* Lindb.; Hartman, Handb. Skand. Fl. ed. 10, **2**: 130. 1871. *Eucalyx obovatus* Breidl. Mitt. Nat. Ver. Steiermark **30**: 291. 1894. *Aplozia obovata* Loeske, Moosfl. des Harzes 59. 1903. *Mesophylla obovata* Corbière, Rev. Bryol. **31**: 13. 1904. [Text figs. 10–14.] On damp or wet rocks. Maine: east slope "saddle," Mt. Katahdin (*J. F. Collins 2186b*); Chimney Pond, Mt. Katahdin (*A. Lorenz*). New Hampshire: Tuckerman's Ravine, Mt. Washington (*J. A. Allen, A. W. E.*); Oakes Gulf, Mt. Washington (*A. W. E.;* distributed in Underwood & Cook's Hep. Amer. *113*, as *Jungermannia cordifolia*); Thompson's Falls, White Mountains (*L. M. Underwood;* distributed in Miss Haynes's Amer. Hep. *6*).

[1] Ann. Naturhist. Hofmus. Wien. **23**: 136. *pl. 7, f. 13–22.* 1909.

The species was based on material collected in the Giant Mountains of Silesia and Bohemia, and is widely distributed in Europe. In America it is recorded in the literature not only from New England but also from Greenland, Nova Scotia, Washington, California and Colombia. It grows in damp or wet localities and is often submerged. In temperate regions it prefers the higher mountains, attaining a vigorous development above the timber line; in more northern regions it sometimes descends to the sea level. It has been the cause of fully as much confusion as *N. hyalina*, and some of the older reports of its occurrence are in need of revision. Even the author of the species, Nees von Esenbeck, sometimes failed to distinguish it from *Jungermannia amplexicaulis* Dumort., a species which is scarcely more than an aquatic form of *J. sphaerocarpa* Hook. By subsequent writers it has perhaps been more confused with *N. hyalina* and other species of *Nardia*. The Colombian record noted above, the only one from South America, was published by Gottsche[1] many years ago and was based on specimens collected by Lindig in the province of Bogotá. Gottsche described these specimens under a special varietal name, *β bogotensis*, showing that he did not regard them as typical; and in all probability they would now be considered distinct from *N. obovata*. The Alaskan and Californian records are likewise open to criticism. The first was based on specimens collected by Trelease[2] at Farragut Bay and Kadiak; the second on specimens collected by Howe[3] at Blue Lake, Humboldt County. In Trelease's specimens it has proved quite impossible to demonstrate a paroicous inflorescence; the plants are in all probability dioicous and therefore do not agree with *N. obovata*, as understood at the present time. In Howe's specimens the writer has found a single young perianth, in which the mouth is contracted to a distinct beak. This would indicate that it belonged to the genus *Jungermannia*, and the specimen in question is evidently very close to *J. sphaerocarpa* Hook., if, indeed, it should not be referred to that species. The record from Washington, based on specimens collected by Foster[4] at Hamilton, seems to be correct, and the same is true of one of the records from Nova Scotia, based on specimens collected by Nichols[5] in the valley of the Barrasois

[1] Am. Sci. Nat. Bot. V. **1**: 119. 1864.
[2] Evans, Proc. Washington Acad. **2**: 298. 1900.
[3] Mem. Torrey Club **7**: 96. 1899.
[4] See Miss Haynes, Bryologist **12**: 67. 1909.
[5] Bryologist **19**: 41. 1916.

River, Cape Breton (*1445*). The other Nova Scotia records for the species, also made by Nichols, represent the closely related *N. subelliptica* Lindb. and will be considered in another connection. No material from Greenland has been available for study, but the published records, made by the Danish botanist, C. Jensen,[1] are undoubtedly trustworthy. Unfortunately, our knowledge, even at the present time, is not always sufficient to render a positive verdict in the case of sterile and aquatic material, in spite of the attention which Schiffner and other European students have given to modifications induced by an aqueous environment.

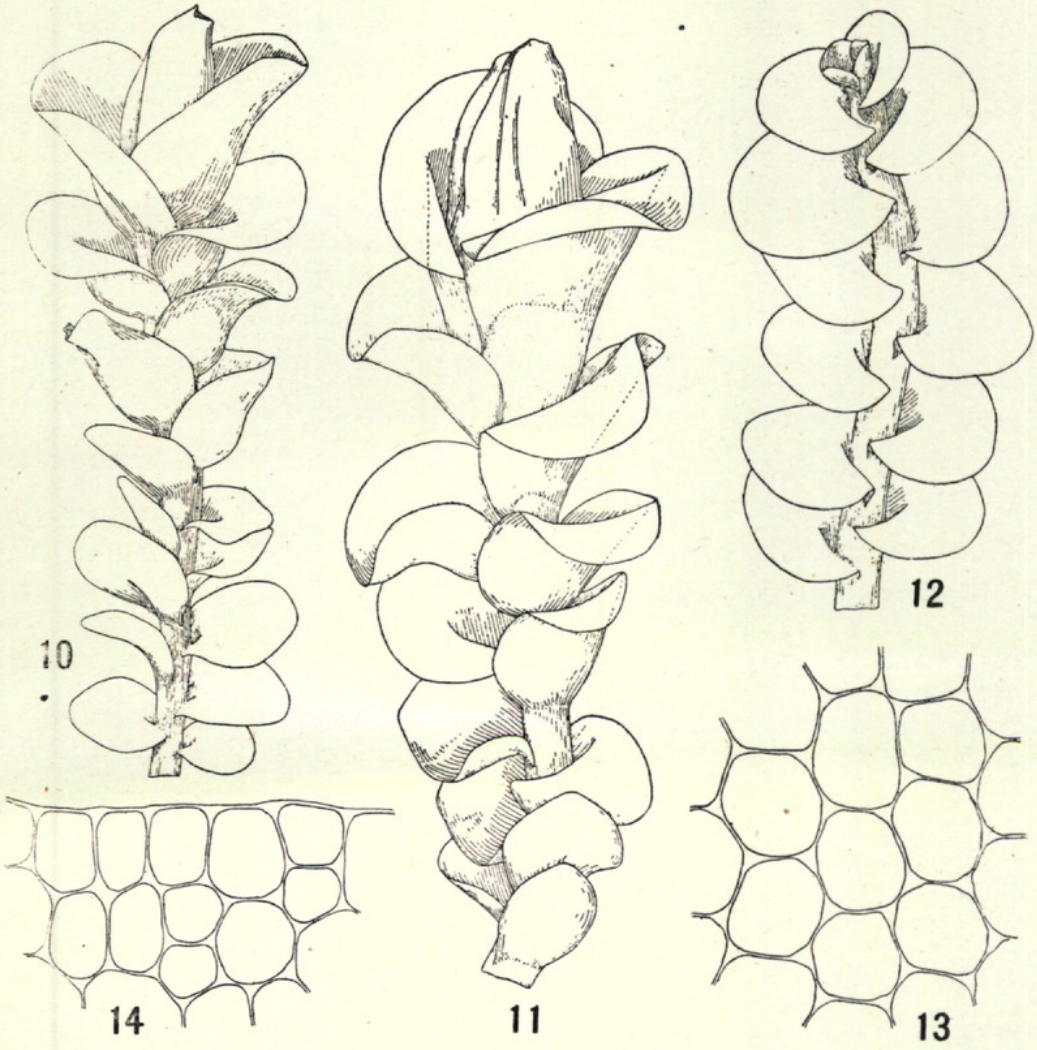
The general habit of *N. obovata* is not unlike that of *N. obscura;* the older stems cling to the substratum, while the younger stems are free or nearly so. There is therefore a tendency for the rhizoids to be restricted to the older stems and to the stolons, which are usually produced in abundance. The branching is the same as in the two preceding species, but no subfloral innovations have been observed even in the absence of fertilization. The color of the plants is originally a deep dull green, but brownish or reddish pigmentation is often present, and in extreme cases a distinct crimson hue becomes apparent in transmitted light. The plants never show the deep purple color which is often associated with *N. obscura.* The rhizoids are usually red but may be pale or even colorless; no tendency to form a ventral bundle is to be observed.

The leaves (Figs. 10–12) are distant to loosely imbricated and are about as large as those of *N. hyalina.* From a long series of measurements the length was found to be between 0.75 and 1.17 mm. and the width between 0.7 and 1.55 mm. There is a tendency for the leaves to be a little longer than broad, but many of the leaves measured were as broad as long and a few were even broader than long. In most cases the shape might be described as broadly ovate with a rounded apex. The line of attachment is normally oblique but sometimes the obliquity is slight and a subtransverse attachment is approximated, especially in the dorsal part. In this respect it often exceeds the condition found in *N. obscura.* At the dorsal base the leaves are decurrent, sometimes for a considerable distance; at the ventral base the decurrence is often equally distinct. In what may be regarded as the most typical cases, the leaves spread widely and

[1] Meddel. om Grønland **15**: 381. 1897; **30**: 309. 1906.

abruptly from the line of attachment, but many deviations from this condition are to be expected, even on an individual stem.

The leaf-cells agree pretty closely with those of *N. hyalina* in their measurements. A series of about fourteen specimens, both European



Figs. 10–14. NARDIA OBOVATA (Nees) Lindb.

10, 11. Stems with male bracts and perianths, dorsal view, × 15. 12. Sterile stem, dorsal view, × 15. 13. Cells from the median portion of a leaf, × 265. 14. Marginal cells from another leaf of the same specimen, × 265. Rhizoids and the verruculae on the leaf-cells are not shown. Fig. 10 was drawn from a specimen collected at Thompson's Falls, White Mountains, New Hampshire, by L. M. Underwood, and distributed by Miss Haynes, Amer. Hep. *6;* the remaining figures were drawn from a specimen collected in Oakes Gulf, Mt. Washington, New Hampshire, by the writer, and distributed by Underwood & Cook, Hep. Amer. *113*, as *Jungermannia cordifolia.*

and North American, gave the following average dimensions: marginal cells, 15–36 μ; median cells, 27–49 × 22–39 μ. The trigones can

nearly always be demonstrated but are usually much smaller than those of *N. hyalina*, agreeing better with those of *N. obscura* (Figs. 13, 14). The cuticle is usually distinctly striate-verruculose, at any rate in the basal part of the leaves.

The paroicous inflorescence (shown clearly in Fig. 10) will serve to distinguish *N. obovata* from most of its immediate allies. The male bracts are not numerous, only two or three pairs being present in most instances, and the modifications which they show are less striking than in either of the preceding species. They are, however, of the same general character, a basal sac being formed by the inflexion of the dorsal part, thus giving the appearance of a complicate-bilobed leaf. The keel is usually somewhat arched but may be almost straight, and the dorsal lobe is usually smaller than the ventral, although sometimes approximating it in size. According to Müller each bract encloses two antheridia.

The perichaetial bracts, which immediately succeed the male bracts, usually number three or four, although sometimes only two are present. They are not very distinctive, but tend to be larger than the vegetative leaves and even more nearly transverse in their attachment, so that they often clasp the perianth at the base. The upper part usually flares widely and may be somewhat reflexed. The bracts, with the possible exception of the most basal one, are borne on the perigynium. The latter organ is about as long as the perianth in case fertilization has taken place; in the absence of fertilization it remains much shorter. The perianth projects slightly beyond the bracts and usually begins to narrow from the very base. Throughout its entire length it is deeply and irregularly plicate, much as in *N. hyalina*, and the mouth itself is somewhat contracted, although no beak is ever formed. If the apical portion of the perianth is carefully spread out the mouth is seen to be minutely and irregularly lobulate, the individual lobules being more or less crenulate or ciliolate from projecting cells. Throughout its entire extent the perianth is composed of somewhat elongated cells, but the elongation is less marked than in *N. obscura* and an isodiametric condition is sometimes approached.

Müller's description of the stalk of the capsule is very definite. He states that three concentric layers of cells are present, the outermost numbering sixteen in cross-section, the second eight and the innermost four. In the writer's experience these numbers are inconstant. In a

section cut from the Oakes Gulf material the outermost layer showed eighteen cells, the second twelve and the innermost seven. It is evident, therefore, that the stalk belongs to Douin's "type général," agreeing in this respect with *N. hyalina* and *N. obscura*. The cells of the capsule-wall are much like those of *N. hyalina*. Those of the outer layer average about 55 × 20 μ, and the thickenings in the transverse walls are infrequent; those of the inner layer average about 11 μ in width and usually measure 40–70 μ in length. These measurements are slightly different from those given for *N. hyalina*, but the measurements of the spores and elaters are essentially the same in the two species.

Some of the differences between *N. obovata* and the two preceding species have already been brought out in the above discussion. In distinguishing it from *N. hyalina* the very unlike habitats should be borne in mind, *N. hyalina* preferring sandy banks and *N. obovata* damp or wet rocks. The differences in habit and in color are likewise significant, *N. hyalina* being usually prostrate, adherent to the substratum and pale, while *N. obovata* tends to be ascending, free from the substratum and dark. The plants are further remarkable for their curious turpentine-like odor, although this peculiarity is found also in *N. obscura*. In distinguishing *N. obovata* from this latter species, which likewise grows on rocks, the larger size, the lack of a purple pigmentation, the more exerted perianth, the less elongated cells of the same and the lobulate mouth will prove especially helpful. Perhaps the paroicous inflorescence, which distinguishes *N. obovata* from both these species is the most important of its differential characters. This character, however, is shared by several other species of *Nardia* and also by *Jungermannia sphaerocarpa* and its allies. Fortunately there is little danger of confusing *N. obovata* with many of these paroicous species. The only ones which approach it closely are *N. paroica* and *N. subelliptica*, which need not be considered further at the present time.

The great variability of *N. obovata* is well described by C. Jensen,[1] in connection with its occurrence on the Faroe Islands. "Near the coast," according to his account, "the small forms — fruiting abundantly during spring — are frequent in crevices and on the ground among rocks. In the mountains the plants gradually become stouter

[1] Bot. of the Faeröes **1**: 135. 1901.

in size and habit, but less abundant in fruit, until they above 300–400 m. form large, deep, dark purplish-brown, barren tufts in rills and round springs." Schiffner recognizes the following varieties by name: var. *bipartita* (K. Müll.) Schiffn., var. *elongata* (Nees) Schiffn., and var. *rivularis* Schiffn. The first of these is known from a single locality in the Vosges Mountains of France. The second, which is commoner, is not very clearly distinguished and seems to intergrade with the typical form of the species; Collins's specimens from Mt. Katahdin and Allen's from Mt. Washington represent it fairly well. The third is not yet definitely known from North America; it was based on sterile, completely submerged specimens from Bohemia, collected by Schiffner, and the opinion is expressed by its author that it may represent a distinct specific type. Schiffner[1] has lately referred to this variety, as a forma *flaccida*, the *Jungermannia flaccida* of Hübener, a species from Germany and Norway, which had long ago disappeared from the literature. If the specific status of the variety should ever be established the plant should of course bear Hübener's specific name.

4. *Cephalozia Loitlesbergeri* Schiffn. In bogs. NEW HAMPSHIRE: Mt. Lafayette and Lonesome Lake, Franconia Mountains, July, 1908 (*C. C. Haynes*). CONNECTICUT: Norfolk. June 10, 1919 (*A. Lorenz & A. W. E.*). Widely distributed in Europe and recently collected by G. E. Nichols[2] on Cape Breton Island, Nova Scotia. The species has recently been discussed at length by the writer,[3] so that it will be sufficient to compare it here with the closely related *C. connivens* (Dicks.) Lindb. Both species are characterized by a pale color, deeply bilobed leaves, with sharp connivent lobes, an autoicous inflorescence and a perianth with a long-ciliate mouth. They may be at once distinguished, however, by their leaf-cells. In *C. Loitlesbergeri* these average about 30 μ in diameter; in *C. connivens*, about 50 μ. In all probability *C. Loitlesbergeri* will be found to have a wide distribution in eastern North America.

The additions to local state floras, not already mentioned in the preceding pages, are as follows: —

For Maine: *Jungermannia sphaerocarpa*, Clearwater Falls, Megantic

[1] Oesterr. Bot. Zeitschr. **50**: 271. 1910.
[2] Bryologist **19**: 42. 1916.
[3] Bryologist **20**: 22. 1917.

Corporation, Franklin County (*A. Lorenz*); *Calypogeia sphagnicola*, Mt. Desert (*A. Lorenz*); *Notothylas orbicularis*, West Farmington (*A. Lorenz*).

For Massachusetts: *Riccardia pinguis*, Richmond (*A. W. E.*); *Pellia Neesiana* and *Lophocolea alata*, Tolland (*A. Lorenz*).

The census of New England Hepaticae now stands as follows: total number of species recorded, 191; number recorded from Maine, 142; from New Hampshire, 151; from Vermont, 129; from Massachusetts, 121; from Rhode Island, 79; from Connecticut, 145; from all six states, 62.

Explanation of Plate 126.

Nardia obscura Evans.

1, 2. Stems with perianths, Fig. 1 showing also a stolon, dorsal view, × 15. Figs. 3–5. Male stems, dorsal view, × 15. 6. Cells from the median portion of a leaf, × 265. 7. Marginal cells from the same leaf, × 265. 8. Longitudinal section of a young sporophyte and surrounding parts, × 25. Only a few of the rhizoids are represented, and the verruculae on the leaf-cells are not shown. Figs. 4 and 5 were drawn from a specimen collected at Beacon Falls, Connecticut, by the writer; the remaining figures, from the type specimen, collected at the "V," Waterville, New Hampshire, also by the writer.

Sheffield Scientific School, Yale University.

The Variations of Ranunculus repens.— The commonly naturalized Swamp Buttercup, *Ranunculus repens* L., is so variable that American botanists are often perplexed to reconcile the extreme variations. These have been clearly differentiated in Europe and it may be useful to American students to have the following brief key to the more pronounced varieties.

A. Middle leaflet of the basal leaves cuneate to subtruncate at base: petals 5–9: stamens numerous B.
  B. Lobes and teeth of the leaves deltoid or ovate to oblong, obtuse or bluntish.
    Trailing or repent branches or stolons present.
      Stems and petioles distinctly pubescent.
        Pubescence appressed ..... *R. repens* L. (typical).
        Pubescence wide-spreading ..... Var. *villosus* Lamotte.
      Stems and petioles glabrous or nearly so ..... Var. *glabratus* DC.
    Trailing or repent branches wanting ..... Var. *erectus* DC.
  B. Lobes and teeth of the much-cleft leaves lanceolate to linear, acuminate. Var. *linearilobus* DC.
A. Middle leaflet of the basal leaves rounded or subcordate at base: petals very numerous, forming a "double" flower ... Var. *pleniflorus* Fernald.

M. L. Fernald, Gray Herbarium.