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VOL. II, No. I

Nitophylla of California

Description and Distribution

BY

CHARLES PALMER NOTT

WITH NINE PLATES

Issued August 3, 1900

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
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¹ Contributions from the Botanical Laboratories of the University of California, No. 10.

I. INTRODUCTION.

OUR knowledge of the genus *Nitophyllum* Grev. as represented upon the coast of California and adjacent shores has been hitherto of a fragmentary and limited nature. The number of species found in the region named, the points of their occurrence, and their identity with the forms already known, or their title to recognition as distinct species, have been for some time largely matters of conjecture. With a view of providing a more connected account of these species, so far as data could be obtained, the following descriptions and accompanying notes upon distribution are presented.

II. HISTORY.

The first notice of Californian *Nitophylla*, so far as the writer is aware, was made by W. H. Harvey (1858, Pt. II, p. 104, Supp., p. 128), who mentions the species of *Nitophyllum* then known upon the western coast of North America. Two forms, *N. fryeanum* and *N. laceratum* (*N. violaceum*)¹, were mentioned as occurring at Golden Gate, San Francisco Bay, California. Still later, in a "Notice of a Collection of Algæ made on the Northwest Coast of North America, chiefly at Vancouver's Island, by David Lyall, in the years 1859-61." Harvey (1862, p. 170) gives the original description of *Hymenena latissima* (*N. latissimum*), specimens of which were dredged, or found adrift in Esquimault Harbor, Vancouver's Island, B. C.

The next mention of Californian *Nitophylla* is found in the "Bidrag till Florideernes Systematik" of J. G. Agardh (1871, p. 49), where reference is made to Harvey's species *Hymenena latissima* Harv. (*N. latissimum*).

A noteworthy addition to the number of North American species was made when Professor W. G. Farlow (1875, p. 365) published a "List of the Marine Algæ of the United States, with Notes of New and Imperfectly Known Species."

¹ The names in parentheses are those applied to the species as recognized in this paper, where the quoted name differs.

In this paper were enumerated the following six species: *N. (Neuroglossum) andersonii* J. Ag. (*N. andersonianum*); *N. fissum* J. Ag. (*N. ruprechtianum*); *N. fryeanum* Harv.; *N. laceratum* Grev. (*N. violaceum*); *N. latissimum* J. Ag.; *N. ruprechtianum* J. Ag.

In the following year Farlow (1876, p. 695) published a second list, which included all the above mentioned species with the addition of *N. arcolatum* D. C. Eaton (*N. latissimum*) and *N. spectabile* D. C. Eaton.

The most comprehensive account of *Nitophyllum* yet presented was that contained in the *Epicrisis Floridearum* of J. G. Agardh (1876, pp. 446-472, 698-701). This account of the genus included all of the species then known to occur on the west coast of North America, with the exception of *N. spectabile* D. C. Eaton. To the forms mentioned by Harvey and Farlow were now added *N. multilobum* J. Ag., *N. violaceum* J. Ag., and *N. flabelligerum* J. Ag. (*N. ruprechtianum*).

Farlow (1877, pp. 238, 245), in a paper discussing some algæ new to the United States, comments on some of the species mentioned by him in the two papers of 1875-76, and also gives the original description of *N. spectabile* D. C. Eaton.

Between 1877 and 1898, the literature pertaining to Californian *Nitophylla* consists of lists of the forms occurring on the coast, with the exception of Hervey's "Sea Mosses" (1881), a popular work, in which some of the characteristics of color, size and venation of the *Nitophylla* are described. Several other writers should here be noticed. Dr. C. L. Anderson (1891, p. 224), M. A. Howe (1893, p. 67), Daniel Cleveland, and A. J. McClatchie (1897, p. 358) have published lists of coast forms. No additions were made to the number of west coast forms by any of these writers except the last named, whose paper contains the first mention of the occurrence of *N. uncinatum* J. Ag. upon the Californian coast.

The latest and most complete statement in regard to west coast *Nitophylla* is found in the volume published by J. G. Agardh (1898).

According to Agardh twelve species of *Nitophyllum* and two species of *Neuroglossum* are assigned to the west coast of North America. The complete list is as follows, viz.: *N. farlowianum* J. Ag. (*N. ruprechtianum*); *N. flabelligerum* J. Ag. (*N. ruprechtianum*); *N. fryeanum* Harv. (*N. fryeanum*); *N. latissimum* J. Ag.; *N. macroglossum* J. Ag. (*N. latissimum*); *N. multilobum* J. Ag.; *N. marginatum* J. Ag. (*N. ruprechtianum*); *N. ruprechtianum* J. Ag.; *N. spectabile* Eaton.; *N. stenoglossum* J. Ag. (*N. violaceum*); *N. uncinatum* J. Ag.; *N. violaceum* J. Ag.; *Neuroglossum andersonianum* J. Ag. (*Nit. andersonianum*); *Neuroglossum lobuliferum* J. Ag. (*Nit. violaceum* ?).

Agardh, basing his distinction between species upon differences in color, texture, form of frond, and position of cystocarps, as well as upon the more reliable characters, such as shape and position of sori, and venation of frond, regards all these forms established by him as valid species.

It should be observed, however, in regard to these forms, that the descriptions are in many cases, as admitted by the author himself, drawn up from fragmentary or imperfect specimens. Further, the characteristics which are employed to a considerable extent by Agardh as distinctions between species, and even between subsections, are variable to a marked degree. Observation of a considerable range of forms by the writer has led to the conclusion that sufficient allowance has not been made for the variations which require that great freedom should be used in defining the boundaries of species occurring on the Californian coast. A distinction should be made between the more variable characters such as color, texture, form of frond, and position of the cystocarps, and the less variable characters, such as shape and position of sori, and venation of frond.

After a careful examination of the descriptions of the species as formulated by Agardh, and further study and comparison of the variations of the plants themselves, the writer is obliged to conclude that the degree of elasticity which seems desirable in considering Californian forms has not been permitted in regulating the limits of a species, or

else access has been had to material which has not come under the writer's observation. A further consideration of these forms will be found in the remarks upon species in a later portion of this paper.

The writings of the three authors mentioned above, viz., Harvey, Agardh, and Farlow, constitute the important literature upon Californian *Nitophylla*, and their work alone will be considered in the further discussion of the species.

III. GENERAL DESCRIPTION.

The fuller discussion of the species of *Nitophyllum* of the Californian coast will be advanced by some special treatment of the prominent morphological characters and geographical distribution of the genus itself, for the sake of the increased light thrown by such treatment upon like points in connection with the forms to be hereafter discussed.

The following synopsis exhibits the principal characters of this genus and will be followed by a discussion of some special features of morphology and distribution, as illustrated by Californian species.

SYNOPSIS OF GENERIC CHARACTERS.

Fronde either erect or exhibiting a prostrate and an erect portion.

Prostrate frond creeping, linear, or irregularly expanded or membranous, occasionally with midrib, nerves, or veins; with or without rhizoids; variously lobed, divided or branched, occasionally proliferating; branches rising at intervals into erect fronds; margin entire, serrate, dentate, crenate, undulate, or lobed; sometimes forming offshoots and innovations.

Erect fronds rising from holdfast or prostrate frond, singly or several together; sessile, subsessile, or stalked; flat and linear, or membranous, variously lobed, divided, forked, segmented, and branched; frequently proliferating;

with or without midrib, nerves or veins; with margin entire, serrate, dentate, crenate, undulate, or lobed. Branching subdichotomous, subpinnate, subpalmate, or palmate, with branches or segments entire, linear or expanded, sometimes much prolonged. Stalk linear, flat, with or without distinct midrib; frequently becoming thickened and cylindrical through wearing away of margin of frond and renewed growth of remaining portion; frequently twisted by wave action; often persistent and freely proliferating.

Midrib, when present, usually conspicuous, narrow or wide, simple below, sometimes branched above, sometimes evanescent or dividing into flabellate or anastomosing nerves, frequently becoming thickened, stout and persistent, freely proliferating. Nerves usually conspicuous, occupying body of frond, margin, or apices, usually branching freely, flabellate, free, or anastomosing, sometimes dividing into minute and inconspicuous veins. Veins inconspicuous or microscopic, occupying body of frond, margin or apices, simple or branching, flabellate, free, or anastomosing, commonly evanescent and indistinguishable from ordinary tissue of frond.

Sporangia found on both surfaces of the frond, usually in locally thickened portions, in sori of varied shape, containing tripartite tetraspores. Sori minute and scattered over the entire surface of the thallus, or large, forming orbicular patches disposed irregularly over the surface; or linear marginal patches; or lines arranged radially along the margin; or borne on marginal or surface proliferations of varying size.

Antheridia developed from the superficial cells of the thallus, forming whitish patches scattered over the surface of the frond, the latter frequently becoming rugose.

Cystocarps scattered over both surfaces of the frond, or arranged along the margin, or borne on marginal proliferations, usually large, projecting beyond the surface of the thallus, opening by a carpostome.

REMARKS ON SOME GENERIC CHARACTERS, AS ILLUSTRATED BY CALIFORNIAN SPECIES.

The Prostrate Frond.—The prostrate creeping frond possessed by many species of *Nitophyllum* deserves special consideration. Agardh makes some use of this character in separating the genus into subsections, but the importance of this structure to the plant and the extent to which it may be developed have not, so far as it has been possible to learn, been very fully demonstrated.

Influence of Substratum.—The character of the substratum upon which the plant is located and the extent to which it is exposed to the dashing, drawing, or swirling force of the waves affect both the amount of growth and the shape of the prostrate frond.

The various species of *Nitophyllum* occur in a variety of situations, from about mid-tide mark outward and downward to deep water. They grow in some cases upon the piles of wharves, where the prostrate frond must take advantage of cracks in the wood or roughenings of the surface to secure a foothold. Other species are found upon bare rock-surfaces, exposed to the dash of breakers. The most common situation is that of those species which inhabit sheltered rock crevices or pools surrounded by rocks which protect them from the force of the waves. In such spots there will usually be found upon the rocks a rich growth of Bryozoa and Porifera, whose sponge-like substance affords an excellent foothold for the plants and is conducive to a free development of the prostrate frond. Other algæ, notably the Corallines, afford by reason of their jointed structure and rough surface, excellent habitats. In general, the characters of the prostrate frond correspond to those of the erect portion, but there are marked exceptions. *N. latissimum*, for instance, possesses a membranous, broadly divided, erect frond, while that of *N. andersonianum* is very much branched. Two forms in the same genus could hardly seem more widely different, yet the prostrate frond of the two species is very much alike where growing under

approximately similar conditions of substratum and wave action. Under other conditions the prostrate frond of *N. latissimum* may become widely linear and irregularly lobed, lose the toothed margin which forms one of the points of resemblance to *N. andersonianum*, and acquire a midrib and nerves, in this case resembling the prostrate frond of *N. ruprechtianum*. Again, *N. multilobum*, which as a rule selects sharply inclined or vertical rock-surfaces as a habitat, forms by means of its prostrate frond orbicular patches composed of the closely overlapping, broadly lobed, and membranous portions of the creeping, prostrate frond. The room afforded on the bare rock apparently favors the radial development here exhibited; while the necessity for securing adequate thickness and firmness to meet the dash of the waves has led to the close overlapping or dovetailing of the various divisions of the prostrate frond.

It has already been remarked that the prostrate part of the plant resembles in many respects the erect portion which rises from it. This statement usually holds good with regard to the shape and branching, but does not apply to the venation. As a rule, a midrib or nerves are lacking in the prostrate frond of those species whose erect fronds are provided with such structures.

Formation of Rhizoids.—A number of species also exhibit a response apparently to the stimulus of contact, by sending short processes or rhizoids from the surface of the frond to the substratum to which they adhere. These processes have been observed on the under surface of the prostrate frond of *N. ruprechtianum*, *N. violaceum*, *N. multilobum*, *N. harveyanum* and *N. corallinarum*, and are recorded for several other species. Still more remarkable is the instance observed of the formation of these rhizoids in the case of a plant of *N. violaceum*. This specimen had wrapped itself around portions of the thick frond of *Prionitis lanceolata*, to whose surface numerous processes sent forth from the surface of the *Nitophyllum* in contact with the *Prionitis* had attached themselves.

Offshoots and Innovations.—A point of further interest in connection with the development of the prostrate frond is found in the formation of offshoots and innovations. In the first case, slender branches may arise from the margin of the older portion of the frond. These grow, secure attachment for themselves, and separate from the parent frond, and later give rise in turn to erect fronds. In the second case, by the growth and branching of the prostrate frond, an extended structure is produced, the ramifications of which become separated from each other by the decay and disappearance of the older portions, thus forming innovations in a manner similar to the process occurring in the Bryophytes.

The Erect Frond.—The erect part of the plant commonly rises singly from the prostrate portion, but occasionally the fronds are clustered together, as in *N. multilobum*, where they are grouped in the middle of the orbicular patch formed by the prostrate frond.

Size.—The height and breadth of the erect frond is an extremely variable character. *N. corallinarum*, occurring upon *Corallina chilensis*, does not reach a height of 2 cm.; while *N. spectabile* is reported by D. C. Eaton as reaching 50–60 cm.

Shape and Branching.—Great diversity exists in the shape and branching of the erect frond. Some species are broadly membranous, and but slightly lobed or divided. Good examples of this type are *N. spectabile*, *N. latissimum* and *N. fryeanum*. At the other extreme may be placed such a finely dissected and abundantly branched species as *N. andersonianum*. Between these two opposing types are found all gradations of frond division and arrangement of branches. It is not uncommon to find in one and the same species forms exhibiting a tendency to become broadly membranous, or very much divided and branched. For instance, in *N. ruprechtianum*, there seems to be a tendency toward the flabellate or expanded type of frond, though the typical specimens of the species are characterized by division of the frond into linear, much prolonged

branches. *N. violaceum*, on the other hand, varies in the direction of the finely dissected type of frond. *N. fryeanum* is a membranous form which often becomes narrowly lacinate, with the segments much prolonged. *N. andersonianum*, which has been instanced as an example of a finely dissected frond, becomes, when growing in quiet water, very broadly linear, with the amount of branching largely reduced, and the expanded branches very regularly arranged.

Form and Branching as Specific Characters.—Some allusion has been made in the foregoing pages to the value of such characters as form and branching of the erect frond for distinctive purposes in describing a species. The question was raised then as to the advisability of making too narrow limits for a species upon such distinctions as form and branching, without regard to the effect of environmental factors. The remarkable variations in these two respects existing within the limits of a single species emphasize this fact, and further call attention to the influence of environmental relations upon form.

Stalk.—The stalk, which characterizes many species, varies in length, width and thickness. The plant, by variations in the length of the stalk, may be sessile, subsessile, or long-stalked. In some forms the stalk is narrow and somewhat thickened; in others it is furnished with a thin, expanded margin. It may vary in thickness from a few cell-layers to a thick, almost fleshy tissue. A midrib, when present, usually runs through the median portion of the stalk. Increase in thickness may take place through a growth of the superficial cells, or through an increase in the number of cells composing the central layer. Frequently the thin margin becomes worn away, and this is accompanied by an increase in thickness of the median portion of the frond, so that the stalk becomes cylindrical.

Midrib.—The midrib presents considerable variation in form and extent. In some species it may be distinguished only as a slight thickening of the median portion of the stalk or frond, while in others it is more highly differentiated, appearing as a ridge of considerable prominence. It

may be either simple and unbranched, as is commonly the case in *N. multilobum*, or it may become considerably divided, as in *N. ruprechtianum*. Frequently it does not extend in the frond beyond the upper portion of the stalk or lower segments. In other cases its ramifications reach out into the branches almost to their tip, and there evanesce, or divide into nerves.

Nerves.—These structures are a characteristic feature of the frond in several species, reaching a high degree of development in some forms. In *N. latissimum* no midrib is present, but the large membranous frond is supported by a network of intersecting nerves and veins of considerable prominence. The other species are not distinguished by such a full development of these structures. Usually the nerves are limited to the outer margins or apices of the frond, where they become flabellate or anastomose freely with each other.

Veins.—More or less conspicuous veins constitute a noteworthy structural element in some species, especially in *N. ruprechtianum* and *N. violaceum*. In these plants, particularly where the frond is at all flabellate, a rich development of the finer venation may be seen, whose ramifications extend in a flabellate fashion throughout the frond, or, in some cases, anastomose with one another, finally becoming free.

In *N. fryeanum*, *N. uncinatum*, and *N. corallinarum* the midrib and conspicuous veins are entirely wanting and the only trace of venation is seen in the microscopic veins which characterize these species. These minute structures are frequently very delicate and invisible to the naked eye. They extend as a rule throughout the frond, branching freely or anastomosing. In *N. fryeanum*, however, the delicate veins, in nearly every case, become somewhat stouter toward the base of the erect frond, where they form a more or less conspicuous fan-shaped area. A single species, *N. spectabile*, is destitute of any sort of veins.

Variable and Fixed Characters.—It has been said in a preceding portion of this paper that stress should be laid

upon the greater value of certain characters as specific distinctions and the less value of others. The more variable characters there mentioned have been sufficiently discussed, and the less variable, more important specific distinctions, based upon the character of the venation and shape and position of the sori, may here be treated.

Venation.—The Californian *Nitophylla* may be separated into groups, distinguished from one another by the character of the venation. In that group which includes the greater number of forms, the species possess a midrib, nerves, and conspicuous veins, developed to a greater or less extent according to the species. Some forms exhibit only the midrib, which passes over at once into the undifferentiated frond as in *N. andersonianum*. Others, again, are provided with a midrib which divides into more or less conspicuous nerves, the latter passing again into the ordinary frond, *e. g.*, *N. harveyanum* and *N. multilobum*. Still other forms, such as *N. violaceum* and *N. ruprechtianum*, show a full development of midrib, nerves, and veins, the last named structures usually conspicuous, and either anastomosing or remaining free and flabellate. A second group consists of forms in which no midrib is present, but the surface of the frond is marked by a network of reticulate nerves and veins, as in *N. latissimum*. The forms of the third group, including *N. fryeanum*, *N. uncinatum* and *N. corallinarum*, are destitute of midrib and nerves, and are provided with scarcely perceptible, usually microscopic veins, which either anastomose with one another, or remain free. A fourth group comprises forms which wholly lack venation of any kind whatsoever, as *e. g.*, *N. spectabile*.

Sori.—The sporangia of *Nitophyllum* are gathered together into sori of varying shape and size. These latter structures may be employed as reliable specific distinctions in discriminating between species. The Californian plants, taken as a whole, show a considerable range of forms as regards the shape of the sorus, and likewise a considerable variety in its position. Within the limits of certain species, *e. g.*, *N. violaceum* and *N. ruprechtianum*, these variations

are remarkable. Notwithstanding this fact, the variations can be so expressed in terms of size, shape and position that clear distinctions can be drawn between species. In some cases the sporangia occur in narrow lines of varying width arranged in a flabellate fashion on the upper divisions of the frond, extending perhaps from its median portion to the margin—their regular position in *N. harveyanum* and a disposition frequently seen in *N. ruprechtianum*—perhaps only found as a fringe just within the margin, as often observed in *N. ruprechtianum*. Other forms have the sori in linear strips or patches along the margin of the frond, an arrangement best seen in *N. violaceum*. In another species, *N. multilobum*, the sori are irregular in shape, rounded or linear-elliptical, with their longer dimensions extending transversely across the frond upon whose upper segments they are borne. The sori occur in other instances as rounded or elliptical patches borne either singly upon distal lobes, as in *N. andersonianum*, or scattered irregularly over the surface, as in *N. spectabile*, sometimes displaying a tendency to arrange themselves into lines, as is well shown by *N. fryeanum*. In yet other plants the sori are minute, rounded structures, densely aggregated between the anastomosing nerves and veins of the frond, *e. g.*, *N. latissimum*.

Proliferation.—The capacity for proliferation possessed by some species is very great. To such an extent does this phenomenon take place, that specimens are often found in which the primary frond has remained comparatively undivided, and has produced from its margin numerous proliferations which exceed in size the primary frond itself. The favorite point for the production of proliferations is along the margin of the frond, especially after this has been weathered by the waves. In such cases the original frond may be reduced to a narrow strip, which will produce proliferations surpassing in size the original portion of the plant. In some species, particularly in *N. ruprechtianum*, the frond becomes reduced to the midrib; this persists for a longer or shorter period, and proliferates very freely, so that by this process the plant practically becomes

perennial. Some species, again, notably *N. violaceum* and *N. ruprechtianum*, bear marginal proliferations in great numbers, upon which appear the sporangia and cystocarps.

Antheridia and Cystocarps.—The antheridia and cystocarps need be mentioned only in a cursory way, inasmuch as they take no prominent part in the identification of the species. The antheridia first make their appearance as whitish patches distributed rather evenly over the surface of the frond. As they mature, the frond becomes wrinkled or rugose to a marked degree. Antheridial plants have now been found in three species, viz., *N. frycanum*, *N. latissimum* and *N. spectabile*, in considerable abundance. The cystocarps are conspicuous structures, making their appearance irregularly over the surface. In some species the most weathered or reduced plants seem to be favored in the production of cystocarps; and in this case the latter sometimes occur in clusters of proliferations produced from the surface or worn margins of the frond.

Parasites.—In only one instance have the plants of *Nitophyllum* been found to harbor parasites. As a rule, the species are quite free from epiphytes and parasites.

Gonimophyllum buffhami Batters has been found by the writer (1897, p. 81) upon *N. ruprechtianum*. The plants are a pale pink color, contrasting strongly with the deep lake red of the host plant. The parasite seems to prefer the lower portions of the frond as its habitat, occurring on the *Nitophyllum* near its base much more frequently than elsewhere. It grows in patches, extending in some cases an inch in breadth, while the individual fronds reach a height of ten millimeters. So far, *Gonimophyllum* has been found only upon the tetrasporic *N. ruprechtianum*.

Agardh (1898, p. 88) is of the opinion that *Gonimophyllum* is a monstrous form of *N. laceratum*. He suggests further that *N. laceratum* occasionally may be hermaphroditic, contrary to the normal course of development, and that this monstrous form may be the structure concerned in the phenomenon.

Geographical Distribution of the Genus.—The genus *Nitophyllum* is distributed universally throughout the oceans

of the globe. It has been found in the Arctic and Antarctic oceans, along the shores of the continents bordering upon the Atlantic and the Pacific, in the Mediterranean Sea and the Indian ocean, and in the waters of Australia. The coast of the British Islands is particularly rich in species, while some of the finest examples of the genus come from Australia.

About seventy species are known, of which number ten occur on the west coast of North America. Of the ten species thus credited, eight are limited to California or neighboring shores. A ninth species, *N. uncinatum*, is one of the oldest known forms, and is more widely distributed, being found in the Adriatic Sea, on the coast of Australia, in California, on the shores of Europe, in the upper Atlantic and Mediterranean Sea, and in New Zealand waters. The tenth species, *N. harveyanum*, is an inhabitant of New Zealand coasts.

Habitat.—The species of *Nitophyllum* occur on other algæ and on *Phyllospadix*; on bare rocks exposed to the dash of the waves or protected from their violence; or upon rock surfaces which have become thickly coated with Corallines or various Porifera and Bryozoa; or upon the piles of wharves on the surface of the wood. The plants range from the littoral zone between tide marks to the sublittoral zone and have been dredged at a depth of 12–15 fathoms.

IV. DESCRIPTION AND DISTRIBUTION OF SPECIES.

KEY TO THE CALIFORNIAN SPECIES OF NITOPHYLLUM.

FronD provided with midrib only, or with midrib and nerves, or midrib, nerves, and usually conspicuous veins.

FronD with midrib only, margin of frond serrate or dentate, sori in rounded patches on distal lobes of frond.

N. andersonianum (32).

FronD with midrib and nerves, but without veins.

Sori forming flabellate lines on upper segments of frond.

N. harveyanum (29).

Sori forming transverse patches on upper segments of frond.

N. multilobum (27).

Fronde with midrib, nerves and usually conspicuous veins.

Color a pale violet through bright violet red to purple violet; thin and papery in texture; sori forming narrow flabellate lines on upper divisions of frond, or linear patches along margin, or rounded patches borne on the crispate margin or on marginal proliferations, or appearing in both lines and patches.

N. violaceum (39).

Color a bright red to blackish red; firm and leathery in texture; sori forming wide flabellate lines on upper divisions of frond, or rounded patches on marginal or surface proliferations, or appearing in both lines and patches. *N. ruprechtianum* (34).

Fronde without midrib, but provided with network of conspicuous nerves and veins. *N. latissimum* (16).

Fronde without midrib, nerves, or conspicuous veins, but provided with microscopic veins.

Fronde ample, erect, membranous below, branching above; sori forming elliptical patches scattered over surface of frond.

N. fryeanum (22).

Fronde erect, branching throughout, apices of ultimate branches recurved or hooked. *N. uncinatum* (26).

Fronde minute, creeping, ultimate lobes becoming free; sori forming rounded patches on free lobes; on *Corallina chilensis* (and other algæ?). *N. corallinarum* (24).

Fronde destitute of veins, membranous; sori forming elliptical patches scattered over surface of frond. *N. spectabile* (21).

N. latissimum J. Ag.

Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 464.

Hymenena latissima HARVEY, W. H., Proc. Linn. Soc., (Botany) Vol. VI, 1862, p. 170.

N. latissimum AGARDH, J. G., Bidrag Florid. Sys., 1871, p. 49. FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365; Report U. S. Fish Comm. for 1875, p. 695, 1876.

N. areolatum EATON, D. C., Farlow, l. c., p. 695.

N. latissimum AGARDH, J. G., Epicrisis Florid., Contin. Spec. Gen. et Ord. Alg., 1876, pp. 464 and 699. FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 238. FARLOW, W. G., ANDERSON, C. L., and EATON, D. C., Algæ Amer.-Bor. Exsiccatae, No. 68, 1878. HERVEY, A. B., Sea Mosses, 1881, p. 175. ANDERSON, C. L., Zoe, Vol. II, 1891, p. 224. HOWE, M. A., Erythea, Vol. I, 1893, p. 68. McCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358. NOTT, C. P., in Phyc. Bor.-Amer., COLLINS, F. S., HOLDEN, I., and SETCHELL, W. A., Fasc. VII; No. 335, 1897. TILDEN, J. E., American Algæ, Century III, No. 212, 1898. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 83.

N. macroglossum AGARDH, J. G., l. c., p. 84.

Synopsis.—Fronde both prostrate and erect. Prostrate frond creeping, slender, linear, much branched; without rhizoids, midrib, nerves, or veins; margin serrate or toothed.

Erect frond subsessile or shortly stalked, flat, membranous; without midrib, but with numerous, conspicuous nerves and veins; palmately divided or segmented, frequently proliferating; with margin usually entire, occasionally minutely serrate. Segments linear or wedge-shaped, usually expanded and lobed at apices. Stalk, when present, usually short, occasionally longer, formed by the wearing away of frond on margins at base and subsequent thickening of nerves and remaining portion of frond. Nerves and veins numerous, conspicuous, extending over almost entire surface of frond, evanescent in outer lobes, branching and anastomosing, frond thus conspicuously areolate.

Proliferations usually numerous, especially upon more reduced portions of frond, membranous, segmented or lobed, nerved and veined.

Sporangia in minute sori scattered over both surfaces of the frond between the nerves and veins, in the conspicuous areoles.

Antheridia forming dull whitish patches over the entire surface, the latter becoming ridged, indented, or rugose.

Cystocarps numerous, large, irregularly disposed over both surfaces, projecting beyond the surface.

Remarks on the Species.—The color of *N. latissimum* does not change to any extent when dried. In the living state the tint is a deep, rich, lake red, becoming a shade darker in the dried condition. Plants frequently occur which attain a length of 35–40 cm., with the frond divided into numerous segments from 3–5 cm. in width. The species is one of the handsomest and most luxuriant in habit of any of the forms inhabiting the coast.

N. latissimum is characterized by its broadly expanded fronds, divided into large, rounded lobes and segments, and by the extensive network of prominent nerves and veins covering the surface. This conspicuous network gives to the surface a markedly areolated appearance, which serves to distinguish the plants from all others of the genus as represented on Californian shores. The frond frequently proliferates along the margin, thus giving rise to numerous ovate or lanceolate proliferations, which possess a well marked venation and often produce sporangia and cystocarps. Proliferations likewise appear freely from reduced portions of the frond.

The creeping, much branched, claw-like, prostrate frond possessed by *N. latissimum* is an excellent adaptation for the purpose of enabling the plant to retain its foothold upon the rough and seamy piles and rock surfaces which are its habitat. Very little variation has been observed in the prostrate frond; and it seems to be a well defined and specially differentiated structure.

Tetrasporic plants are of the most common occurrence. Sporangia are produced very abundantly over the entire surface, between the nerves and veins, thus adding to the distinctive areolate aspect of the plant. The sori are minute and crowded together, giving the impression of large sori completely filling the areoles. Antheridial specimens have been observed in but one locality. They reach a large size, being among the most magnificent examples of the species. In the early stages of development the antheridia form pale, whitish patches. Later, they become more evident, and when well developed, cause the entire frond to appear dull reddish white. The surface of the frond is then decidedly rugose.

A comparison of *N. latissimum* with a specimen of *N. hilliae* Grev., distributed by Le Jolis in Algues Marines de Cherbourg, No. 215 (in herbarium W. A. Setchell), shows a striking similarity between the two species in texture, venation, and character of lobes or branches. A series of specimens of *N. hilliae* in the herbarium of Professor W. G. Farlow shows that this plant varies greatly as to prominence of veins. Careful comparison of *N. latissimum* with strongly veined specimens of *N. hilliae* brings out a strong resemblance between the two. With the material in hand, however, it is not advisable to do more than point out the possibility that the two species may be identical.

It is desirable to call attention at this point to the latest views of Agardh (1876, pp. 464 and 699, 1898, pp. 83-85) concerning *N. latissimum*.

According to Agardh, *N. latissimum* is a form which was first collected by David Lyall at Vancouver Island, B. C., and described by Harvey (1862, p. 170) under the name

Hymenocna latissima. A similar form was received somewhat later by Agardh from Golden Gate, San Francisco Bay, collected by Berggren. Further than this, corresponding forms were issued in the Alg. Amer.-Bor. Exsicc. (1878, No. 68), collected by Dr. C. L. Anderson, at Santa Cruz.

Again, according to Agardh, there is still another form, viz., *N. macroglossum*, which is referred to Californian shores. This plant was collected originally by Berggren also at the Golden Gate, and at first was included by Agardh in *N. latissimum*. Specimens collected by the writer (1897, Fasc. VII, No. 335) at the type locality are said by Agardh to be identical with the plant first referred by him to *N. latissimum* and now included under *N. macroglossum*.

The writer has now examined in the field and herbarium a wide range of plants comprehended under these two species of Agardh. Specimens, collected at numerous localities and at various times in the year along the coast from San Pedro northward to Puget Sound entrance, provide a fair amount of material as a basis for estimating Agardh's species. An especially abundant series of forms was collected by the writer between January and May at Golden Gate, San Francisco Bay, the type locality for Agardh's *N. macroglossum*. This collection included numerous specimens of both the species above referred to as established by Agardh.

A discriminating examination of Agardh's descriptions shows, as far as the writer can determine, that *N. latissimum* differs from *N. macroglossum* in being of a paler color, possibly less luxuriant in habit, with by no means such a well developed system of venation. The nerves and veins anastomose less freely, project above the surface of the frond less prominently, or not at all, as is more commonly the case, and soon evanesce into the frond. The areoles are larger and more conspicuous by reason of the broad, flat aspect of the nerves and veins. The sori are fewer in number and are most numerous about the borders of the areoles.

The range of forms examined by the writer with these points in mind exhibits, it is true, the structural differences pointed out by Agardh. But further, it should be observed that the species here in question, as field studies show, is apparently a form occurring between December and August, reaching its finest development in February and March, and at that time exhibiting the characters of *N. macroglossum*. The forms collected from April to August show the characters of *N. latissimum*, with frequent occurrence of transition forms between the two species.

The evidence collected by the writer in field and herbarium points to the conclusion that *N. macroglossum* and *N. latissimum* are seasonal variations of the same species, that is, *N. latissimum*.

Habitat.—On piles of docks and wharves, or on sloping rock surfaces where the wave action is not violent; lower littoral to sublittoral zone.

Distribution.—At various points along the coast from San Pedro to Vancouver.

Localities.—San Pedro! (Mrs. S. P. Monks); Santa Barbara! (Dr. and Mrs. L. M. Dimmick; Mrs. S. P. Cooper); shores of San Luis Obispo County! (Mrs. R. W. Summers); Pacific Grove! (M. A. Howe; Mrs. J. M. Weeks; C. P. Nott); Santa Cruz! (Dr. C. L. Anderson; Mrs. J. M. Weeks); San Francisco! (G. W. Lichtenhaler); San Francisco Bay entrance (Golden Gate) at Fort Point! (M. A. Howe; W. A. Setchell; W. J. V. Osterhout; C. P. Nott); at Lime Point! (C. P. Nott); Fort Ross! (W. A. Setchell); Klatsop, Oregon, (L. F. Henderson, in Herb.; W. G. Farlow, *vide* W. A. Setchell); Port Orchard, Washington! (J. E. Tilden); Esquimault Bay, Vancouver Island, B. C. (Harvey, in Proc. Linn. Soc., (Botany) Vol. VI, 1862, p. 170; Farlow, Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365); Puget Sound! (N. L. Gardner).

Nitophyllum spectabile D. C. Eaton.

In FARLOW, Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 245.

Nitophyllum spectabile FARLOW, W. G., Report U. S. Fish Comm. for 1875, p. 695, 1876; Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 238. EATON, D. C., in Farlow, l. c., p. 245. FARLOW, W. G., ANDERSON, C. L., and EATON, D. C., Algæ Amer.-Bor. Exsiccatae., No. 67, 1878. HERVEY, A. B., Sea Mosses, 1881, p. 174. ANDERSON, C. L., Zoe, Vol. II, 1891, p. 224. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 43.

Synopsis.—Frond both prostrate and erect. Prostrate frond thin, linear, creeping, destitute of venation; becoming thickened when weathered; branches irregularly; branches rising into erect fronds.

Erect frond sessile or subsessile, flat, membranous; destitute of venation; irregularly oblong, deeply pinnately lobed, occasionally palmately segmented, sometimes proliferating; margin entire, sinuate, or lobed. Segments linear, lanceolate, ovate, or cuneate, frequently deeply lobed at apices.

Sporangia in elliptical sori, disposed at nearly regular intervals over both surfaces of the frond. Antheridia in whitish patches over entire surface of frond, giving to latter an areolate aspect. Cystocarps numerous, conspicuous, irregularly disposed over both surfaces, projecting beyond the surface.

Remarks on the Species.—This plant retains, when dried, the bright, rosy red hue which characterizes it in the living state. The species is said by Professor Eaton, who established it, to reach a length of 50–60 cm. It is one of the largest and finest species of the coast. The general aspect of the frond is much like that of *N. fryeanum*. It differs from that form, however, in not possessing any kind of venation.

Comparison of *N. spectabile* with *N. ruthenicum* (P. & R.) Kjell. aroused a suspicion that the two forms might be identical. A more careful examination showed that, in specimens of *N. ruthenicum* received from Professor Kjellman, the plants were “obsoletely veined below,” as is stated in the description of *N. ruthenicum* (1889, p. 25, Pl. I, figs. 11–12), and as is shown in the figure. *N. spectabile*, on the contrary, is totally destitute of venation. All the evidence at hand demonstrates that *N. spectabile* apparently is a distinct species.

The writer is indebted to Professor W. A. Setchell for the following note upon *N. spectabile*, through the courtesy of Professor W. G. Farlow, who kindly permitted an examination of his specimens of *Nitophylla* in connection with

the preparation of this paper. Professor Setchell says, "Specimens in herbarium of Professor Farlow (ex. herb. Acad. Petrop.) labelled '*Aglaophyllum ruthenicum*, Exp. Lutk. ad litora Americanæ borealis-occidentalis, Ross' are young (about an inch high, with no fruit present), and might be the young plants of *N. spectabile*. In the herbarium of Farlow are also several specimens from St. Paul Islands, in Behring Sea (legit White), which might be *N. spectabile*."

The account of this species was advanced to a great extent by examination of a large collection of material from Mrs. J. M. Weeks, of Santa Cruz, Calif., who made an especial effort to secure antheridial, tetrasporic, and cystocarpic plants. The material thus obtained confirms the conclusion that *N. spectabile* is entitled to rank as a distinct species, as established by Professor D. C. Eaton.

Habitat.—On rocks? or other algæ, sublittoral to elittoral zone. Dredged in 12–15 fathoms, Monterey Bay, Calif.

Distribution.—Along the coast from Santa Monica northward to Santa Cruz.

Localities.—Santa Monica! (Miss S. P. Monks); Pacific Grove, in Monterey Bay! (C. P. Nott); Santa Cruz! (Dr. C. L. Anderson, *fide* Eaton in Farlow, Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 245; Mrs. J. M. Weeks).

Nitophyllum fryeanum Farlow.

Algæ Amer.-Bor. Exsiccatae, No. 69, 1878.

Nitophyllum fryeanum HARVEY, W. H., Ner. Bor.-Amer., Supp., 1858, p. 128? (See remarks on species). FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365; Report U. S. Fish Comm. for 1875, p. 695, 1876. FARLOW, W. G., ANDERSON, C. L., and EATON, D. C., Algæ Amer.-Bor. Exsiccatae, No. 69, 1878. HERVEY, A. B., Sea Mosses, 1881, p. 176. ANDERSON, C. L., Zoe, Vol. II, 1891, p. 224. HOWE, M. A., Erythea, Vol. I, 1893, p. 68. McCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 74.

Synopsis.—Frond both prostrate and erect. Prostrate frond much reduced, flat, membranous, lobed, without venation or rhizoids.

Erect frond sessile or subsessile, flat, membranous, with microscopic veins; ---dichotomously or palmately branched or segmented; margin entire,

serrate or toothed. Segments linear, frequently prolonged, occasionally expanded and lobed at apices. Veins not numerous, extending through the frond, branching and anastomosing.

Proliferations minute or wanting, appearing along the margin of the frond.

Sporangia in small elliptical sori scattered over the entire frond, tending to become arranged into lines. Antheridia in whitish areolate patches scattered over surface. Cystocarps conspicuous, irregularly disposed over both surfaces, projecting beyond the surface.

Remarks on the Species.—The color of *N. fryeanum* is very attractive, being a bright rosy red in both the living and dried states. Some of the plants reach a height of 15 cm. The size and more especially the shape is subject to considerable variation. The frond may be short and deeply lobed, or long and branching, with the branches considerably prolonged and linear.

N. fryeanum is noteworthy as being one of the three forms of the coast which possess delicate, microscopic veins. With the exception of this character, *N. fryeanum* and *N. spectabile* have many points in common. The last named species, however, is destitute of any kind of venation.

It is a matter of some doubt whether Harvey's (1858, Supp., p. 128) original description of this plant does not better apply to *N. multilobum*. His mention of a lobed and crenulate margin does not seem to hold good for *N. fryeanum*. Harvey's name, however, was applied to the specimens issued in the Alg. Amer.-Bor. Exsiccatae (1878, No. 69) and Agardh (1898, p. 74) also retains Harvey's name, with an additional reference to the specimens above mentioned. It seems advisable, therefore, to retain this name for the plant here dealt with, which is identical with that published in the Alg. Amer.-Bor. Exsiccatae.

There were reasons for supposing that *N. fryeanum* might be referred to *N. ruthenicum* (P. & R.) Kjellman (1889, p. 25, Pl. I, figs. 11-12), with which it agrees to a certain extent in the characters of venation and sori. Carefully selected specimens were forwarded to Professor Kjellman, who replied that the two species were not identical. The plants exchanged with Kjellman for purposes of

comparison, while not wholly inducing the writer to accept Kjellman's conclusion as to the non-identity of the two species, yet do not furnish sufficient reason for declaring them identical. Until a more extended comparison can be made of a wide range of forms, the writer prefers to leave the species as established in the Alg. Amer.-Bor. Exsiccatae (1878, No. 69).

The writer further takes this opportunity to express his obligations to Mrs. J. M. Weeks for material of *N. frycanum* collected by her, which permitted a careful study of antheridial, tetrasporic and cystocarpic plants.

Habitat.—No reliable data are at hand concerning the habitat of this species. Some twenty-five specimens seen by the writer were all washed ashore from deep water. The plant presumably occurs upon rocks, and other algæ, in the lower sublittoral, and perhaps elittoral zone.

Distribution.—Known to occur with certainty at but two localities on the Californian coast. At Golden Gate, San Francisco Bay, it apparently has not been collected since the first specimen, if indeed it was identical, was secured by A. D. Frye and forwarded to Harvey.

Localities.—Pebble Beach, Monterey Peninsula! (Miss Bayles); Santa Cruz! (Dr. C. L. Anderson; Mrs. J. M. Weeks); Golden Gate, San Francisco Bay? (A. D. Frye, *vide* Harvey, Ner. Bor.-Amer., Supp., 1858, p. 128).

Nitophyllum corallinarum, sp. nov.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, flat, membranous, with microscopic veins and with rhizoids; lobed and branching, with branches becoming erect at intervals, margin entire.

Erect frond sessile, shortly stalked, flat, membranous, with microscopic veins; ovate-spatulate to elliptical, two to three times longer than broad; subdichotomously lobed or divided, margin entire. Segments minute, ovate, oblong or cuneate. Stalk very short, narrowly linear or cylindrical, passing into a midrib, the latter extending throughout frond, usually branching and free.

Sporangia large, prominent, in sori of varying shape and size, solitary or clustered on body of frond or its segments.

Remarks on the Species.—The form from which the synopsis of this species is drawn up was obtained at San Diego by Mrs. E. Snyder, and sent to the writer by Mr. F. S.

Collins. It is the only specimen which, to the writer's knowledge, has thus far been seen on this coast.

N. corallinarum is a very minute plant in comparison with the other *Nitophylla* of the coast. *Corallina chilensis*, upon which the *Nitophyllum* grows, attains a height between 8 and 12 cm., and in the lower portion a width of 5 cm. or more. The branches of the Coralline are arranged pinnately along the main axis from base to apex of the plant. The general outline is very regularly fan-shaped. The epiphytic *Nitophyllum* extends, by means of its prostrate frond, over the entire surface of the Coralline, to which it adheres firmly by means of the rhizoidal processes that are produced abundantly from the surface in contact with the Coralline. From the prostrate frond rise at regular intervals erect branches which are shortly stalked and expand into ovate-spatulate or elliptical fronds, which may reach a height of 7 mm. and a width of 3 mm. The color is a rosy red to dull carmine. So completely is the Coralline enveloped by the *Nitophyllum*, that the natural color of the former, as well as its jointed structure, is very much obscured. The thin and delicate frond of *N. corallinarum* presents the tessellated surface characteristic of the genus. Throughout both the prostrate and erect fronds may be distinguished minute microscopic veins, which branch more or less freely and remain free.

The sporangia are prominent and large, considering the general minute size of the plant. They occur in clusters rather than in sori of definite shape, and are borne upon the body of the erect frond or on its segments. Tetraspores of unusually large size are formed in the sporangia.

This plant may ultimately be found to be identical with some species of Europe. Such a determination must be left, however, to future observation upon more abundant material.

Habitat.—Epiphytic on *Corallina chilensis*.

Distribution.—Concerning the distribution of *N. corallinarum* little can be said. The Coralline upon which it grows is found along the coast from San Diego northward

to Fort Ross, but no observations are known to the writer on the occurrence of *N. corallinarum* at any other place than the type locality.

Locality.—San Diego! (Mrs. E. Snyder in herb. F. S. Collins).

Nitophyllum uncinatum *ŷ. Ag.*

Spec. Gen. et Ord. Alg., Vol. II, Pt. 2, 1852, p. 654.

Nitophyllum uncinatum McCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358; also in Phyk. Bor.-Amer. COLLINS, F. S., Holden, I., and SETCHELL, W. A., Fasc. VII, No. 337, 1897. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 65.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, narrow, linear, thin and membranous; frequently weathered, reduced, and thickened along median portion, with microscopic veins, and with rhizoids; margin entire, or toothed; branching, branches rising into erect fronds at intervals.

Erect frond sessile or subsessile, flat and linear, thin and delicate, sometimes thickened in median portion, with microscopic veins; branching subdichotomously from the base upwards, with margin entire, or occasionally toothed. Branches linear, occasionally expanded, or acuminate, frequently recurved or hooked at apices. Veins microscopic, extending throughout frond, occasionally branching and anastomosing.

“Sporangia in solitary disc-like sori, on the upper branches” or “in rounded sori” on the outer branches. (See Remarks on Species.) Antheridia as yet unobserved. Cystocarps minute, marginal or submarginal, produced at infrequent intervals, projecting slightly beyond surface.¹

Remarks on the Species.—*N. uncinatum* has a bright, rosy red tint when alive, usually changing to a dull purplish or brownish red when dried. The fronds may attain a length of 10–15 cm. The plant is one of the more delicate species of the coast, as may be seen in the thin and membranous character of the frond. Throughout the narrow, linear segments extend microscopic veins, which, with the numerous recurved or hooked apices of the branches, may be regarded as the prominent morphological characters.²

¹ Account of cystocarps from specimen in Hauck und Richter, Phykotheca Universalis. Fasc. VII, No. 306, 1889.

² Nordhausen (Pringsheim's Jahrbücher f. Wiss. Botanik, Band XXXIV, Heft 2, 1899, p. 263) finds that the hooked apices of the branches of *N. uncinatum* serve as climbing organs.

No fruiting specimens of *N. uncinatum*, so far as can be ascertained, have been reported from Californian shores. The plant seems to be an exclusively southern form on this coast, having been collected only at San Diego and San Pedro, in southern California. From these two localities numerous and abundant collections have been taken, none of which, however, have revealed fruiting specimens. There is a strong probability that the plant propagates itself largely, if not entirely, by vegetative means. It occurs commonly on *Phyllospadix*, in quiet water, conditions of substratum which would favor the active development of the prostrate frond. Its local abundance is shown by its occurrence in such quantities as sometimes to clog the nets of fishermen.

The description of the sori, as given in the synopsis of the species, is taken from Agardh (1852, p. 654, 1876, p. 465, 1898, p. 65). The account of the cystocarp is based upon an examination of the specimen issued in the *Phykotheca Universalis* (see note under synopsis of species). There seems to be little doubt that the species of this coast is identical with the European plant.

Habitat.—In quiet water, on other algæ, and on *Phyllospadix*.

Distribution.—*N. uncinatum* is a cosmopolitan species, limited in its local distribution, having been found at but two points on the coast.

Localities.—San Diego! (Herb., F. S. Collins); San Pedro! (Mrs. E. A. Lawrence; A. J. McClatchie; Mrs. S. C. Purdy; W. A. Setchell).

Nitophyllum multilobum J. Ag.

Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 698.

Nitophyllum multilobum AGARDH, J. G., Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 698. FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 238; ANDERSON, C. L., Zoe, Vol. II, 1891, p. 224. COLLINS, F. S., HOLDEN, I., and SETCHELL, W. A., Phyc. Bor.-Amer., Fasc. VII, No. 336, 1897. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 45.

Synopsis.—Fronde both prostrate and erect. Prostrate frond creeping, irregularly expanded and membranous, sometimes a rounded expansion, sometimes irregularly branched or lobed; with rhizoids; without midrib, nerves or veins; margin entire, sinuous, or somewhat lobed.

Erect frond slightly stalked, flat and linear, with distinct midrib; simple below, subdichotomously or subpalmately segmented, not proliferating; margin sinuous, toothed or incised. Segments decidedly bullose, usually obtusely lobed, with sinuous or toothed margin. Stalk short, linear, flat, occasionally becoming thickened. Midrib well developed, rather wide, frequently branched, soon evanescent.

Sporangia formed in large, irregularly oblong, frequently lobed or confluent sori, transversely placed upon the segments of the frond. Antheridia as yet unobserved. Cystocarps few, large, conspicuous, scattered over both surfaces.

Remarks on the Species.—In the fresh state *N. multilobum* is a dark red to dull carmine, becoming a burnt carmine to blackish red when dried. The plant is a dwarf one, rarely reaching a height of 9 cm.

The predominant characters of *N. multilobum* are seen in the rather prominent development of the midrib, in the bullose aspect of the frond, and in the peculiar transverse sori. The first named structure is confined to the lower portion of the frond, where it is visible as a definite thickening of the median part, though it does not project prominently above the surface. At its upper extremity it frequently branches, and the resulting portions evanesce very soon into the ordinary tissue of the frond. The bullose frond of *N. multilobum* is an important feature in the appearance of the tetrasporic plant. Usually the surface of the segments which form the upper portion of the plant exhibits this trait. Here the surface is alternately raised and depressed, while the margin becomes crinkled and lobed. The sori, together with the bullose aspect, furnish the most certain means of identifying the species. No other plant of the coast possesses such a characteristic feature as these transverse sori, usually produced in great abundance on the segments of the frond.

The characteristic transverse sori serve to distinguish *N. multilobum* from *N. harveyanum*, with which this plant otherwise has several points in common. In *N. harveyanum*, however, the sori form flabellate lines on the segments of

the frond. In color, the two species are much the same. The midrib of *N. harveyanum* is usually more pronounced than that of *N. multilobum*. *N. harveyanum* is much slenderer than *N. multilobum*, and may attain a height three or four times that of the latter.

Habitat.—On bare rock surfaces or on rocks coated with Corallines, from high water mark to the sublittoral zone.

Distribution.—Limited at the present time to the Californian coast. Has now been reported from Carmel Bay northward to Cape Mendocino. Apparently a northern form.

Localities.—Carmel Bay! (C. P. Nott); Pacific Grove! (C. P. Nott); Santa Cruz! (Mrs. J. M. Weeks); Land's End, San Francisco! (W. A. Setchell; C. P. Nott); Golden Gate, San Francisco Bay (Berggren, *vide* J. Agardh, *Epicrisis Floridearum*, 1876, p. 698; W. A. Setchell); Lime Point, San Francisco Bay! (C. P. Nott); Dillon's Beach (W. A. Setchell); Fort Ross! (C. P. Nott); Cape Mendocino (C. G. Pringle, in herb., W. G. Farlow, *vide* W. A. Setchell).

Nitophyllum harveyanum *f.* *Ag.*

Epicrisis Floridearum, *Contin. Spec. Gen. et Ord. Alg.*, 1876, p. 462.

Nitophyllum harveyanum J. AG., *Phyk. Bor.-Amer.* COLLINS, F. S., HOLDEN, I., and SETCHELL, W. A., *Fasc. XIV*, No. 693, 1900.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, linear, flat; without rhizoids, destitute of midrib, and not proliferating; branching, branches becoming erect at intervals; margin entire, serrate, or somewhat laciniate.

Erect frond stalked, flat, linear; with midrib and flabellate nerves; branching, rarely proliferating, margin entire, or somewhat lacinate. Branches palmate or subpalmate, linear or becoming expanded, occasionally lobed or cleft. Stalk flat, linear, with distinct midrib, becoming thickened and cylindrical through wearing away of margin and renewed growth of median portion. Midrib narrow, conspicuous, branching above, becoming divided into flabellate nerves, the latter conspicuous, branching freely, remaining free and flabellate. Veins minute or wanting.

Sporangia in linear sori extending flabellately from the nerves to the margin of the frond. Antheridia as yet unobserved. Cystocarps large, prominent, irregularly disposed, projecting beyond the surface.

Remarks on the Species.—*N. harveyanum* varies in color in the living state from deep salmon red to dull carmine, becoming purplish to blackish red when dried. The plant may reach a height of 20 cm., but is as a rule 6–10 cm.

The prostrate frond in *N. harveyanum* does not develop so extensively as in other species. It is destitute of midrib and nerves, and is not specially thickened. *N. harveyanum* is a sparingly branched form as regards its erect frond and the whole plant is rather stiff and unyielding, even when freshly taken from the water. The midrib is conspicuous, tapering slightly towards its upper extremity, and rather suddenly becoming divided into flabellate nerves. The margin in the lower portions of the frond and upon the stalk frequently wears away, the remaining median portion then becoming thickened and cylindrical. In the branches the margin occasionally is serrate or laciniate.

N. harveyanum was first collected on this coast at Land's End, San Francisco, by Professor W. A. Setchell. It grew in company with *N. multilobum*, to which, at this locality, it bears some resemblance, on account of its size and venation. Professor Setchell, however, upon noting the non-bullose character of the frond and the flabellate arrangement of the sori, so different from the transverse sori of *N. multilobum*, concluded that the plant was a distinct species. The writer, when examining the plant in connection with other material secured by him at Fort Ross, was of the opinion that it must be the plant described by Agardh (1876, p. 699) under the name *N. flabelligerum*, although previously the conclusion had been reached that Agardh's *N. flabelligerum* was but a form of *N. ruprechtianum*.

Sufficient comment has been made already upon the distinctions to be drawn between *N. harveyanum* and *N. multilobum*. It is desirable, however, to point out here some of the differences existing between *N. harveyanum* and certain forms of *N. ruprechtianum*. There is enough of similarity between certain variations of the latter species and *N. harveyanum* to give reason for the suspicion that the two are identical. The examination of a good range of

specimens of *N. ruprechtianum* soon brings to light the variation in that species, however, and helps to establish its non-identity with *N. harveyanum*.

Certain forms of *N. ruprechtianum* exhibit a pronounced dark purplish red tinge, both in the fresh and dried states, and are somewhat stiff and brittle. The segments of the frond are narrower, and more or less prolonged. Such forms almost invariably bear flabellately arranged, linear sori, and on the whole, present the distinctive characters of *N. harveyanum*. Between such an extreme variation as this and the typical *N. ruprechtianum*, however, there may be found every gradation in color, form of segments, and position and shape of sori, which are discussed more in detail under *N. ruprechtianum*. The form in question, however, usually retains enough of the distinctive color and venation of *N. ruprechtianum* to enable it to be recognized.

The writer is further indebted to Professor Setchell for a comparison made by him between specimens of *N. harveyanum* in the herbarium of Professor Farlow, and plants from this coast. The specimens in Professor Farlow's herbarium are from New Zealand, and are designated as *N. harveyanum* by Agardh. The resemblance in habit between these and plants collected by the writer at Fort Ross is very striking, both in the tetrasporic and cystocarpic plants. Judging from Agardh's description and from this comparison of specimens, there seems to be good reason for keeping this species under *N. harveyanum*.

Habitat.—*N. harveyanum* is found most frequently upon very much exposed rock surfaces which are bare or coated with Corallines, at extreme low tide-mark in the littoral and sublittoral zones.

Distribution.—Along the coast from Santa Cruz northward to Puget Sound. Apparently a northern form.

Localities.—Santa Cruz! (Dr. C. L. Anderson); San Francisco! (G. W. Lichtenthaler); Land's End, San Francisco! (W. A. Setchell; C. P. Nott); Duxbury Reef! (W. A. Setchell); Fort Ross! (C. P. Nott); Puget Sound! (Thomas Stratton).

Nitophyllum andersonianum *f. Ag.*

Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 474.¹

Nitophyllum (Neuroglossum) andersonii FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365; Report U. S. Fish Comm. for 1875, p. 696, 1876.

Neuroglossum andersonianum AGARDH, J. G., Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 474.

Nitophyllum andersonii HERVEY, A. B., Sea Mosses, 1881, p. 177.

Nitophyllum (Neuroglossum) andersonii ANDERSON, C. L., Zoe, Vol. II 1891, p. 224.

Nitophyllum andersonii HOWE, M. A., Erythea, Vol. I, 1893, p. 68. MCCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358.

Neuroglossum andersonianum AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 122.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, slender, linear, without rhizoids; branching irregularly, occasionally proliferating; without midrib, nerves, or veins. Margin beset at regular intervals with spine-like, sometimes recurved, pinnate teeth. Branches becoming erect at intervals, expanding into erect fronds.

Erect frond shortly stalked, linear, flat, simple below, branching above, with midrib; margin serrate, dentate, or beset with numerous spine-like, pinnate teeth. Branches subpinnately arranged, linear, or alternate at base and expanding at their apices, usually much prolonged. Stalk linear, flat, with definite midrib and thin margin, the margin sometimes disappearing and the median portion becoming thickened, almost cylindrical. Midrib of varying width, becoming prominent, in some cases thickened, almost cylindrical, branching and evanescent in upper portions of frond.

Sporangia in rounded sori, the latter usually large and conspicuous, at the apices of the upper, sometimes expanded, branches. Antheridia and cystocarps so far unobserved.

Remarks on the Species.—The color of *N. andersonianum* varies from bright red to dull carmine when alive, becoming a burnt carmine in the dried specimens. More often the plant has the darker hue mentioned above. The frond may attain a height of 20 cm.

The prostrate frond is commonly slender and much branched, showing much similarity to the corresponding portion of *N. latissimum*. It is destitute of midrib and nerves, and seldom becomes thickened or broadly linear. The erect frond branches freely, while its divisions exhibit considerable variation in width. In some plants they are very slender, linear, and much divided or branched. In

¹ This plant was here for the first time described. It had, in 1875, been mentioned by Farlow (cf. citations) under the name *Nitophyllum (Neuroglossum andersonii)* J. Ag. ms.

others the segments are quite broad and very regularly pinnately arranged. The cause of this variation apparently may be found in the environment. When exposed to violent wave action the fronds become extensively branched. In comparatively quiet waters, on the other hand, the expanded frond reaches its widest development. The predominant characteristic of *N. andersonianum* is the production, along the margin of both the prostrate and erect frond, of numerous pinnately arranged, spine-like, minute projections or teeth. The midrib, in its normal state, is the slightly thickened median portion of the frond, due to an increase in size of the cells of the central layer. Unless the frond is stimulated to further growth by injury, the midrib remains in this state, and, on reaching the upper branches of the frond, soon evanesces. Under the process of weathering, however, the margin becomes worn away. This seems to incite the cells of the median portion to renewed growth, with the result that the stalk and definite midrib become thickened and almost cylindrical. This species does not commonly proliferate.

The tetrasporangia are as yet the only reproductive structures observed. The antheridia and cystocarps have not, so far as can be learned, been seen in the species.

It seems to the writer desirable to allow this species to remain under *Nitophyllum* rather than to assign it to *Neuroglossum*. The habit, sori, and inner structure furnish evidence for thus placing it. Since it was first reported from this coast, doubt seems to have existed in the minds of writers as to whether it was a *Nitophyllum* or a *Neuroglossum*. The synopses already in existence of the genus *Neuroglossum* and of the present species do not at all permit a definite idea to be gained of the internal structure, and widely varying statements exist as to the position of the sori. But the careful study of an extensive range of specimens has served to establish the writer's belief that for the reasons above mentioned the species can be referred to *Nitophyllum* until a comparison can be made with type specimens.

Habitat.—On other algæ and on rocks covered with Porifera and Bryozoa at low tide-mark in the littoral and sublittoral regions.

Distribution.—*N. andersonianum* has now been observed along the coast from San Pedro northward to Carmel Bay. It has never been recorded elsewhere than from the coast of California.

Localities.—San Pedro! (Mrs. E. A. Lawrence); Santa Barbara! (Dr. L. N. Dimmick; Mrs. S. P. Cooper); shores of San Luis Obispo County! (Mrs. R. W. Summers); Carmel Bay! (C. P. Nott); Pacific Grove! (Mrs. J. M. Weeks; M. A. Howe); Santa Cruz! (Dr. C. L. Anderson, Mrs. Boardman).

Nitophyllum ruprechtianum J. Ag.

Bidrag till Florideernes Systematik. Lunds Universitets Årsskrift., Tome VIII, 1871, p. 51.

Nitophyllum ruprechtianum FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365; Report U. S. Fish Comm. for 1875, p. 696, 1876. AGARDH, J. G., Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 470.

Nitophyllum flabelligerum AGARDH, J. G., loc. cit., p. 699.

Nitophyllum ruprechtianum HERVEY, A. B., Sea Mosses, 1881, p. 178. ANDERSON, C. L., Zoe, Vol. II, 1891, p. 223. HOWE, M. A., Erythraea, Vol. I, 1893, p. 68. MCCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358. TILDEN, J. E., American Algæ, Century III, No. 213, 1898. AGARDH, J. G., Contin. Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 94.

Nitophyllum marginatum AGARDH, J. G., loc. cit., p. 93.

Nitophyllum farlowianum AGARDH, J. G., loc. cit., p. 95.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, flat, narrowly membranous, or linear; with rhizoids; frequently proliferating, lobed or branching; often provided with midrib and nerves; margin entire, cuneate, or lobed; frequently forming offshoots or innovations.

Erect frond stalked, with midrib, nerves, and veins; branching, very often proliferating; margin entire, cuneate, undulate, crispulate, lacinate or lobed, often beset with minute proliferations. Branching subdichotomous or subpalmate, with branches linear and often much prolonged, occasionally alternate below, becoming expanded and cuneate above, frequently divided or lobed. Stalk linear, flat, with definite midrib, very often becoming cylindrical through wearing away of margin and thickening of midrib, frequently twisted by wave action, often persistent and freely proliferating. Midrib

conspicuous, branching, sometimes divided into usually conspicuous flabellate nerves and veins, or unfrequently remaining undivided and evanescent; frequently weathered, thickened, persistent, and proliferating freely from sides and end. Nerves flabellate, free or anastomosing, often conspicuous, or inconspicuous and evanescent, sometimes dividing into minute veins. Proliferations produced very freely, on stalk, on margin of frond or on reduced frond, minute and rounded or large, linear, cuneate, frequently lobed or divided, with midrib and flabellate nerves, often bearing sori and cystocarps.

Sporangia in linear sori flabellately disposed about margin of frond, or in linear or irregular submarginal patches, or upon proliferations abundantly produced along margin of frond or upon its surface. Antheridia as yet unobserved. Cystocarps large, infrequent, projecting, irregularly disposed over both surfaces, or gathered together along the margin, or borne upon marginal or surface proliferations.

Remarks on the Species.—Considerable variation in color may be observed in *N. ruprechtianum*. The plants, when young, are often bright red, becoming dull red or carmine with increasing age. The proliferating fronds often exhibit this change in color. When dried, the plant becomes a deep carmine to blackish red. A length of 20–30 cm. is not uncommon, as the plant is vigorous in its growth. Frequently a large number of abundantly branched fronds develop from a single stalk. Good specimens often form masses 30 cm. in diameter and 30 cm. or more in height.

The prostrate frond in *N. ruprechtianum* is developed rather more extensively than in any other species of the coast. It is usually membranous in character, and may either be undifferentiated to any extent or occasionally be provided with midrib and nerves. Owing to the free development and frequent branching of the prostrate frond, there is formed on the substratum an extensive ramification whose outer ends, by the decay or accidental rupture of the older portions of the frond, become separated, and constitute the starting point for a new frond.

The predominant characters of *N. ruprechtianum* are displayed in the robust habit, the abundant proliferations, and the variety in the position of the cystocarps and sori, and the shape of the latter.

Proliferation takes place more abundantly in *N. ruprechtianum* than in any other of the Californian forms. The frond very commonly becomes worn away by the action of

the waves, and by friction upon other algæ and upon rocks. The portions thus reduced persist for a considerable time and give rise to numerous proliferations which exhibit all the characters of the original frond.

It seems strongly probable that the remarkable degree of variation in the shape and position of the sori in *N. ruprechtianum* has been a fruitful source of error to those who have been called upon to identify the forms belonging to this species. It is difficult, perhaps, without extensive examination of plants on the shore at all seasons, to realize what a diversity of form may be found within the specific limits. Especially is this diversity important in considering the sori, which are usually much employed in establishing specific distinctions.

The examination of abundant material of *N. ruprechtianum* has shown that the plants fall into three groups distinguished by the differences in the method of production of the sori, without regard to other features. In one group the sori are produced on the upper, flabellately expanded segments of the frond, and are arranged in rather wide linear sori, or lines, distinct or occasionally confluent, and extending in a more or less connected fashion from the median portion of the segment to the margin. A second group exhibits these linear sori usually confined, however, to the apices of the segments, while along the margin are produced numerous minute proliferations upon which are borne sori having the form of rounded patches. In a third group, the sori are confined to the marginal proliferations or to the similar proliferations appearing upon both the margin and the surface. While, in general, these variations in the position and shape of the sori are seen on different plants, yet it is of great importance in employing them as specific characters to keep in mind the fact that these three different dispositions of the sori are likewise found on one and the same plant.

A similar habit with respect to the production of sori is seen in *N. violaceum*, where, however, the linear sori are much narrower and the marginal ones are often widely

linear and extend in some cases a considerable distance along the margin. When compared with *N. harveyanum*, which also bears linear sori arranged likewise in flabellate fashion, it is seen that, while the resemblance in the production of the sori is strong, *N. harveyanum* possesses a darker purplish tint, is not so robust in habit, and is destitute of such a well developed system of venation as belongs to *N. ruprechtianum*.

The agreement between *N. ruprechtianum* and *N. violaceum* in the production of sori and venation is much more marked, yet the two can be distinguished by the characteristic violet hue and papery texture of *N. violaceum*, in contrast to the dull red color and leathery texture of *N. ruprechtianum*.

The same variety of position as is seen in the case of the sori may also be observed in the cystocarps. These structures may be borne by *N. ruprechtianum*, either upon the surface, when they are scattered at irregular intervals over the entire surface or form a border just within the margin, or they may be borne singly or several together on surface or marginal proliferations.

The existence of such numerous transition forms between the two extremes of surface and marginal production of the sori, a fact clearly established by a careful examination of material from a long extent of coast, points to the conclusion that within the limits of the species known as *N. ruprechtianum* it is possible to include a wide range of forms characterized by the features already pointed out, and that sufficient grounds do not exist for the establishment of several species among which these forms may be distributed.

The evidence afforded by these transition forms should, therefore, be employed in examining the species established by Agardh (1876, p. 699; 1898, pp. 93-96), viz., *N. flabelligerum*, *N. marginatum* and *N. farlowianum*, which, so far as the writer can determine from the descriptions, have been split off from *N. ruprechtianum*. The characterization of these three species is made to

depend upon differences in texture, branching, venation and sori. In the foregoing pages an attempt has been made to show the amount of variation possible in these characters, and to emphasize their relative value for specific purposes. The numerous collections made between widely distant limits along the coast at various points and at different seasons of the year, as well as all the available material at hand in herbaria, have failed to yield forms which could not be referred to *N. ruprechtianum* as defined in the foregoing account of the species.

A word with respect to the general shape and segmentation of the frond may be added in regard to the variation existing in *N. ruprechtianum*. Forms may be found that tend to become elongated, with much prolonged, narrow, and acute segments. Near to these may be placed forms likewise with the segments prolonged, but flabellately expanded, and with rounded apices. The tendency to expansion is seen to best advantage, finally, in plants that become divided into a few broadly wedge-shaped segments, with these in turn somewhat deeply lobed, with the lobes rounded as in the flabellate type.

Habitat.—*N. ruprechtianum* especially occurs on rocks usually covered with Corallines or Bryozoa and Porifera, among which the prostrate frond attains a rich development, in deep rock pools on gently sloping shores, littoral to sublittoral zones.

Distribution.—Along the coast from San Diego, California, northward to Port Orchard, Washington.

Localities.—San Diego! (D. Cleveland); Point Loma! (Miss Minnie Reed); La Holla! (Miss Minnie Reed); San Pedro! (Mrs. S. P. Monks); Santa Barbara! (Dr. and Mrs. L. M. Dimmick; Mrs. S. P. Cooper); shore of San Luis Obispo County! (Mrs. R. W. Summers); Port Harford! (W. A. Setchell); Avila Beach! (Miss Mabel Miles); San Simeon! (E. Palmer); Carmel Bay! (C. P. Nott); Pacific Grove! (M. A. Howe; Mrs. J. M. Weeks; C. P. Nott); Santa Cruz! (Mrs. Boston; C. L. Anderson; Mrs. J. M. Weeks); Duxbury Reef! (W. A. Setchell);

Dillon's Beach! (W. A. Setchell); Fort Ross! (W. A. Setchell; C. P. Nott); Port Orchard, Washington! (J. E. Tilden).

Nitophyllum violaceum *f. Ag.*

Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 700.

Nitophyllum laceratum HARVEY, W. H., Ner. Bor.-Amer., Vol. II, 1858, p. 104. FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. X, 1875, p. 365; Report U. S. Fish Comm. for 1875, p. 695, 1876.

Nitophyllum violaceum AGARDH, J. G., Epicrisis Floridearum, Contin. Spec. Gen. et Ord. Alg., 1876, p. 700. FARLOW, W. G., Proc. Amer. Acad. Arts and Sci., Vol. XII, 1877, p. 238. HERVEY, A. B., Sea Mosses, 1881, p. 180. ANDERSON, C. L., Zoe, Vol. II, 1891, p. 224. HOWE, M. A., Erythea, Vol. I, 1893, p. 68. McCLATCHIE, A. J., Proc. So. Cal. Acad. Sci., Vol. I, 1897, p. 358. NOTT, C. P., in Phyc. Bor.-Amer., COLLINS, F. S., HOLDEN, I., and SETCHELL, W. A., Fasc. VIII, No. 389, 1897. AGARDH, J. G., Contin., Spec. Gen. et Ord. Alg., Vol. III, Pt. 3, 1898, p. 91.

Nitophyllum stenoglossum AGARDH, J. G., loc. cit., p. 92.

Neuroglossum lobuliferum? AGARDH, J. G., loc. cit., p. 121.

Nitophyllum violaceum formum crispulum SETCHELL, Phyc. Bor.-Amer. COLLINS, F. S., HOLDEN, I., and SETCHELL, W. A., Fasc. XIV, No. 694, 1900.

Synopsis.—Frond both prostrate and erect. Prostrate frond creeping, broadly linear, or membranous, with rhizoids, branching, without midrib or nerves; margin toothed or laciniate.

Erect frond stalked, flat, linear, occasionally with midrib, with flabellate nerves; subdichotomously or subpalmately divided into numerous segments, in some cases finely laciniate, frequently proliferating; margin entire, finely serrate, crispate, or toothed; segments or branches in some cases broadly obcuneate, in other cases narrow, becoming broadly linear, much prolonged and flabellately expanded at apices or remaining linear. Stalk short, soon merging into the frond, usually without midrib, but with flabellate, sometimes anastomosing nerves extending into the branches; or long, somewhat narrow and thickened, almost cylindrical, and again merging into the flabellately nerved branches. Nerves not very conspicuous, usually extending throughout the frond from base nearly to apex, becoming divided into flabellate, frequently anastomosing veins, the latter soon evanescent.

Sporangia in narrow lines flabellately disposed, occasionally confluent, on upper segments of frond, or placed singly or in clusters along the margin, or upon marginal sporophylls, the latter appearing at intervals or in a dense fringe along the margin. Antheridia as yet unobserved. Cystocarps large, projecting, irregularly disposed over both surfaces, or submarginal, or upon marginal proliferations.

Remarks on the Species.—The color of *N. violaceum* varies from a pale violet through bright violet red to purple violet, in both the living and dried states. The plants attain

a height of 20–25 cm. Though not so robust in habit as *N. ruprechtianum*, still some specimens of *N. violaceum* are vigorous in their growth, branching freely and forming large, handsome plants. The plant is papery or parchment-like in texture, rather brittle when dried, and does not adhere well to paper.

N. violaceum, as before remarked, agrees with *N. ruprechtianum* in many morphological details, such as character of branching, general shape and position of sori, and venation; but it may be distinguished from that species by its different color and texture, and the minute differences in size and shape of the sori.

An extremely wide range of variation may be seen in the amount of dissection which the frond of *N. violaceum* undergoes. On the one hand, there is found a form in which the frond becomes divided from the base into a great number of slender, much prolonged branches, which divide again and again, until finally the apices of the ultimate branches are prolonged in a flabellate fashion sufficiently to show the specific characters of venation and color. On the other hand, there occur forms rather broadly membranous at base, that divide into a few broadly obcuneate segments cleft from the outer edge into narrower portions which are prolonged into lobes, again exhibiting the characters of the species. Between these extreme types may be found intermediate forms that in some cases vary toward the finely dissected frond, in others, toward the broadly membranous frond. Stunted and weathered plants also occur in considerable numbers in late winter and spring. The frond in these instances is occasionally thickened and rather fleshy, while the sori are gathered into clusters of marginal proliferations or remnants of the former margin. Proliferation takes place, though not to the same extent as in *N. ruprechtianum*. The proliferations are, as a rule, small, and of varying size. They usually bear sori.

In common with *N. ruprechtianum*, *N. violaceum* challenges attention by reason of the peculiarities of its sori, which exhibit again the same range of variation in regard

to their shape and position that was observed in *N. ruprechtianum*. There are to be found forms with the sori arranged in flabellate, occasionally confluent lines, differing, however, from *N. ruprechtianum* in the relative narrowness of the lines. Numerous transition forms occur which combine the flabellate linear sori with rounded or linear patches upon the margin. Finally, frequent instances may be found of plants bearing the sori as rounded or semicircular patches along the margin, or upon marginal proliferations.

The same conclusion that was reached in regard to the limits of the species in the case of *N. ruprechtianum* may be applied to *N. violaceum*, for here almost exactly similar conditions exist as to specific characters. The variations are in similar directions. Extended study of the forms from numerous localities has shown that they may be referred along the lines there laid down, which leads to the conclusion that *N. violaceum* is a species with limits sufficiently wide to include all the forms common to the coast.

The two species established by Agardh (1898, pp. 92 and 121), viz., *N. stenoglossum* and *Neuroglossum lobuliferum*, seem, therefore, to the writer, as nearly as can be determined from the descriptions, to be forms of *N. violaceum*.

Habitat.—On rocks covered with Corallines, Bryozoa and Porifera, in sheltered situations or in rock pools on gently sloping shores, and on piles of wharves, in the littoral and sublittoral zones.

Distribution.—Along the coast from San Pedro northward to Fort Ross.

Localities.—San Pedro! (Mrs. Lawrence; Mrs. S. C. Purdy); White's Point! (A. J. McClatchie); Santa Barbara! (Dr. L. N. Dimmick; Mrs. S. P. Cooper); San Simeon! (E. Palmer); Carmel Bay! (C. P. Nott); Pacific Grove! (M. A. Howe; C. P. Nott); Santa Cruz! (Dr. C. L. Anderson); Land's End, San Francisco! (C. P. Nott); Fort Point, San Francisco! (M. A. Howe; W. A. Setchell; C. P. Nott); North Beach, San Francisco! (W. A. Setchell; C. P. Nott); Golden Gate, San Francisco Bay (Berggren,

vide J. G. Agardh, *Epicrisis Floridearum*, 1876, p. 700); San Francisco! (G. W. Lichtenthaler); Lime Point, San Francisco Bay! (C. P. Nott); Duxbury Reef! (W. A. Setchell); Fort Ross! (C. P. Nott).

By way of summarizing some of the features mentioned in the foregoing account, the following table, showing the distribution of species within Californian limits, is incorporated. It will be seen that ten species occur on the coast. These have now been reported from twenty-eight localities, ranging from San Diego northward to Puget Sound, Washington, and points on Vancouver Island, B. C., embracing twenty degrees of latitude and fourteen hundred miles of coast line. It may be pointed out that there is here a coastal distribution equal to that of the Atlantic shores of Europe and the Mediterranean together.

In the light of the evidence collected from a wide range of material in field and herbarium, the ten species recognized may be considered valid until more extended comparison with European specimens proves their identity with previously described species.

TABLE OF DISTRIBUTION OF SPECIES.

(San Diego, Calif., northward to Esquimault Bay, B. C.)

	<i>N. andersonianum.</i>	<i>N. corollinarum.</i>	<i>N. friganum.</i>	<i>N. harveyanum.</i>	<i>N. latissimum.</i>	<i>N. multibum.</i>	<i>N. ruprechtianum.</i>	<i>N. spectabile.</i>	<i>N. uncinatum.</i>	<i>N. violaceum.</i>
San Diego.....		*						*		
Point Loma.....							*	*		
La Jolla.....							*	*		
San Pedro.....	*				*				*	*
White's Point.....							*			*
Santa Monica.....					*		*		*	*
Santa Barbara.....	*				*		*		*	*
San Luis Obispo County.	*					*	*		*	*
Port Harford.....						*	*		*	*
Avila Beach.....						*	*		*	*
San Simeon.....						*	*		*	*
Carmel Bay.....	*					*	*	*	*	*
Pacific Grove.....	*					*	*	*	*	*
Santa Cruz.....	*		*		*	*	*	*	*	*
Land's End.....			*	*	*	*	*	*	*	*
Fort Point.....				*	*	*	*	*	*	*
Golden Gate.....			*?	*	*	*	*	*	*	*
North Beach.....				*	*	*	*	*	*	*
San Francisco.....				*	*	*	*	*	*	*
Lime Point.....				*	*	*	*	*	*	*
Duxbury Reef.....				*	*	*	*	*	*	*
Dillon's Beach.....				*	*	*	*	*	*	*
Fort Ross.....				*	*	*	*	*	*	*
Cape Mendocino.....						*	*	*	*	*
Klatsop, Oregon.....					*	*	*	*	*	*
Port Orchard, Wash.....					*	*	*	*	*	*
Puget Sound, Wash.....				*	*	*	*	*	*	*
Esquimault Bay, B. C....					*	*	*	*	*	*

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UNIVERSITY OF CALIFORNIA,
BERKELEY,
June, 1900.

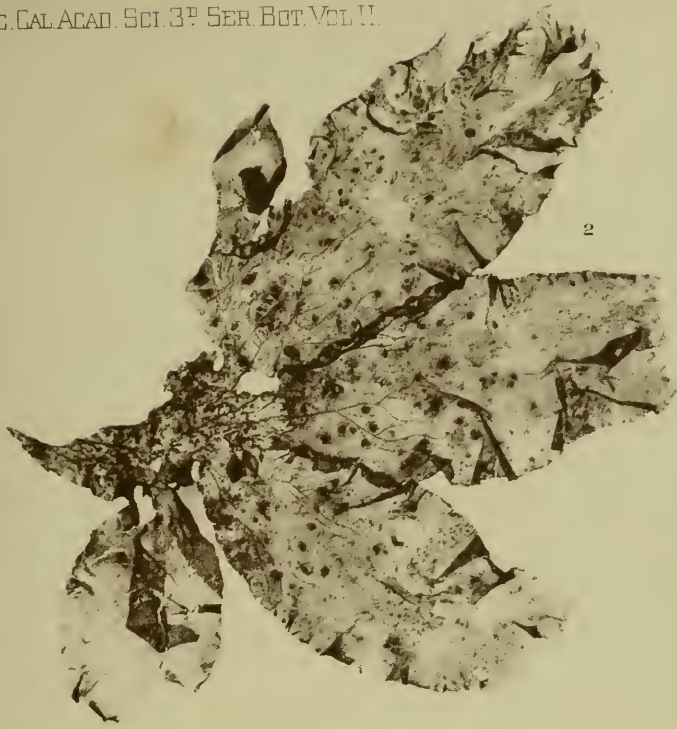
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EXPLANATION OF PLATE I.

Nitophyllum latissimum.

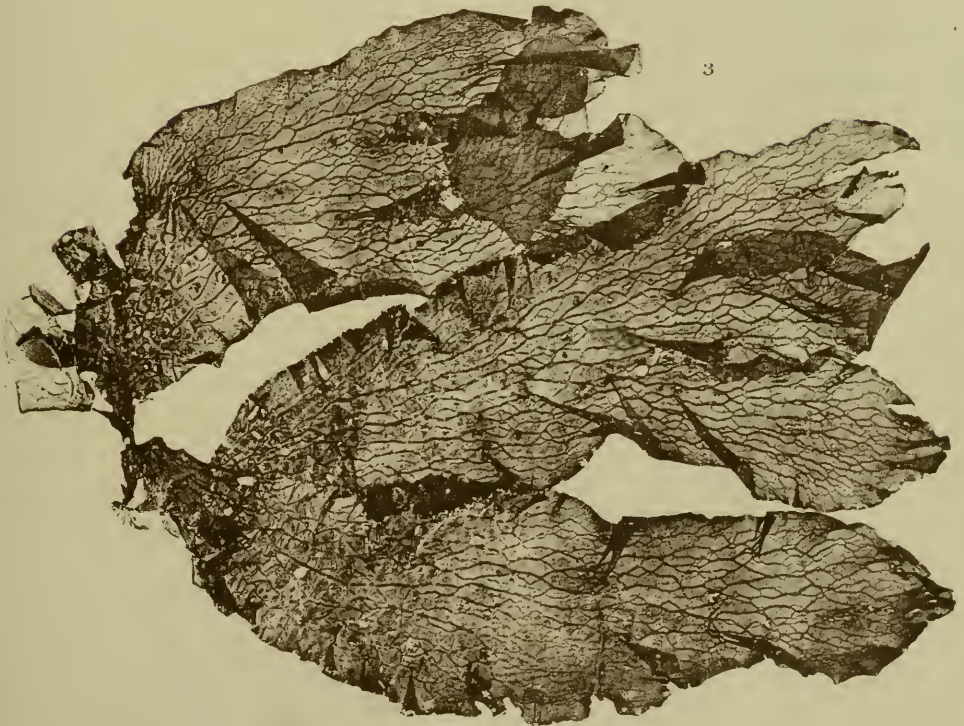
- Fig. 1. Tetrasporic plant of late spring, with broad, flat veins and large areoles. One-third natural size.
- Fig. 2. Cystocarpic plant, otherwise as in fig. 1. One-third natural size.
- Fig. 3. Antheridial plant, mature, showing in the lower third the characteristic wrinkled surface of the antheridial plant. One-third natural size.



2



1



3

EXPLANATION OF PLATE II.

Nitophyllum latissimum.

- Fig. 4. Typical cystocarpic plant, showing portion of prostrate frond, venation, proliferation, cystocarps, and a portion of the creeping, claw-like prostrate frond. One-third natural size.

Nitophyllum spectabile.

- Fig. 5. Typical tetrasporic plant, showing prostrate frond, young and mature erect fronds, and position and shape of sori. One-third natural size.



4



5

FIG. 4. NITOPHYLLUM LATISSIMUM.

FIG. 5. NITOPHYLLUM SPECTABILE

EXPLANATION OF PLATE III.

Nitophyllum frycanum.

- Fig. 6. Cystocarpic plant, showing disposition of cystocarps and segments of frond. One-third natural size.
- Fig. 7. Tetrasporic plant, showing palmate frond with much prolonged segments, arrangement of sori and delicate veins. One-third natural size.
- Fig. 8. Tetrasporic plant, showing venation and attenuate segments of frond. One-third natural size.
- Fig. 9. Cystocarpic plant, showing pinnately arranged segments of frond. One-third natural size.

Nitophyllum corallinarum.

- Fig. 10. Tetrasporic plant, showing frond creeping over branches of *Coralina chilensis*, and sori borne on free, erect fronds, *e. g.*, at *x* and *x'*. One-half natural size.

Nitophyllum multilobum.

- Fig. 11. Tetrasporic plant, showing habit and characteristic transverse sori. One-half natural size.

Nitophyllum uncinatum.

- Fig. 12. Sterile plant, showing character of branching and characteristic recurved apices of branches. One-half natural size.

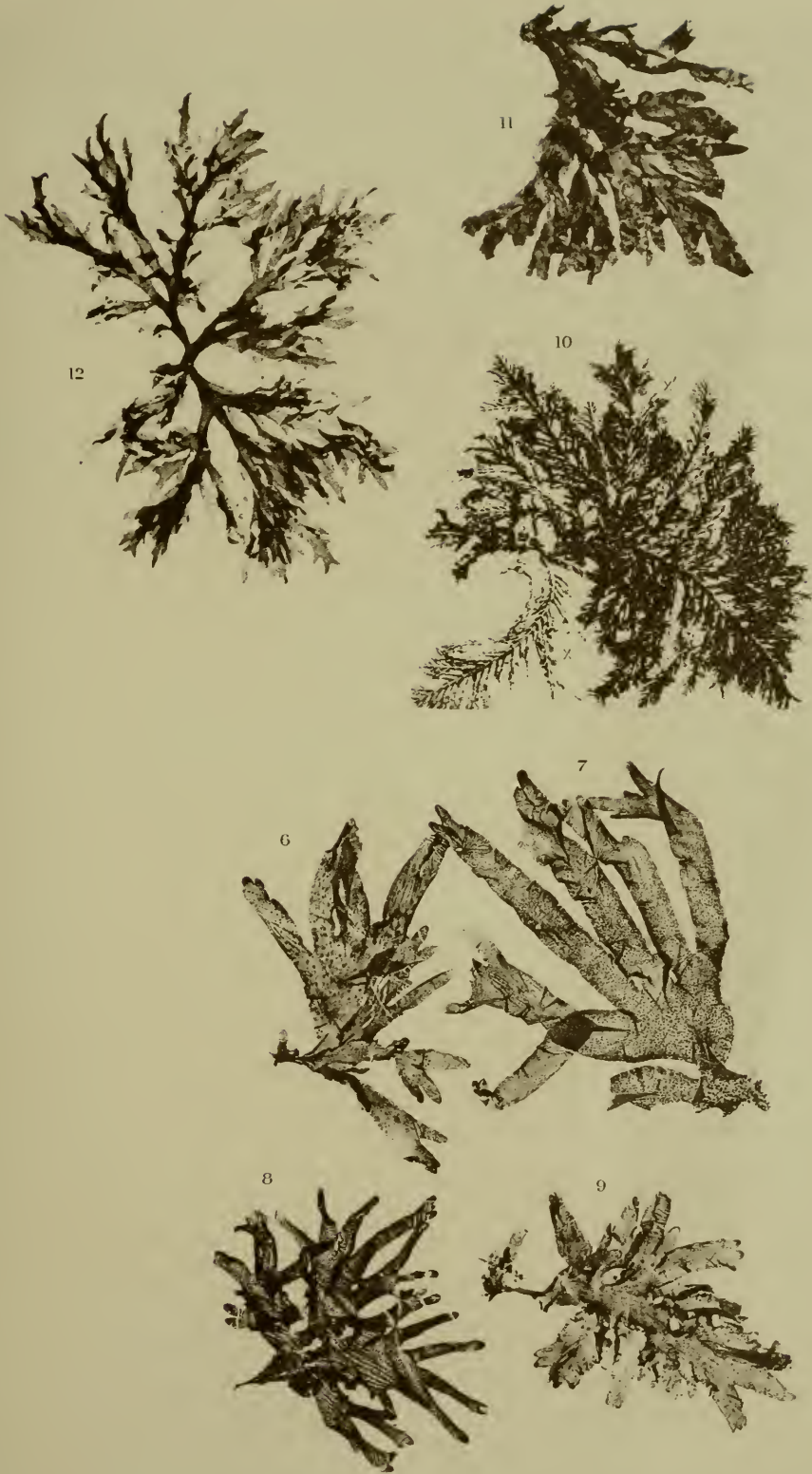


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FIGS 6-9. *NITOPHYLLUM FRYEANUM*.
FIG. 10. *NITOPHYLLUM CORALLINARUM*, SP. NOV.

FIG. 11. *NITOPHYLLUM MULTILOBUM*.
FIG. 12. *NITOPHYLLUM UNCINATUM*

EXPLANATION OF PLATE IV.

Nitophyllum harveyanum.

- Fig. 13. Slender form, tetrasporic, showing habit. One-half natural size.
Fig. 14. Robust form, showing linear sori and flabellately expanded habit.
One-half natural size.

Nitophyllum ruprechtianum.

- Fig. 15. Prostrate frond of the stout membranous type. One-half natural size.

Nitophyllum fryeanum.

- Fig. 16. Prostrate frond of the delicate membranous type, showing rhizoids as minute processes on surface. One-half natural size.

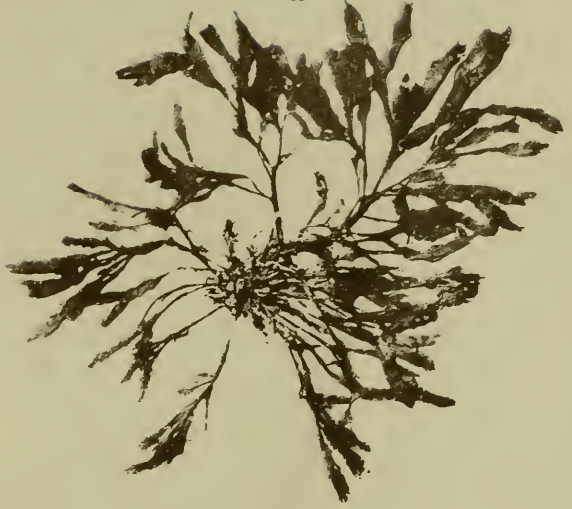
Nitophyllum andersonianum.

- Fig. 17. Prostrate frond, of the freely branching type, with portions of the bases of erect fronds. One-half natural size.

14



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16



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FIGS 13-14. NITOPHYLLUM HARVEYANUM.
FIG. 15. NITOPHYLLUM RUPRECHTIANUM

FIG. 16. NITOPHYLLUM FRYEANUM
FIG. 17. NITOPHYLLUM ANDERSONIANUM.

EXPLANATION OF PLATE V.

Nitophyllum andersonianum.

- Fig. 18. Robust form, sterile, showing usual character of branching, with branches flabellately expanded at apices. One-third natural size.
- Fig. 19. Broad membranous form of quiet waters, sterile. One-third natural size.
- Fig. 20. Slender form, sterile, showing fine dissection of frond. One-third natural size.
- Fig. 21. Transition form, tetrasporic, much branched, showing tendency to become membranous. One-third natural size.

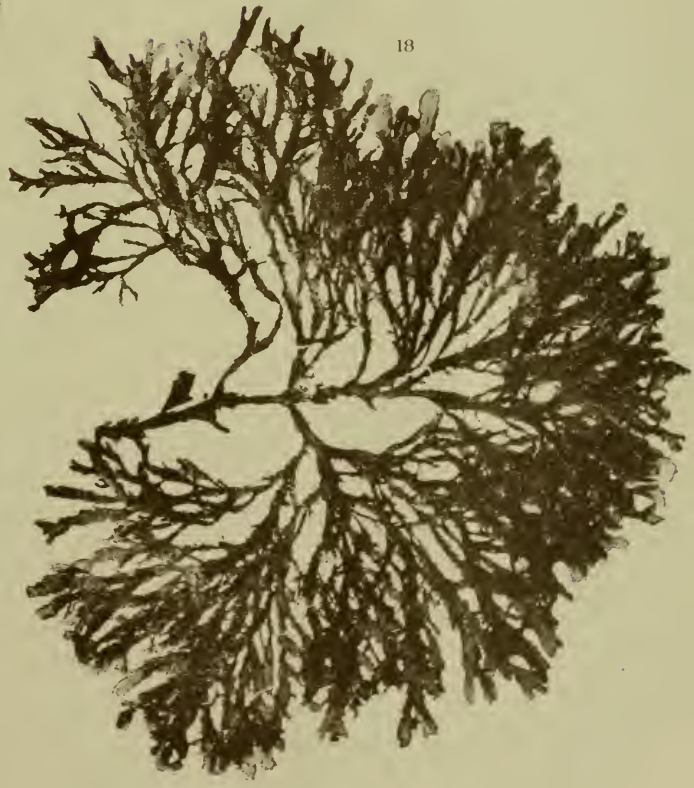
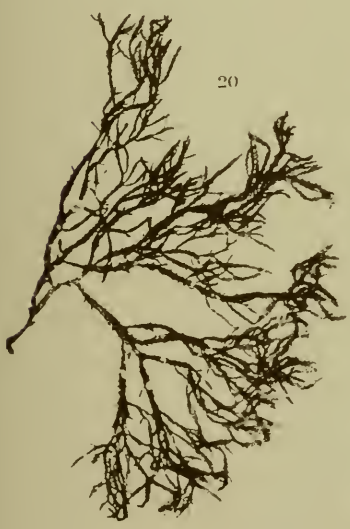


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NITOPHYLLUM ANDERSONIANUM

EXPLANATION OF PLATE VI.

Nitophyllum ruprechtianum.

- Fig. 22. Expanded, membranous frond, sterile. One-fifth natural size.
- Fig. 23. Examples of weathered and proliferating plants. One-fifth natural size.
- Fig. 24. Slender, much prolonged type, minutely proliferating along margin, sori on proliferations. One-fifth natural size.
- Fig. 25. Typical plant, showing stalk, branching, venation, and proliferations, with sori on proliferations. One-fifth natural size.



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NITOPHYLLUM RUPRECHTIANUM

EXPLANATION OF PLATE VII.

Nitophyllum ruprechtianum.

- Fig. 26. Typical plant, showing stalk, branching, venation, proliferations, and sori on proliferations. One-third natural size.
- Fig. 27. Portion of frond, showing flabellately disposed sori. One-third natural size.
- Fig. 28. Same, showing sori (linear) confined to apices of branches. One-third natural size.
- Fig. 29. Weathered frond, cystocarpic, with prostrate frond. One-third natural size.
- Fig. 30. Portion of frond, showing linear sori confined to ends of branches and rounded sori on marginal proliferations. One-third natural size.

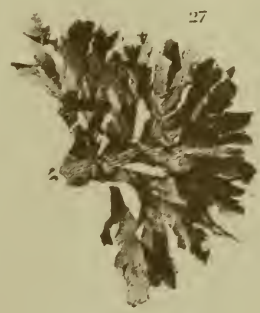


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EXPLANATION OF PLATE VIII.

Nitophyllum violaceum.

- Fig. 31. Intermediate form, showing segments of frond, with crispate margin and marginal sori. One-fifth natural size.
- Fig. 32. Typical form, showing slender, linear branches, marginal proliferations, and sori forming linear patches along margin or rounded patches on the proliferations. One-fifth natural size.
- Fig. 33. Intermediate form, with branches flabellately expanded at ends; sori as in preceding figure. One-fifth natural size.
- Fig. 34. Robust, membranous form, sterile. One-fifth natural size.
- Fig. 35. Reduced and weathered form, the conspicuous sori placed singly or together along the margin, or borne on proliferations. One-fifth natural size.
- Fig. 36. Weathered form, as in preceding figure. One-fifth natural size.
- Fig. 37. Finely dissected form. One-fifth natural size.



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NITOPHYLLUM VIOLACEUM

EXPLANATION OF PLATE IX.

Nitophyllum ruprechtianum.

- Fig. 38. Portion of tetrasporic plant, showing rather wide, linear, flabellately disposed sori. Four-fifths natural size.
- Fig. 39. Same, showing transition from linear, flabellate sori to rounded sori borne on marginal proliferations. Four-fifths natural size.
- Fig. 40. Same, showing sori borne only on marginal proliferations. Four-fifths natural size.

Nitophyllum violaceum.

- Fig. 41. Portion of tetrasporic plant, showing narrow, linear, flabellately disposed sori. Four-fifths natural size.
- Fig. 42. Same, showing transition from linear, flabellate sori to rounded, inframarginal sori. Four-fifths natural size.
- Fig. 43. Same, showing rounded inframarginal sori. Four-fifths natural size.

Nitophyllum latissimum.

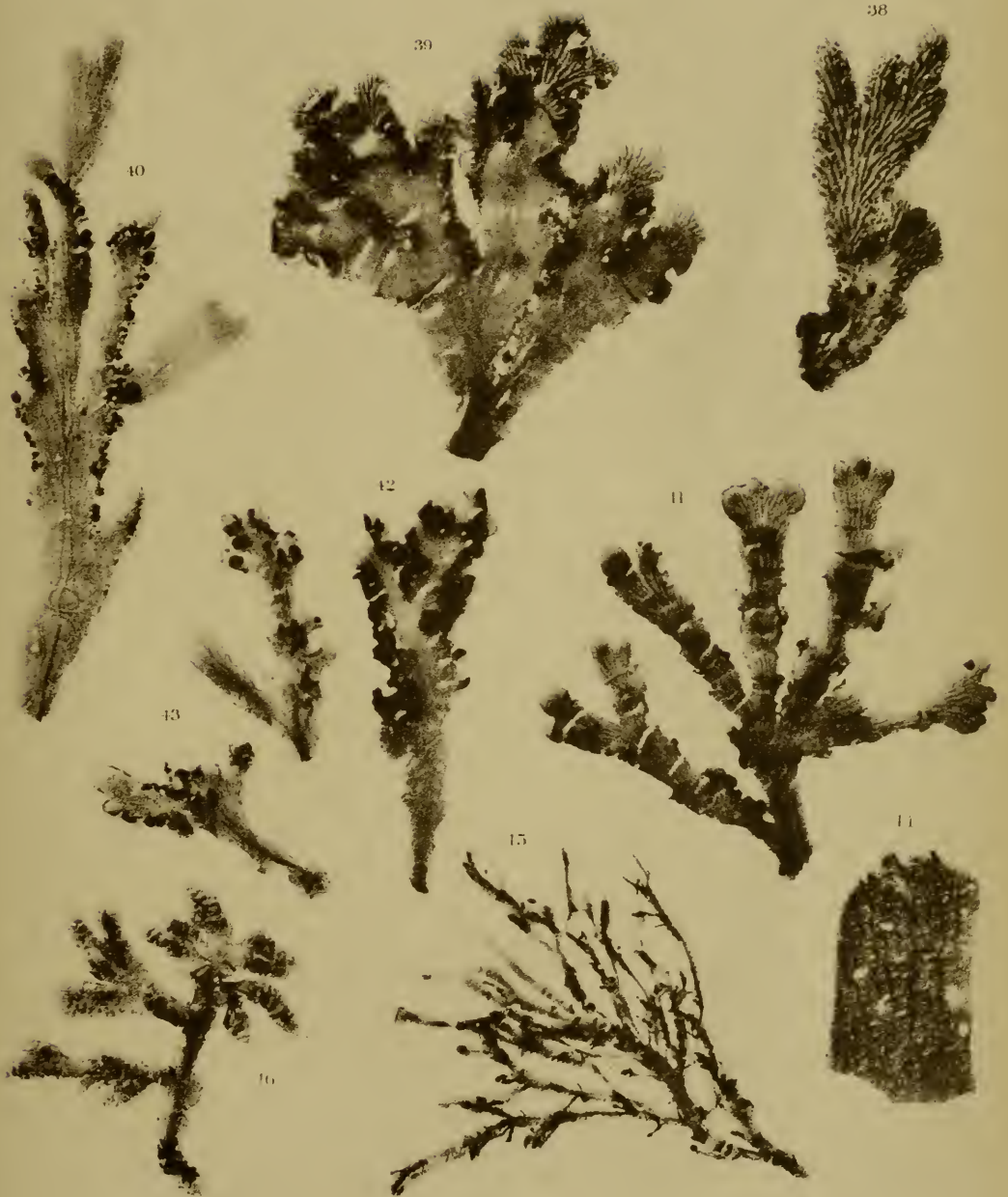
- Fig. 44. Detail of tetrasporic sori, showing venation, and areoles occupied by minute sori. Four-fifths natural size.

Nitophyllum andersonianum.

- Fig. 45. Portion of tetrasporic plant, showing sori as rounded or elliptical patches on distal segments of frond. Four-fifths natural size.

Nitophyllum multilobum.

- Fig. 46. Portion of plant, showing characteristic transverse sori. Four-fifths natural size.



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FIGS 38-40 NITOPHYLLUM RUPRECHTIANUM.

FIG 44 NITOPHYLLUM LATISSIMUM.

FIGS. 41-43. NITOPHYLLUM VIOLACEUM

FIG 45 NITOPHYLLUM ANDERSONIANUM

FIG 46. NITOPHYLLUM MULTICEBUM

